

# Pulmonary Calling: The Rise of Pulmonary Telemedicine During the COVID-19 Pandemic

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September 10, 2020

## Abstract

*Objective* The Division of Pulmonary and Sleep Medicine at Children's Hospital of Philadelphia rapidly implemented pulmonary telemedicine visits during the coronavirus disease 2019 (COVID-19) pandemic. The feasibility, utility, and favorability of telemedicine visits for a wide range of pediatric pulmonary conditions were assessed. *Methods* Providers were sent a survey on May 8, 2020 to assess attitudes, perspectives, and favorability of pulmonary telemedicine visits based on their composite experiences since the conversion to telemedicine visits on March 24, 2020. A similar survey was sent to all patients who completed a pulmonary telemedicine visit from May 17, 2020 through June 12, 2020. Patient and provider survey responses about pulmonary telemedicine utility, benefits, limitations, and overall experience were analyzed. *Results* Overall, patients and providers expressed a high degree of satisfaction with the telemedicine experience, with 92% of patients and 72% of providers rating their telemedicine experience as excellent or very good. Both patients and providers were most interested in using telemedicine for regular follow-up visits and for sooner appointments. More than 70% of patients and 90% of providers indicated telemedicine was more convenient for patients compared to in-person clinic visits. All providers and 85% of patients who responded indicated interest in continuing telemedicine in the future. *Conclusions* This study demonstrates that telemedicine is a feasible and favorable method of healthcare delivery of pulmonary medicine for the full spectrum of conditions treated by pediatric pulmonary and sleep medicine specialists. This has important implications for the use of telemedicine during the COVID-19 pandemic and beyond.

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## INTRODUCTION

The novel coronavirus disease (COVID-19) first appeared in China in the late fall of 2019, and on March 13, 2020, was declared a national emergency in the United States (U.S.) following the World Health Organization's declaration of a global pandemic two days prior. This event challenged healthcare systems across the U.S. to quickly implement and sustain new ways to see and treat patients, providing both challenges and opportunities for healthcare providers. A transformative moment for telehealth to become mainstream<sup>1</sup>, rapid implementation of telemedicine visits became essential to maintain care for patients while keeping them safe during a rapidly spreading pandemic.

While the concept of modern-era telemedicine is not new, prior to the COVID-19 pandemic, telemedicine was infrequently used to provide medical care in urban tertiary care centers. Telemedicine's relevance in pediatrics had been highlighted by the American Academy of Pediatrics in their statement in 2015 as a care delivery model, educational and research tool<sup>2</sup>. An analysis of 28 published studies about the use of telehealth did not show strong supporting evidence for its use<sup>3</sup>.

Similar to many large tertiary care centers, the Children's Hospital of Philadelphia (CHOP) had some limited experience with telemedicine platforms. Prior to March 13, 2020 and the COVID-19 pandemic, the division of pulmonary and sleep medicine at CHOP had only used telemedicine in a small pilot program. Discussions had occurred more than 18 months prior regarding expanding the use of telemedicine in a subset of patients, but progress was hindered by lack of reimbursement by third-party payers and interstate medical licensure concerns. Our first telemedicine video visits were implemented on March 24, 2020 at the start of the COVID-19 pandemic.

In tandem with our rapid implementation of telemedicine, we conducted a quality improvement study to assess the feasibility, utility and favorability of pulmonary telemedicine visits through the use of provider and patient/family surveys. We hypothesized that telemedicine is an effective and feasible means of providing medical care to children and adolescents seeking pulmonary care and is a favorable option to provide care for children with a wide range of pulmonary diagnoses.

## METHODS

### Background

Telemedicine video visits were offered by our division to all patients with previously scheduled appointments that were cancelled due to COVID-19 and to all subsequent patients requesting a pulmonary appointment in our general and subspecialty pulmonary programs. The first telemedicine video visits completed by the division of pulmonary and sleep medicine at CHOP began on March 24, 2020. In order to maintain HIPPA compliance and provide ease for families, we utilized Vidyio, the video software package available with our electronic health record, EPIC.

In order to gauge effectiveness, satisfaction and areas needing improvement during this rapid period of telemedicine implementation, we constructed patient and provider surveys to capture responses related to the pulmonary telemedicine experience. The purpose of collecting this data was clinical quality improvement and did Internal Review Board review was not required. All data were collected in a de-identified manner.

## Study setting

This study was performed within the Division of Pulmonary and Sleep Medicine at CHOP, which consists of a care network in an urban environment composed of a tertiary care hospital and ambulatory pediatric subspecialty care centers located within the main campus in the city of Philadelphia as well as subspecialty care centers throughout the Greater Philadelphia area and New Jersey suburbs. The practice includes general pediatric pulmonary medicine as well as subspecialty programs in aerodigestive medicine, asthma, bronchopulmonary dysplasia, cystic fibrosis, lung transplantation, interstitial lung disease, primary ciliary dyskinesia, sickle cell disease, sleep medicine, and technology dependent children. The division's healthcare providers included 29 pediatric pulmonologists (11 of whom also practice sleep medicine), 7 advanced practice providers, 5 psychologists (all from the sleep medicine program), 7 pulmonary fellows, and a team of registered nurses, social workers, dietitians, respiratory therapists, and medical assistants.

