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Acceptability of Telerehabilitation for Magnification Devices for the Visually Impaired Using Various Approaches to Facilitate Accessibility

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Purpose: We examined different methods to reduce the burden of accessing technology for videoconferencing during telerehabilitation for magnification devices for the visually impaired.

Methods: During telerehabilitation studies over the past 5 years, vision rehabilitation providers assessed and gave training to visually impaired participants with newly dispensed magnification devices at home who connected to Zoom videoconferencing via loaner tablets or smartphones with assistance from (phase 1; $n = 10$) investigators by phone, (phase 2; $n = 11$) local Lions Club volunteers in participants' homes, or (phase 3; $n = 24$) remote access control software in a randomized controlled trial with 13 usual care controls who received in-office training. All participants completed the same post-telerehabilitation phone survey.

Results: A significantly greater proportion of phase 3 subjects indicated they strongly or mostly agreed that the technology did not interfere with the session (96%) compared to phase 1 (60%; 95% confidence interval [CI], 1.2–12.5; $P = 0.03$) or phase 2 (55%; 95% CI, 1.8–188; $P = 0.01$). The majority indicated telerehabilitation was as accurate as in person (68%), they were comfortable with telerehabilitation (91%) and interested in a future session (83%), and their magnifier use improved (79%), with no significant differences in these responses between phases (all $P > 0.10$), including comparisons of participants randomized to telerehabilitation or in-office training in phase 3 who reported similar overall satisfaction levels ($P = 0.84$).

Conclusions: Participants across all phases reported high levels of acceptance for telerehabilitation, with least interference from technology using remote access control in phase 3.

Translational Relevance: With accommodations for accessibility to videoconferencing technology, telerehabilitation for magnification devices can be a feasible, acceptable, and valuable option in countries with resources to support the technology.

translational vision science & technology

Introduction

At the beginning of the COVID-19 pandemic, utilization of ophthalmologic telemedicine services reflected several disparities.[1] Specifically, older adults,[2–4] minorities,[2,4] non-English-speaking individuals,[2] or those with lower income[3] were less likely to have a video visit. Blind and visually impaired participants were significantly less likely to have heard of telehealth or virtual care.[5] Even when informed of telehealth services, visually impaired individuals may experience barriers and insufficient accessibility due to their lack of experience with technology such as videoconferencing. Because the prevalence of visual impairment increases with age, this may further exacerbate the digital divide, which refers to disparities related to access to resources of information technology.[6] A case-control study using 2013 to 2018 US National Health Interview Survey (NHIS) national survey data of adults aged 65+ revealed that those with visual impairment were significantly less likely to use the Internet and were more socioeconomically disadvantaged than normally sighted seniors.[7] Providing accommodations and assistance with accessibility to telemedicine technology is an important initiative to overcome disparities.

Synchronous telehealth services for visual impairment (i.e., telerehabilitation) occurs between a vision rehabilitation provider in office and a visually impaired patient at home to facilitate assessment and training for visual aids. This approach has the potential to overcome several barriers encountered by visually impaired individuals for vision rehabilitation services traditionally rendered in office.[8–11] However, visual impairment can pose accessibility challenges for patients who need to remotely connect to videoconferencing services. As an example, at the start of the COVID-19 pandemic, visually impaired patients who were initially scheduled at the VA Western New York Healthcare System in Buffalo, New York, were subsequently rescheduled for a home-based telerehabilitation evaluation and therapy assessment.[12] However, nearly half (46%) did not have video access and had to delay a future in-person vision rehabilitation visit.[12] Although we found that the vast majority of visually impaired patients seen for vision rehabilitation services in our clinic have a smartphone,[13] their use may be limited to basic calls or texts. In phase 1 of our telerehabilitation study reported here (i.e., the initial pilot study), the majority of the visually impaired participants had no prior videoconferencing experience.[14] Our study team experienced difficulty when attempting to connect some participants to Zoom videoconferencing using only phone assistance from a remotely located member of the study team.[14] Thus, it became evident that a more effective approach was needed. Hence, our recent research explored novel methods to connect visually impaired participants to telerehabilitation sessions to address this challenge.

