Article • Effectiveness of App-Based Home Vision Therapy on Symptom Reduction During the COVID-19 Pandemic

Lauren Strawn, OD• SUNY College of Optometry • New York, New York

Daniella Rutner, OD, MS, MBA • SUNY College of Optometry • New York, New York

Erica Schulman, OD • SUNY College of Optometry • New York, New York

Lauren Strawn, OD
New York, New York

Assistant Clinical Professor, SUNY College of Optometry

Dr. Irwin B. Suchoff Residency in Vision Therapy and Rehabilitation, SUNY College of Optometry, 2016

OD, SUNY College of Optometry, 2015

BS, Biology, Seton Hall University, 2011

ABSTRACT

Background: During the COVID-19 pandemic, weekly vision therapy sessions were discontinued as patients were unable to receive in-person treatment. The University Eye Center (UEC) implemented several measures to foster continuity of care. Among the systems implemented were asynchronous and synchronous telehealth platforms: the Binovi smart phone application and the OTTO virtual visit platform, respectively.

Methods: A thirteen-question survey was sent to all 232 UEC patients whose vision therapy was interrupted by the pandemic. The survey asked patients to rate their overall satisfaction and visual symptoms with the newly implemented therapeutic management modalities offered between March and August 2020. Sixty-three completed surveys were received. Comparison between the different therapeutic management modalities included overall satisfaction and visual symptom reduction with treatment.

Results: Patients who used visually based telehealth (either synchronous or asynchronous) reported slightly higher overall satisfaction (mean: 4.43 +/- 0.65) as compared to those who did not (4.04 +/- 1.09). There was no statistical difference between the groups (p-value 0.216). Patients who used visually based telehealth (either synchronous or asynchronous) reported a significant reduction in visual symptoms, with 66.7% reporting a significant decrease in symptoms, as compared to those who did not use visually based telehealth, with only 27.1% reporting a significant decrease in symptoms in the latter case (p-value 0.035).

Conclusion: When in-office therapy is unavailable, interactive asynchronous or synchronous visually based telehealth modalities, such as Binovi and OTTO, are of benefit in the reduction of visual symptoms with good patient satisfaction.

Keywords: Telehealth, Binovi, Otto, Vision Therapy, COVID-19

Introduction

Vergence, accommodative, and oculomotor dysfunction, as well as other binocular and visual processing problems, have been shown to improve with vision therapy.[1-4] Vision therapy is typically performed in-office, with bi-weekly, weekly, or bi-monthly treatment. Consistency of the rehabilitative process supports neural pathway change for lasting results.[5-6] In-office therapy allows for the use of a variety of specialized equipment not readily available for home use. Furthermore, in a randomized clinical trial, it was shown that in-office therapy was significantly more effective at reducing symptoms than home therapy alone.[1]

Significant disruption of in-office healthcare across the United States in 2020 occurred because of the COVID-19 pandemic.[7] Conditions quickly escalated New York City, where the SUNY College of Optometry University Eye Center (UEC) is located, prompting Governor Andrew Cuomo to declare a state of emergency.[8,9] On March 12, 2020, New York City and public schools closed, and with a statewide stay-at-home order declared on March 20, 2020.[10-11] This directed all non-essential businesses to close. In compliance, the UEC moved from routine care to emergency-only care beginning March 22, 2020.This order stayed in effect until May 26, 2020, when the UEC began to expand in-person services slowly, with full clinic operations resuming August 24, 2020.