## Implementation of telemedicine

In response to state and federal guidance related to the COVID-19 pandemic, and utilizing social distancing measures adopted in our region, we transitioned to the use of telemedicine visits for all outpatient pulmonary care beginning March 24, 2020. Prior to the pandemic, our practice offered no telemedicine services and thus procedures needed to be developed using the EPIC electronic health record system, which had been used for clinical documentation by the division for over 10 years. Specific templates for documentation were developed for various visit types by our telemedicine task force. Providers were trained to perform telemedicine visits through job aids created by the telemedicine task force. Providers conducted telemedicine video visits through the EHR application on their hospital-issued iPhone or iPad, and patients were provided instructions to download and log onto the associated patient portal application.

## Questionnaires

Surveys were developed using Research Electronic Data Capture (REDCap), a secure web application for online surveys and databases, and sent to all patients who were seen for a pulmonary telemedicine video visit between two specified time periods: May 17, 2020 through June 1, 2020, and June 1, 2020 through June 12, 2020. The patient surveys were emailed on June 6 and June 18 to the respective groups. The survey was an eleven-item questionnaire constructed by our division's telemedicine task force and was emailed to patients following their telemedicine visit. The survey was designed to elicit information regarding their overall experience with telemedicine visits, likelihood of continuing telemedicine visits if offered, benefits and limitations of telemedicine versus in-person visits, and technical difficulties encountered (E-Appendix 1).

The provider survey was a 16-item questionnaire designed by our division's telemedicine task force and sent to 84 providers in our division. The providers were emailed a link to complete this survey via REDCap on May 8, 2020. The survey included questions about the overall experience and efficiency of video visits, interest in continuing to use telemedicine visits, its benefits and limitations, barriers and technical difficulties encountered (E-Appendix 2).

## Data collection and analysis

Clinical documentation in our care network is performed using a single unified electronic medical record system within an institutional HIPAA-compliant EHR system. Patient demographic variables including location of residence, age, race and ethnicity were extracted. Data was collected through survey responses which were compiled and reported through REDCap. Responses to individual items were summed and respondent percentages were calculated.

## RESULTS

Between March 24, 2020 and June 30, 2020, our division completed 3,787 telemedicine visits, with 150 to 300+ visits being conducted per week from April through June (Figure 1). Beginning in June, in-person visits started being offered again on a case by case basis, and a hybrid model of in-person clinic visits and telemedicine video visits was adopted.

There were 788 patients seen for a pulmonary telemedicine visit from May 17,2020 through June 12, 2020. A majority of these patients (67%) lived in Pennsylvania and nearly 30% lived in New Jersey. Over half of the patients were male. Nearly 60% of patients identified as being Caucasian and 25% as being African American. Nearly 90% of patients did not identify as being Hispanic or Latino. The median age of patients was 7 years (mean 7.79 years, standard deviation 5.8 years; 25-75% IQR 3-12 years).

Fifty-four (6.9%) patients responded to the survey about their experience with telemedicine. Six of these patients (11%) had prior experience with telemedicine in another division. The majority of patients were previously cared for at the institution's main clinic site in Philadelphia (60%) and 40% were previously seen in suburban subspecialty care centers. Forty-one providers responded to the survey. Over half of the providers who responded were physicians (Table 1). The most commonly seen diagnoses were patients with general pulmonary conditions, sleep-related breathing disorders, and asthma.

All of the providers who responded to the survey indicated they would be interested in continuing telemedicine in the future, and 46 patients (85%) indicated that they would be interested in telemedicine after the pandemic resolved (Figure 2). Both patients and providers were most interested in future telemedicine use for regular follow-up visits and to obtain an appointment sooner (Figure 3). Both patients and providers had a positive telemedicine experience, with 92% of patients rating their telemedicine experience as excellent or very good and 72% of providers rating their telemedicine experience as excellent or very good (Figure 4A). Benefits of telemedicine visits as perceived by patients and providers are further delineated in Figure 4B and 4C and had some areas of overlap. Additional comments provided by patients about the benefits of telemedicine visits were that the “patient does not have to miss a whole day of school” and it provided access to care for patients that live in another state by removing “a lot of the financial aspects of gas/food/hotel.” Providers commented that telemedicine visits allowed them the ability “to see patients more frequently without them having to travel [to the appointment]”, provide care to patients during inclement weather, and improve efficiency and flow “due to a lack of barriers encountered during in person visits” (e.g. waiting for rooms to open up, waiting to be triaged).