Telerehabilitation offers the potential to provide valuable training in the use of various magnification devices or visual aids. Our studies have focused on traditional magnification devices, such as handheld or stand optical magnifiers, and portable electronic video magnifiers. The research we report here was conducted over the past 7 years, in which we implemented three different approaches to improve the accessibility of telerehabilitation services for those with visual impairment. We evaluated participants' satisfaction with the sessions through prospective cohort studies and a randomized controlled trial (RCT) comparing telerehabilitation service with usual in-office vision rehabilitation care. The goal of this work was to provide a greater evidence basis for the acceptability of telerehabilitation for individuals with visual impairment as a modality of care delivery.

Methods

Studies involving telerehabilitation were conducted in three phases spanning a 7-year period during the years of 2016–2022: phase 1 in 2016–2017, phase 2 in 2018–2019, and phase 3 in 2020–2022. Phase 1 (pilot) was a prospective cohort pilot study that connected participants in their homes to the telerehabilitation videoconference session via guidance from the principal investigator by phone,[12] phase 2 (Lions) incorporated assistance from community Lions Club members who set up the telerehabilitation sessions in participants' homes, and phase 3 (RCT) was a randomized controlled trial in which participants were randomized to two groups utilizing a 2:1 allocation ratio to evaluate telerehabilitation services in the home versus in-office vision rehabilitation as the usual care control group. Participants in all three phases were adults aged 18+ years who had newly received portable electronic video, handheld, or stand optical magnifiers; multiple devices were allowed. Each participant was involved in only a single phase and did not participate in more than one of our studies of telerehabilitation. Thus, each participant represents an unique telerehabilitation encounter. Phase 1 (pilot) included 10 participants;[12] phase 2 (Lions) included 11 subjects, with 9 participants in a prospective cohort study and 2 participants from the RCT; and phase 3 (RCT) compared

24 participants in the telerehabilitation group to 13 usual-care control group participants who received magnifier training in office (without telerehabilitation). All causes of visual impairment were included in all phases. Exclusion criteria for all three phases were medical or self-reported history of cognitive impairment, non-English speaking, or no access to a home telephone. Participants with mild to moderate hearing impairment were included in the study, while those who were unable to consistently hear the clinical provider during the initial in-office dispense for the magnifier due to severe hearing loss were not recruited. Phase 3 (RCT) further defined exclusion for cognitive impairment as a raw score of less than 20 on the Telephone Interview for Cognitive Impairment,[15] which was administered at time of study enrollment. Participants in all three phases had an in-office vision rehabilitation assessment before study enrollment and received a new magnifier prescribed by the vision rehabilitation provider, at which time they all received initial in-office training with the new magnifier. Prescriptions to obtain or update the participants' distance and/or near spectacle correction were also issued at the initial office visit when appropriate. Best-corrected visual acuities (BCVAs) were measured at distance with either an Early Treatment of Diabetic Retinopathy Study (ETDRS) chart or Snellen chart (then converted to logMAR values) and at near with a continuous text reading card or the MNread test.[16]

Across all study phases, participants were recruited from vision rehabilitation clinical practices, which included both academic institutions and private practices. Phase 1 included four recruiting sites: (1) New England College of Optometry (NECO) in Boston, Massachusetts; (2) University of Nebraska Medical Center (UNMC) in Omaha, Nebraska; (3) Alphapointe in Kansas City, Missouri; and (4) Southern California College of Optometry (SCCO) in Fullerton, California. Phase 2 included participants from two sites: (1) Nova Southeastern University, College of Optometry (NSUCO) in Ft. Lauderdale, Florida, and (2) Mid-Michigan Eye Care, a private practice in Midland, Michigan. Phase 3 included eight sites: (1) NECO; (2) UNMC; (3) SCCO; (4) Mid-Michigan Eye Care; (5) Low Vision Services in Alexandria, Virginia; (6) Frank Stein & Paul S. May Center for Low Vision Rehabilitation in San Francisco, California; (7) Boston University Eye Associates in Brockton, Massachusetts; and (8) University of California, Los Angeles (UCLA), Stein Eye Institute. The providers for the vision rehabilitation training were optometrists at seven sites and three occupational therapists at UNMC, Alphapointe, and the San Francisco site.