These public health measures, while vital and necessary to slow the spread of COVID-19 throughout the community, halted in-office vision therapy treatment for 5 months for many patients. In order to foster patients' continuity of care and to reduce visual symptom regression, UEC launched two telehealth measures, asynchronous and synchronous. Asynchronous telehealth is a technique wherein the patient or the doctor collects data and transmits that information for review by the clinician at another point in time when the patient's condition and management is reviewed and can be updated as necessary (e.g., the Binovi Pro smart phone application).[12,13] In contrast, synchronous telehealth is the delivery of health information between doctor and patient in real time (e.g., OTTO telehealth platform video calls).[12,14] Patients were allowed to opt into several therapeutic management methods, including asynchronous (Binovi Pro smart phone application) and synchronous telehealth platforms (OTTO telehealth platform video calls) and phone calls between providers and patients, in addition to pausing in-office therapy and/or having patients perform home therapy procedures independently.[15]

The Binovi Pro is an application of the central hub of the Binovi platform.[13] The platform has an extensive library of both written and video instructions for in-office vision therapy procedures, as well as the ability to create customizable content, of which the UEC took full advantage. The app was available for UEC patients to download on their smart devices, thereby linking the patient to their UEC provider. This allowed the patient's doctor to upload specific vision therapy activities to the patient's account with customizable details, including materials necessary, number of attempts, or time specifications. The patient could then view and review when necessary to obtain clear instructions for home therapy activities. Additionally, the patient could then use the app to record their progress with the home therapy sessions, indicating how challenging each activity felt. Furthermore, patients were able to send HIPAA-secured communication to their doctors. Providers could track this information via their own smart device, adjusting the patient's therapeutic procedures, making those more or less challenging based on the patient's feedback and ability to perform the assigned activities. This provided patients with an asynchronous telehealth modality, with all necessary equipment and materials mailed directly to the patient. Patients were instructed to perform their therapy activities four to five times per week, for approximately 15 minutes per day, similar to a home therapy assignment schedule typical for patients undergoing in-office therapy.

Synchronous video telehealth appointments were launched during the pandemic as well via the OTTO virtual visit platform, which seamlessly integrated into UEC's current electronic health records.[14] This enabled doctors to observe their patients performing specific activities and to correct any errors, to adjust procedural difficulty, to assess eye movements and ocular deviations, and to provide feedback in real time. Synchronous telehealth was scheduled based on the patient's needs: weekly, twice per month, or monthly, scheduled for 45 minutes.

Patients with traumatic brain injury often have the symptom of photosensitivity. This light sensitivity can affect the patient's ability to use tablets or computers.[13] Therefore, therapy instructions could be printed from the Binovi application. Additionally, telephone follow-up visits were offered for these patients.

As all of the options above were new to both patients and providers, the option for follow-up visits and maintenance schedules was left up to the patient, in consultation with their providers.

Methods

A survey was created to assess the overall effectiveness of the various new management modalities initiated during the COVID-19 pandemic, when in-office therapy was not available to foster continuity of care. Patients were asked to rate their overall satisfaction and reduction of their visual symptoms with the new modalities. Overall satisfaction was rated on a scale of 1-5, with 5 being extremely satisfied. Symptom reduction was assigned a numerical value (3 for significantly reduced, 2 for moderately reduced, 1 for slightly reduced). Patients were asked to self-report their gender and age and to select all of their current diagnoses. The diagnoses were described in layperson terms, and scientific jargon was avoided. All patients, regardless of their study participation, were allowed to select any or all modalities that they used for treatment after consultation with their providers. The categories with which the participants were presented in the survey included: Binovi smart phone app, video telehealth visits (OTTO), phone calls with provider, self-guided practicing, or no therapy. In addition, participants were asked to select their employment status, as well as the type and frequency

of visual symptoms that they experienced before starting therapy and during the COVID shutdown.

An introductory letter was mailed along with the survey (Appendix) to assure the patients that their participation in the survey was voluntary and would not affect their current or future treatment at the UEC in any way. A total of 232 letters and surveys were mailed to actively enrolled UEC vision therapy patients whose therapy was interrupted by the New York State shutdown on March 20, 2020. Two copies were mailed out, four months apart, to encourage completion. All responses were anonymous. The study followed the tenets of the Declaration of Helsinki and was approved by the SUNY College of Optometry Institutional Review Board (IRB).