For phases 1 and 2, the study protocol was approved by the institutional review boards at Nova Southeastern University and NECO. For phases 2 and 3, the study protocol was approved by the institutional review board at UCLA. All study protocols followed the tenets of the Declaration of Helsinki. All participants provided oral informed consent by phone during all phases. The study protocol was listed on clinicaltrials.gov (Identifier: NCT04066075).

For telerehabilitation during all three phases, a kit with loaner equipment was provided at the time of the session or shipped in advance of the telerehabilitation session. Participants used the loaner devices to access the session, rather than their own Internet-enabled device. Table 1 lists the loaner equipment used in each phase, which varied across phases for the type of Internet-enabled device; that is, phase 1 provided a Verizon MiFi 4G LTE mobile hotspot (model 6620 L Jetpack; Verizon Wireless, New York, NY, USA) with tablets (9.7-in. Onda V919 [Onda Electronics, Guangzhou, China] and/or 7-in. Vido T99 [Vido Digital Electronics Co. Ltd., Shenzhen, China] with Android operating system) and/or iPad mini (Apple Corporation, Cupertino, CA, USA), while phase 2 used a Verizon data-enabled iPad mini or Samsung Galaxy S6 smartphone, and phase 3 used

Table 1. Accommodations via Loaner Equipment and Assistance for Initiating the Telerehabilitation Videoconference Session That Were Utilized in Each Phase

Phase	Years	Loaner Equipment	Assistance
1 Pilot	2016–2017	Android tablets and iPad mini with MiFi	PI phone call and printed instructions with images
2 Lions	2018–2019	Verizon data-enabled Samsung Galaxy S6 smartphone or iPad mini	Lions Club volunteers with kit to set up in subjects' homes
3 RCT	2020–2022	Verizon data-enabled Samsung Galaxy S6 smartphone	Remote control access software (RescueAssist by LogMeIn, Inc.)

PI, principal investigator.

only a Verizon cellular data–enabled Samsung Galaxy S6 smartphone. An external speaker was utilized for some of the phase 1 participants but not in phase 2 or 3. All three study phases included the same stand for the tablet or smartphone and the same standardized near acuity cards (i.e., MNread charts and Lighthouse continuous text) to assess participants' reading with their magnifier. Photocopies of the near cards were provided in sealed envelopes with instruction to open only during the session. We used videoconference services from Zoom.us for all three study phases.

Table 1 lists the type of assistance for accessing the Zoom videoconference platform, which also varied across the study phases. For phase 1 (pilot), the study principal investigator (AKB) contacted the participant and/or a normally sighted companion by phone about an hour before the scheduled telerehabilitation session time, to guide them through the setup process and help with any issues related to accessing the Zoom videoconference portal. Additionally in phase 1, the loaner kit included a hard-copy, large-print manual with a step-by-step list of instructions and photos of how to connect to the session. In phase 1, 70% of participants were assisted by normally sighted family members or acquaintances. Due to challenges that participants experienced with technology in phase 1,[14] we subsequently recruited local Lions Club members for phase 2. They were trained to bring the loaner equipment to the participant's home and set up the session to reduce the burden of the technology for visually impaired participants. Phase 3 (RCT) required changes to this protocol due to the COVID-19 pandemic when we were unable to have Lions volunteers in participants' homes. Thus, phase 3 involved the use of remote access control software (RescueAssist by LogMeIn, Inc., Boston, MA, USA) on our loaner smartphones that enabled the study principal investigator (AKB) to remotely connect the participant to the Zoom videoconferencing session after confirming by phone that they were ready. Phase 3 participants only needed to turn on the loaner smartphone and place it in the loaner stand during the session. Phases 2 and 3 did not require normally sighted family members or acquaintances to be involved in the setup of the telerehabilitation sessions.

Across all phases, after the initial in-office training with the new magnifier at the time of its dispense, participants used it at home and during daily activities for at least a month before telerehabilitation or the in-office visit for additional training was scheduled. Participants were eligible for telerehabilitation or additional in-office training session 1 to 4 months after the magnifier was dispensed; most participants received this additional training 1 to 2 months after they obtained the magnifier. A standard protocol for the interaction between the vision rehabilitation provider and the participant during the telerehabilitation encounter was utilized consistently across all three study phases for the training sessions with magnifiers. Telerehabilitation sessions took place in participants' homes with the provider in office and typically lasted about an hour. The duration of the session was consistent across all study phases, and a second or third session was scheduled after the hourlong session in phase 3 (RCT) if needed, based on the participant's needs. We asked all participants to set up the loaner equipment in the place where they do most of their reading with their magnifier in their home. The provider evaluated the participant's technique with their magnifier (i.e., working distance, viewing angle, lighting) and their reading fluency (i.e., speed, accuracy, and print size) while using the Lighthouse continuous text card and MNRead test, followed by their own reading materials of interest. Individualized magnifier training was provided to each participant, based on their needs with the device. Generally, the training strategy involved verbal instructions from the provider to make any necessary adjustments to the placement of the magnifier and/or reading material, including feedback on the working distance, viewing angle, movement of the magnifier, and/or level of zoom (i.e., for portable electronic devices) to obtain the best magnification and field of view while reading continuous text. If relevant, the providers asked participants to demonstrate how to change the battery in the magnifier. For phase 3 (RCT), 13 participants in the usual-care control group received training in office with their provider, instead of telerehabilitation for new portable electronic video, handheld, or stand optical magnifiers. For the in-office sessions, the providers administered the same standardized reading tests and gave training to optimize magnifier usage, as in the telerehabilitation protocol.

Participants in all three study phases completed the same satisfaction survey to give feedback on the telerehabilitation session using multiple-choice rating scales. The survey questions are included as Supplementary Material. Participants in the RCT who were in the in-office usual-care group completed the satisfaction survey items that were relevant to the training they received. During phase 3 (RCT), we inquired about whether participants had hearing loss or nonvisual physical disability during the survey. All surveys were administered to participants by research assistants at NSUCO (phases 1 and 2) or UCLA (phases 2 and 3) who called the participant by phone within 1 week following the telerehabilitation or in-office

session. Each participant had only one telerehabilitation session in phase 1 (pilot) and phase 2 (Lions), while up to three sessions were scheduled within a 3-month period in phase 3 (RCT) (mean of 1.8 sessions across participants). We only included the survey responses for the initial session in phase 3 for comparison to phases 1 and 2.

Data Analyses

Descriptive statistics were used to summarize the study data and findings. Pearson chi-square tests were used to evaluate for differences between phases or the randomized groups in phase 3 for dichotomous variables for participants' demographics or characteristics. Simple linear regressions were used to evaluate patient demographics or characteristics that were continuous variables (i.e., age or travel time) to assess whether there were any differences between phases or the randomized groups in phase 3. We used a Box Cox transformation for continuous variables that were nonnormally distributed as per Shapiro–Wilk analysis (i.e., visual acuity measures and optical magnifier powers) in order to perform analyses with simple linear regressions to determine if there were any significant relationships between study phases or randomized groups. Logistic regressions or Pearson chi-square tests were used to evaluate whether there were differences in participants' survey responses between any two phases or randomized groups. Data were analyzed using Stata/IC version 15.1 (Stata Corp., College Station, TX, USA).

Results

Participants' Characteristics

The demographics and characteristics for the participants in each study phase and randomized group are listed in Table 2. Most participants were older adults (i.e., over age 70) with a wide range of education. Their self-rated vision ranged from good to poor, and none of the participants rated their vision as excellent or very good. The mean amount of travel time to their vision rehabilitation provider's office was 35 minutes, with a range of 5 to 165 minutes across all participants. On average, 25% of the study participants reported they never accessed the Internet anywhere in the past 6 months, and 58% of the study participants had never used videoconferencing before the study.

Across all study phases and randomized groups, there were no statistically significant differences for the participants' demographics or characteristics in Table 2 when comparing between any two phases or the randomized groups in phase 3 (all $P > 0.05$), with the exception of significant differences between phases 1 and 2 for the number of minorities ($P = 0.03$) and travel time (mean difference 25 minutes; 95% confidence interval [CI], 0.8–49; $P = 0.04$), as well as a significant difference in age between telerehabilitation participants in phases 1 and 3 (mean difference 14 years; 95% CI, 3.7–23.4; $P = 0.009$), since phase 3 included a few younger adults. Notably, there were no statistically significant differences for the variables in Table 2 when comparing phase 3 (RCT) participants who had telerehabilitation versus in-office training (all $P > 0.30$).