Results were grouped by patient into those who reported using visually based telehealth methods (Binovi, OTTO video telehealth) and those who selected other options (telephone check-ins, self-guided practice, or discontinued care). Since many participants reported using few multiple-management methods, any participant who reported Binovi or video telehealth was placed into the telehealth category, even if other methods were reported as well.

Descriptive statistics, including proportions for categorical variables and mean (SD) for continuous variables, were first used to describe the demographics, clinical characteristics, and outcome variables of the enrolled subjects and were then used to compare them among the different study groups. For the continuous variables, such as overall satisfaction and symptom reduction with treatment, either the Kolmogorov-Smirnov or the Shapiro-Wilk test was used to confirm normality of measurements prior to performing the statistical analyses. To assess any significant differences in subject characteristics between the two groups (visually based telehealth method users and all others), an unpaired T-test for continuous variables (or Wilcoxon test for non-normal variables) and a chi-squared test for categorical variables were performed. Two-sided p-values <0.05 were considered to be statistically significant. All statistical procedures were performed using R statistical package (www.R-project.org).

Results

Sixty-three surveys were returned. Thirty-five reported their gender as female (56%), and twenty-eight reported as male (44%). Participants were asked to select a category of ages that corresponded with their own age (Table 1). Results were grouped into two categories: those who used visually based telehealth, whether asynchronous or synchronous (Binovi, OTTO video telehealth), and those who had only telehealth via telephone or who continued unguided home-based therapy. This was determined based on the self-reported responses that the participants chose on the surveys that were returned. Several participants reported using both Binovi and OTTO video telehealth, and those responses were only counted once in the analysis (Table 2). Table 2 shows the total responses provided for each management method; the total is over 100% as patients were able to select multiple clinical management options. A similar number of participants selected some form of telehealth: nine reported using Binovi (14.2%) and nine reported using OTTO (14.2%). Twelve participants reported scheduling phone calls with their provider (19.0%). The majority of participants, thirty-four (54.0%), reported some form of self-guided practice, and twenty-two reported no management at all (24.9%). Seventeen participants selected multiple modalities that were used throughout the COVID shutdown (27.0%).

Participants in the survey were asked to report their diagnoses at the beginning of their course of therapy. These were described in simple terms to ease patient understanding for self-selection. The highest

Table 1. Self-Reported Age and Gender of Total Responses Received From Home-Based Therapy Survey

Age	Male (%)	Female (%)
Under 6	0 (0%)	2 (3.2%)
7-12	18 (28.6%)	15 (23.8%)
13-18	2 (3.2%)	2 (3.2%)
19-40	5 (7.9%)	8 (12.7%)
41-60	3 (4.8%)	4 (6.3%)
61 and over	0 (0%)	2 (3.2%)
No response	0 (0%)	1 (1.6%)
Total	28 (44.4%)	35 (55.6%)

Table 2. Total Responses of Each Management Method Utilized from Home-Based Therapy Survey

Management Modality	N (%)
Binovi	9 (14.2%)
OTTO Telehealth	9 (14.2%)
Phone call with provider	12 (19.0%)
Self-guided practice	34 (54.0%)
None	22 (24.9%)
No response	0 (0%)
Multiple modalities	17 (27.0%)

Table 3. Total Responses for Each Diagnosis Category from Home-Based Therapy Survey

Diagnosis	All Telehealth	Other
Traumatic brain injury/ concussion	3 (20.0%)	7 (14.6%)
Eye teaming issues	4 (26.7%)	8 (16.7%)
Eye turn	2 (13.3%)	10 (20.8%)
Amblyopia/lazy eye	1 (6.7%)	9 (18.8%)
Eye focusing issues	7 (46.7%)	19 (39.6%)
Tracking issues	6 (40.0%)	15 (31.3%)
Do not know	1 (6.7%)	10 (20.8%)
Other	3 (20.0%)	7 (14.6%)
No response	0 (0.0%)	1 (2.1%)
Multiple responses	9 (60.0%)	21 (43.8%)

Table 4. Responses of Satisfaction with Treatment from Home-Based Therapy Survey

Type of Management	All Telehealth	Other	P-value
Satisfaction with treatment			
Mean (SD)	4.43 (0.65)	4.04 (1.09)	0.216
Satisfaction with provider			
Mean (SD)	4.47 (0.74)	4.22 (1.06)	0.414
Total number	15	48	

Responses were reported on a scale of 1-5, with 5 being extremely satisfied.