Participants' Ratings of the Training Session

Figure displays the participants' ratings for the additional training sessions. Among those who received a new optical or portable electronic video magnifier, a significantly greater proportion of phase 3 (RCT) subjects indicated they strongly or mostly agreed that the technology for the videoconferencing did not interfere with the session (96%) than in phase 1 (pilot) (60%; odds ratio [OR], 3.8; 95% CI, 1.2–12.5; $P = 0.03$) or phase 2 (Lions) (55%; OR, 18; 95% CI,1.8–188; $P = 0.01$). Across all study phases and randomized groups, the majority of participants agreed strongly

Table 2. Participants' Demographics and Characteristics Across Study Phases and Randomized Groups

Phase/Group	Subjects, *n*	Age, y	Male, %	% Race Minority	Travel, min	% Self-Rated Vision as Poor	% Not a College Graduate	% Prior Video Conference	% Never Use Internet
1 Pilot	10	80 (9; 63–91)	40	0	50 (33; 15–120)	30	60	20	30
2 Lions	11	72 (11; 47–95)	45	36	25 (16; 5–60)	27	55	36	20
3 RCT telerehabilitation	24	67 (20; 20–93)	25	25	31 (22; 9–90)	25	75	54	25
3 RCT in office	13	73 (19; 25–91)	31	17	41 (45; 5–165)	17	62	—	—
All phases/groups	58	71 (17; 20–95)	33	21	35 (30; 5–165)	25	66	42	25

Mean (SD; range) values are provided for age and travel time to in-office visits with the vision rehabilitation provider. Missing data in the table (—) for the in-office training were not collected as part of the survey. Race Minority = black or Hispanic.

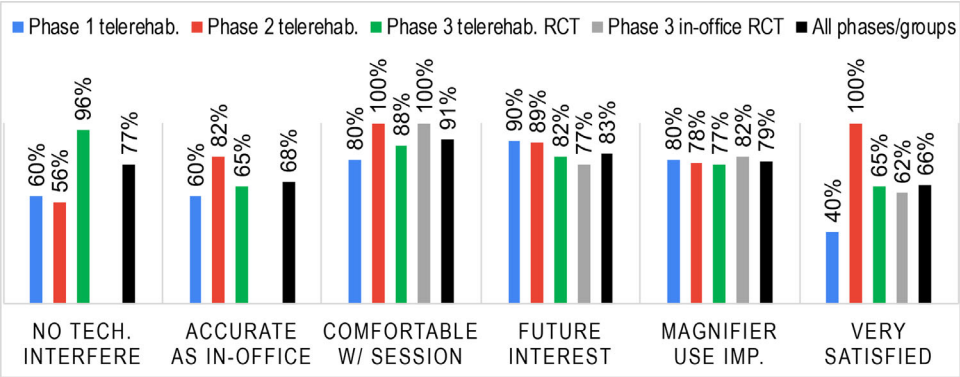

Figure. Bar graph displaying the proportion of participants whose survey responses indicated they strongly or mostly agreed that the technology did not interfere with the session (i.e., no tech. interfere), telerehabilitation was as accurate as in-office training (i.e., accurate as in-office), they were comfortable with the evaluation and training (i.e., comfortable w/session), they were interested in a future session (i.e., future interest), they perceived that their magnifier use improved following the training session (i.e., magnifier use imp.), or they were very satisfied with the session (i.e., very satisfied) across study phases and randomized groups.

Table 3. Participants' Mean (SD; Range) Visual Function Recorded in Office and Their Magnification Devices for Which Training Was Provided in Each Phase or Randomized Group

Phase/Group	Distance BCVA (logMAR)	Near BCVA (M-notation)	Near VA (M) With Magnifier	Magnifier Power (D)	PEVM, %	SM, %	HHM, %
1 Pilot	0.56 (0.3; 0.17–1)	2.0M (1.7; 0.6–6.3)	0.75M (0.36; 0.2–1.3)	12D (6; 6–24)	40	40	50
2 Lions	—	—	—	—	9	27	64
3 RCT telerehabilitation	0.61 (0.3; 0.18–1.5)	2.2M (1.8; 0.63–7)	0.71M (0.44; 0.4–2)	10D (4; 6–20)	21	21	67
3 RCT in office	0.56 (0.3; 0.18–1)	1.2M (0.7; 0.5–2.5)	0.55M (0.13; 0.4–0.8)	11D (3; 8–16)	8	31	85
All phases/groups	0.59 (0.3; 0.17–1.5)	1.9M (1.6; 0.5–7)	0.68M (0.4; 0.2–2)	11D (4; 6–24)	19	28	68

Data from in-office vision tests were not collected in phase 2. D, dioptic power of optical magnifiers; HHM, handheld optical magnifier; PEVM, portable electronic video magnifier; SM, stand magnifier; VA, visual acuity in M-notation at near.

or mostly that telerehabilitation was as accurate as in-person (68%), agreed strongly or mostly that they were comfortable with additional evaluation and training via telerehabilitation (phases 1–3) or in office (phase 3 RCT) (91%), were somewhat to very interested to receive training again in the future via the same modality (83%), and indicated they had an improvement in magnifier use after the session (78%), with no significant differences in these responses between any two phases or randomized groups (all $P > 0.10$). Phase 1 (pilot) had the smallest proportion of telerehabilitation participants who were very satisfied overall (40%), which was significantly different from all of the phase 2 (Lions) participants, who were very satisfied ($P = 0.003$). In phase 3 (RCT), participants randomized to telerehabilitation versus in-office training were not significantly different in the rating for being very satisfied overall with the session ($P = 0.84$). None of the participants in any phase or randomized group reported that they were not satisfied with the telerehabilitation session.

For the between-group or between-phase comparisons of the findings in Figure, we ran additional analyses to account for the variables for participants' demographics and characteristics (Table 2) that were significantly different between study phases or randomized groups (i.e., minorities and travel time between phases 1 and 2; age between phases 1 and 3). All of the comparisons of survey responses between study phases or randomized groups remained nonsignificantly different after accounting for these variables in Table 2 that differed significantly between phases or groups (all $P > 0.10$).

Tables 3 and 4 display the participants' visual acuities recorded at the initial in-office visit and information about their new magnification devices. There were no significant differences between any two phases or groups when comparing these variables in Table 3 for the participants' visual function measures and magnifier characteristics (all $P > 0.05$). After accounting for BCVA at near without the magnifier, there were no changes in the nonsignificant odds ratios for phase 3 telerehabilitation versus in-office participants, who were somewhat to very interested to receive future training via the same modality, self-reported improvement in magnifier use after the session, and overall

Table 4. Number and Proportion of Participants in Each Phase According to Vision Categories

Distance BCVA	Phase 1 Pilot, *n* (%)	Phase 3 RCT Telerehabilitation, *n* (%)	Phase 3 RCT in Office, *n* (%)
Better than 20/40	2 (20)	2 (9)	2 (15)
Mild 20/40–20/60	3 (20)	8 (36)	5 (39)
Moderate 20/61–20/199	4 (40)	9 (41)	3 (23)
Severe 20/200–20/400	1 (10)	2 (9)	3 (23)
Worse than 20/400	0 (0)	1 (5)	0 (0)
Near BCVA without magnifier			
0–0.8M	3 (30)	3 (13)	5 (38.5)
1.0–3.2M	6 (60)	17 (74)	8 (61.5)
Worse than 3.2M	1 (10)	3 (13)	0 (0)

Data from in-office vision tests were not collected in phase 2.

indicated they were very satisfied with the training session (all $P > 0.20$).