Table 5. Responses of Satisfaction with Treatment from Home-Based Therapy Survey

Satisfaction with Treatment	Telehealth	Self-Practice	None
1	0 (0.0%)	0 (0.0%)	2 (9.5%)
2	0 (0.0%)	1 (3.7%)	1 (4.8%)
3	2 (13.3%)	1 (3.7%)	2 (9.5%)
4	4 (26.7%)	4 (14.8%)	11 (52.4%)
5	9 (60.0%)	19 (70.4%)	4 (19.0%)
Did not answer	0 (0.0%)	2 (7.4%)	1 (4.8%)
Total responses	15	27	21
P-value: 0.039			

Satisfaction with Provider	Telehealth	Self-Practice	None
1	0 (0.0%)	0 (0.0%)	1 (4.8%)
2	0 (0.0%)	2 (7.4%)	3 (14.3%)
3	1 (6.7%)	3 (11.1%)	1 (4.8%)
4	6 (40.0%)	9 (33.3%)	6 (28.6%)
5	7 (46.7%)	12 (44.4%)	8 (38.1%)
Did not answer	1 (6.7%)	1 (3.7%)	2 (9.5%)
Total responses	15	27	21
P-value: 0.810			

Responses were reported on a scale of 1-5, with 5 being extremely satisfied.

response for both groups was eye focusing problems, with 46.7% of the telehealth group and 39.6% of the non-telehealth group selecting this diagnosis. Most participants also selected multiple responses, with 60.0% of the telehealth group and 43.8% of the non-telehealth group reporting multiple diagnoses (Table 3).

Two main values were compared between the different treatment modalities: overall satisfaction and visual symptom reduction with treatment. Some patients also declined to answer specific questions on the survey, which were recorded as "no response." Table 4 compares the average satisfaction ratings of both the overall treatment and the provider by management modality. Responses from patients who used any visually based telehealth program (Binovi or OTTO) were placed in the telehealth category, and all others were placed in the "other" category. Participants in the telehealth category reported an average satisfaction with treatment of 4.43 and satisfaction with provider of 4.47. Participants in the non-telehealth group (other) reported slightly lower satisfaction, rating their satisfaction with treatment as 4.04 and satisfaction with their provider as 4.22. However, the p-value comparing the two groups was not statistically significant, with 0.216 for satisfaction with treatment and 0.414 for satisfaction with provider. Responses were reported on a scale of 1-5, with 5 being extremely satisfied.

Results were also analyzed in multiple categories: telehealth (those who used Binovi and OTTO), self-practice (those who practiced on their own or who utilized phone calls with their provider), and none (those who did not practice at all). A percentage comparison was completed due to three groups being analyzed. Comparison of these groups' overall satisfaction with their treatment showed a statistical significance between the groups, with a p-value of 0.039. The telehealth group and the self-practice group showed the highest percentage of those who selected option 5 (extremely satisfied), while the none group showed a higher percentage of those who selected option 4 (Table 5).

Table 6 compares the symptom reduction score between the two treatment groups. Since the questions were not asked on a sliding scale, but rather used a forced-choice option, the percentages of patients who selected each category were compared. Ten participants (66.7%) in the telehealth group reported reduction in their visual symptoms over the course of the COVID shutdown, as compared to 13 participants (27.1%) in the non-telehealth category. This resulted in a p-value of 0.035, which was

Table 6. Responses of Overall Symptom Reduction from Home-Based Therapy Survey

Reduction Score	All Telehealth	Other
1	1 (6.7%)	16 (33.3%)
2	4 (26.7%)	18 (37.5%)
3	10 (66.7%)	13 (27.1%)
Did not answer	0 (0%)	1 (2.1%)
Total responses	15	48
P value: 0.035		

Responses were reported on a sliding scale. Symptom reduction was assigned a numerical value (3 for significantly reduced, 2 for moderately reduced, 1 for slightly reduced).