About a third of the RCT participants in phase 3 (i.e., 37.5% in the telerehabilitation group and 31% of usual-care in-office controls) self-reported mild or moderate hearing loss, which was not significantly associated with any of the satisfaction survey ratings or self-reported improvement in the magnifier use in either randomized group (all $P > 0.15$). Telerehabilitation was successfully completed for all participants with hearing loss using the audio from the study loaner smartphone, except for one case in which the participant and the provider used their own phones on speaker mode for the audio component while using the Zoom video on the study loaner smartphone. About a third of the RCT participants in phase 3 (i.e., 33% in the telerehabilitation group and 31% of usual-care in-office controls) self-reported having any nonvisual physical disability that limits ability to perform everyday activities, including use of a computer or smartphone; this factor was not significantly associated with any of the satisfaction survey ratings or self-reported improvement in the use of the magnifier in either randomized group (all $P > 0.05$). In fact, all of the participants who reported a nonvisual physical disability indicated that their magnifier use improved following telerehabilitation ($P = 0.054$).

Finally, we pooled survey responses across telerehabilitation participants in all three phases, in order to examine if any factors were related to self-reported improvement with the magnifier after the session. All of the participants with a portable electronic video magnifier indicated that their use of it improved after telerehabilitation, as opposed to 70% of participants who reported improvement with handheld or stand optical magnifiers ($P = 0.07$). All participants who stated they never accessed the Internet from anywhere over the past 6 months reported that their magnifier use improved following telerehabilitation ($P = 0.049$) versus 70% who reported magnifier improvement among those who previously accessed the Internet. Participants who were very satisfied with telerehabilitation tended to agree strongly or mostly that it was as accurate as in person ($P = 0.015$).

Discussion

Our multiphase data collectively support the high levels of acceptability by visually impaired individuals for using telerehabilitation for remote training with optical or electronic magnifiers. In phase 3 (RCT), a comparison of the ratings for telerehabilitation versus in-office training revealed there were no significant differences for subjects' comfort level, overall satisfaction, self-rated improvement in magnifier use after the session, or interest to have another session in the future. This supports that visually impaired participants were similarly satisfied with their experience and outcomes with either modality of service delivery. This work provides evidence that a newer but still underutilized method for visual aid training (i.e., telerehabilitation) is a feasible, desirable option to provide care and overcome barriers when accommodations are made to assist with accessibility. Similar to our study, patient satisfaction following virtual ophthalmology consultations was comparable between virtual and in-person visits,[17] validating the continued usage of telemedicine for eye care visits.

Across phases, we evaluated different approaches to help visually impaired participants access the Zoom videoconference platform. When the investigator used remote access control to initiate and end the

telerehabilitation session for optical or electronic magnifiers in phase 3, participants reported less interference of the technology with the session as compared to earlier phases. We believe that remote access control greatly reduced the burden of managing the videoconferencing portal. Over the course of our phase 3 RCT, the increased use of Zoom videoconferencing due to the COVID-19 pandemic potentially increased patient confidence as many people in our society began using it for other interactions. Interestingly, a home visit from local Lions Club members to set up the videoconferencing in phase 2, prior to the pandemic, did not alleviate participants' concerns about the interference of the technology, but Lions volunteers appeared to help with participants' comfort and satisfaction levels. Perhaps the option to involve Lions volunteers can be reinstated when the pandemic ends and it becomes safer from a health standpoint for people to enter homes.

Following phase 1 (pilot), we concluded that phone support alone to access telerehabilitation was inadequate for some participants, especially those who did not have a normally sighted acquaintance to help. Therefore, it was not surprising that overall satisfaction levels were lowest in phase 1, given that most had not used videoconferencing previously and needed quite a bit of support to connect via Zoom, and we were still trying to identify which hardware devices would provide adequate video and audio quality for the session. Across all three phases, ratings for being very satisfied with telerehabilitation were associated with the perception that the videoconferencing session was as accurate as in-person care.

The demographics for all of our study participants (i.e., a median age of 73 years, 35% who were male, and 32% with BCVA of 20/60 [0.46 logMAR] or better) are similar to a previous study of outpatient vision rehabilitation at 28 private clinical centers that reported a median age of 77, 34% male, and 37% with BCVA of 0.46 logMAR or better,[18] indicating our findings may be generalizable to typical patients seeking vision rehabilitation services in the United States. On the other hand, our findings may not be applicable to countries that have limited resources for the requisite technology, such as limited cellular data services in residential areas or ability to procure and ship loaner devices for the videoconferencing. As with most studies, there is a possibility of recruitment bias as our participants had to accept that they would be randomized to either telerehabilitation or in-office care, whereas some participants indicated during recruitment that they preferred only one of the modalities and therefore did not join the RCT in phase 3.