Table 7. Responses of Overall Symptom Reduction from Home-Based Therapy Survey

Reduction Score	Telehealth	Self-Practice	Other
1	1 (6.7%)	7 (25.9%)	9 (42.9%)
2	4 (26.7%)	11 (40.7%)	8 (38.1%)
3	10 (66.7%)	8 (29.6%)	4 (19.0%)
Did not answer	0 (0.0%)	1 (3.7%)	0 (0.0%)
Total responses	15	27	21
P value: 0.058			

Responses were reported on a sliding scale. Symptom reduction was assigned a numerical value (3 for significantly reduced, 2 for moderately reduced, 1 for slightly reduced).

statistically significant. When completing this analysis in three groups (telehealth, self-practice, and none), the p-value increased to 0.058, slightly above the statistically significant threshold. This analysis did still show the highest percentage of symptom reduction in the telehealth group (66.7%), as compared to 29.6% in the self-practice group and 19% in the none group (Table 7).

Discussion

When comparing patient satisfaction between management modalities, the results were not statistically significant. Patients seemed satisfied with any type of management, with patients who used either synchronous or asynchronous telehealth reporting slightly higher satisfaction. This may be due to the fact that the patient was allowed to choose which management modality they used. If patients were assigned at random, they may have felt differently about the management modality to which they were assigned. Given the circumstances of a pandemic, patients were open to any and all options afforded to them for continuation of care. Comparison of satisfaction in three groups that separates out those who did not practice at all, however, shows that the telehealth and self-practice groups were statistically more satisfied. Despite the statistical significance between these groups, the clinical relevance is low. Patients who selected 5 as compared to 4 on a scale of 1-5 are still overall more satisfied than average with their treatment.

Comparing the change in patients' symptoms over the course of their at-home treatment also showed a significant difference. Patients who used the visually based telehealth platforms, such as the Binovi app or OTTO video telehealth appointments, reported greater reduction of visual symptoms than those who had phone calls with their providers, practiced on their own, or waited for in-office therapy to resume. This group had a higher percentage who selected "significantly improved," as well as a lower percentage who selected "slightly improved," as compared to the other groups. This may be due to the visually interactive nature of both the Binovi and OTTO treatment modalities. Being able to communicate freely with their provider, whether on video calls or through an app, as well visualization of techniques and written instruction, allowed for changes and adjustments to be made to the home therapy program more readily than it did for those who only had phone calls or who practiced on their own. Symptoms decreased slightly in the "other" group but showed a more even distribution, suggesting that more consistent symptom reduction was attributed to the telehealth group. When separating out those who practiced on their own and those who reported completing no home practice, the percentages show that the telehealth group still had the highest percentage of symptom reduction. The high p-value may indicate that some practicing, even if performing completely independently, can reduce symptoms, albeit not as much as for those who used interactive modalities.

Reported diagnoses also varied between the two groups. While "eye focusing problem" was selected by the highest number of participants in both categories, the "other" group did show a higher percentage of those selecting "ocular deviation" and "amblyopia/lazy eye," which are more complicated diagnoses than eye teaming or tracking problems. However, the visually based telehealth group reported a higher number of participants selecting "traumatic brain injury/concussion," as well as a higher percentage selecting multiple diagnoses. It is impossible to compare the participants self-reported diagnoses to clinical findings due to the anonymity of the survey results. However, the varied responses in each category suggest that both easy and complex cases were most likely present in each group.