Our participants with portable electronic video magnifiers were more likely to indicate improvement post-telerehabilitation than those with optical magnifiers. This may be due to a greater learning demand to utilize various features and controls that are available on electronic magnifiers. Some of our participants with stand optical magnifiers reported their use improved after telerehabilitation, which agrees with the observations of our providers during the sessions since some participants were initially using stand magnifiers upside-down, as a handheld magnifier prior to training, or with the incorrect glasses (near glasses are required for most stand magnifier use). We did not specifically measure dexterity or whether participants had hand tremors, but physical disabilities other than vision did not limit self-reported improvement with the magnifier following training. Our vision rehabilitation providers followed standard clinical practice and did not dispense handheld magnifiers to patients who did not have the dexterity to use them properly, as stand magnifiers were prescribed in those cases. Our providers were able to accurately assess the angle and distance at which participants were holding the handheld magnifiers during telerehabilitation, in order to provide instruction on those aspects that are key to successful use of those devices. Future, larger studies of telerehabilitation should further evaluate whether efficacy varies according to the type of magnifier or the power of handheld optical magnifiers. All of our participants who never accessed the Internet reported that their optical or electronic magnifier use improved following telerehabilitation, indicating that individuals who are less inclined to use technology may benefit from magnifier training via telerehabilitation. Therefore, providers should provide accommodations, such as loaner equipment with remote access control, to ensure that telerehabilitation services are not limited to those who usually access the Internet and videoconferencing.

Although we did not evaluate any wearable electronic devices for visual impairment, additional studies of these devices are warranted to gain a better understanding of whether telerehabilitation training is beneficial. In a recent RCT of a wearable electronic device as a visual aid, eSight Eyewear, telerehabilitation was highly rated by most of the participants for the same survey items as our studies to evaluate comfort level, overall satisfaction, and future interest.[19] Our RCT differed from the eSight RCT in that we allowed participants to practice with a new visual aid prior to evaluating the effects of additional training and included older adults who did not have Internet access, as they might benefit the most from telerehabilitation

to learn a new device technology. Future work could explore the potential benefits of telerehabilitation to assist with other aspects of low vision, such as providing information about other low-vision aids, services, emotional support, counseling, or training for visual assistive mobile applications (apps), high spectacle add powers for near reading, or eccentric viewing techniques.

Our findings for high levels of patient satisfaction are similar to those reported from other studies of telerehabilitation for disabilities other than visual impairment. Other types of disabilities or chronic conditions that reported high satisfaction with telerehabilitation included Parkinson disease,[20,21] chronic heart failure,[22] esophageal cancer,[23] chronic obstructive pulmonary disease,[24,25] neurorehabilitation,[26] speech therapy,[27] dysphagia,[28] obesity,[29] stroke,[30,31] and physical therapy following knee or hip replacement[32–34] or wheelchair use or mobility.[35,36] In response to the COVID-19 pandemic in 2020–2022, several studies have continued to report good patient satisfaction with telerehabilitation for various disabilities.[37–40] These studies of telerehabilitation for nonvisual disabilities have shown perceived benefits for ease of attending appointments with decreased travel time, increased patient involvement and self-management, being in a familiar environment, involving family assistance and training, and better adherence to rehabilitation schedules.[20,23,25,26,37,39]

Conclusions

Positive feedback from visually impaired participants in our studies supports the feasibility, acceptability, and potential value of telerehabilitation for magnification devices. A sizable proportion of people with visual impairment who were interested in receiving telerehabilitation did not use the Internet and/or videoconferencing previously; it is important to provide assistance with access to videoconferencing via options such as loaner equipment, remote access control software, or support from a normally sighted volunteer or acquaintance in the home who is familiar with the videoconference platform. Further evidence is needed for the efficacy of telerehabilitation for visual impairment using validated outcome measures, which was examined in our RCT in phase 3 and that we plan to publish separately in the future. Additional larger-scale studies are still needed to document the effectiveness of telerehabilitation for remote training with visual aids,[41] in order to lead to an increase in the uptake of this service modality and reimbursement rates.

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