The responses to this survey were all self-reported. Due to the abrupt nature of the COIVD-19 quarantine, clinical data measurements of different diagnoses prior to beginning out-of-office therapy were not obtained. The variety of diagnoses, patient ages, severity of symptoms, and stage of treatment completed also make it hard to compare clinical findings. Symptom data allows us to compare all patients whose treatment was interrupted by the COVID-19 quarantine and assess how these different management modalities impacted the patients directly. The anonymous nature of the survey helped to protect patients' privacy and health information; however, this anonymity prevented the comparison of the patients' self-reported answers of type of management modality and diagnosis to previous medical records. It also precluded the ability to compare visual symptom reduction to clinical examination findings when in-person therapy resumed. Therefore, reduction of visual symptoms cannot be directly linked to clinical improvement in visual skills, but rather speaks to the patients' overall feeling about their symptoms.

Conclusion

While emerging technologies in telehealth may have benefits in healthcare delivery, they are not a substitute for in-office patient examination and therapy. Equipment used in-office is not comparable to nor as readily available as equipment mailed to patients for home-based therapy. Additionally, there is a limited scope of examination techniques that can be used to assess patients remotely, likely leading to an increase in misdiagnosis, mismanagement, and possible malpractice cases. Telehealth can be a valuable supplemental modality in the event that the patient cannot come in for in-office based therapy during times such as the pandemic. Interactive, visually based telehealth modalities, either asynchronous or synchronous like the Binovi app or OTTO video telehealth appointments, showed a greater reduction in symptoms as compared to those who did not use those modalities.

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Appendix-Survey

Please answer the following questions based on your or your child's experience with vision therapy during the COVID-19 pandemic.

1. What is the patient's age? Choose one.
   a. 6 and under
   b. 7-12
   c. 13-18
   d. 19-40
   e. 41-60
   f. 61+

2. What is the patient's gender? Choose one.
   a. Male
   b. Female
   c. Other (please specify): _____
   d. Prefer not to answer

3. What is the patient's work status? Choose one.
   a. Student
   b. Employed Full-time
   c. Employed Part-time
   d. Unemployed
   e. Other (please specify): _____

4. What symptoms or concerns were present prior to starting in-office therapy? Choose all that apply.
   a. Blurred vision
   b. Double vision
   c. Headaches
   d. Eyestrain
   e. Difficulty reading
   f. Dizziness
   g. Other (please specify): _____

5. How often did the patient experience these symptoms prior to beginning in-office therapy? Please rate on a scale of 1-5, with 1 being rarely and 5 being constant.

   1   2   3   4   5

6. How often does the patient currently experience their symptoms? Please rate on a scale of 1-5, with 1 being rarely and 5 being constant.

   1   2   3   4   5

7. What is your diagnosis? Choose all that apply.
   a. Traumatic brain injury/Concussion
   b. Eye teaming issues
   c. Eye turn
   d. Amblyopia/Lazy eye
   e. Eye focusing issues
   f. Tracking issues
   g. Do not know
   h. Other (please specify): _____

8. What goals did the patient want to achieve through vision therapy? Choose all that apply.
   a. Reduce/eliminate blurred vision
   b. Reduce/eliminate double vision
   c. Reduce/eliminate headaches and/or eyestrain
   d. Improve daily tasks (reading, use of electronics, etc.)
   e. Improve coordination/depth perception (reduce clumsiness, improve sports performance, etc.)
   f. Other (please specify): _____

9. Do you feel that the patient's goals have been achieved?
   a. Slightly
   b. Moderately
   c. Significantly
   d. Fully achieved

10. After March 23, 2020, which of the following methods of home therapy did the patient use? Choose all that apply.
   a. Binovi smart phone app
   b. Video telehealth visits
   c. Phone calls with provider
   d. Self-guided practicing
   e. None

11. Please rate your satisfaction with the interactions with your provider 1-5, with 5 being the highest.

   1   2   3   4   5

12. Please rate your satisfaction with the treatment and exercises you were prescribed 1-5, with 5 being the highest.

   1   2   3   4   5

13. Describe your overall impression of your treatment during the COVID-19 pandemic.
   a. Better than in-office therapy
   b. As good as in-office therapy
   c. Worse than in-office therapy