Specific clinical program providers reported that telemedicine may be helpful for general pulmonary patients for more frequent follow-up, families with limited resources, those that live far away, patients that are clinically stable, instances of inclement weather preventing travel to appointments, and patients with frequent questions or phone calls. In the sleep medicine program, survey respondents supported the use of telemedicine for determining if a sleep study is needed, following up on sleep study results, non-invasive ventilatory support follow-up, and behavioral sleep concerns. Providers supported telemedicine visits for asthma follow-up care in those with historically normal lung function testing, in children too young to perform spirometry, or patients whose asthma is well controlled. Cystic fibrosis provider responses identified telemedicine as a useful method for completing quarterly follow-up visits alternating with in-person visits. The aerodigestive program respondents also supported the use of telemedicine for follow-up visits. The technology dependent center respondents reported that telemedicine may be useful for respiratory weaning, trouble-shooting ventilator challenges, and to check on equipment.

The majority of patients (76%) did not perceive significant technical difficulties during their telemedicine visits (Figure 5A). Providers cited technical difficulties sometimes with each aspect of telemedicine including audio, visual, patients not having access to the equipment, patients forgetting scheduled visits, and patients arriving late (Figure 5B). Providers and patients both expressed limitations in the physical examination and inability to obtain standard vital signs. Providers also felt lack of spirometry was a limitation. Both providers and patients indicated distractions at home or inability for a child to sit for video visit were limitations. Suggestions provided by patients to improve telemedicine included being able to use a laptop for the visit rather than a smart phone. Providers suggested having pre-visit check-in assistance to help patients work through technology challenges, using a larger screen for visits, and having improved physical examination capabilities.

## DISCUSSION

The COVID-19 pandemic transformed the role of telemedicine in delivering care to children with pulmonary disorders. Our survey data demonstrate a high level of satisfaction with telemedicine among clinicians, allied health professionals and patients' families. While other publications exist describing telemedicine experiences during the COVID-19 era in several other pediatric subspecialties<sup>4-8</sup>, to our knowledge, this is the first study examining the use of telemedicine visits across the full spectrum of conditions treated by pediatric pulmonary and sleep medicine specialists at a large tertiary care center.

This study adds important perspectives regarding the feasibility, acceptability and overall favorability of telemedicine in a field where physical examination has traditionally played an important role in evaluation and management. While digital auscultative capabilities exist, cost and lack of accessibility for many families has constrained its implementation. Despite these limitations, our study demonstrates that telemedicine is a feasible and favorable method of healthcare delivery of pulmonary medicine during the current global health crisis and beyond.

As defined by the Institute of Medicine, patient-centered care involves “providing care that is respectful of and responsive to individual patient preferences, needs and values” and “focuses on the patient’s experience of illness and healthcare and on the systems that work or fail to work to meet individual patients’ needs<sup>9</sup>.” The patient’s experiences, perspectives and satisfaction are critical components of patient-centered care, and this study assesses these important aspects of telemedicine. The results indicate overwhelmingly positive patient experiences and satisfaction. In healthcare’s ongoing pursuit of providing quality patient-centered care, these will be important markers to continue to monitor to ensure we continue to meet the needs of our patients and their families.

There are several limitations to our data. First, the patient and provider surveys were not administered in an identical fashion. While patients were surveyed in association with a single completed telemedicine visit, providers were surveyed for their overall telemedicine experiences and attitudes from their cumulative encounters with telemedicine since the switch to telemedicine with the COVID-19 pandemic. Second, the patient surveys were only sent to those who completed a telemedicine visit, which could subject our results to bias due to failure to capture data from those who were unable to complete telemedicine visits due to difficulties with technology and/or those who lacked the appropriate resources needed to complete a telemedicine visit (e.g. no smartphones or reliable internet services). Third, the patient surveys were not sent immediately at the conclusion of the visit encounter. While this presents a potential for patients and families to forget some of the details regarding their visit, none of our survey questions relied on recalling specific details of the visit, making it less likely that their responses would differ significantly with this short lapse in time. Fourth, only 6.9% of patients who were sent a survey responded, thus there is the possibility that our results could be different than if we had received responses from all patients. Finally, our data queried patients and providers for subjective experiences and did not include objective metrics. However, a large component of the patient-centered healthcare model is about the patient experience, so the insights gained from our study offer invaluable information. Future studies are needed to examine the impact of telemedicine on objectively measurable health outcomes.

## Conclusions

This study offers important insights about telemedicine use at a large pediatric pulmonary tertiary care center. This study demonstrates the feasibility and utility of telemedicine for children and adolescents with a wide range of pulmonary conditions and shows that telemedicine can be successfully completed with overwhelmingly positive and concordant experiences and perspectives among both patients and providers. Our data suggest that there are important roles for the continued use of telemedicine as an option beyond the COVID-19 pandemic. With the rapid and exponential increase in use of telemedicine brought about by the COVID-19 pandemic, the past few months undoubtedly represent an important milestone in the growth of telemedicine. Despite these strides, important work remains as improvements in the access to telemedicine and physical exam capabilities are pursued. Allowances for telemedicine by medical licensing boards and third-party payers would need to be extended beyond the pandemic to ensure patients have access to care. Further studies are needed to examine how care delivered through telemedicine impacts measurable patient

outcomes and how the financial costs of delivering care compares to traditional in-person visits.

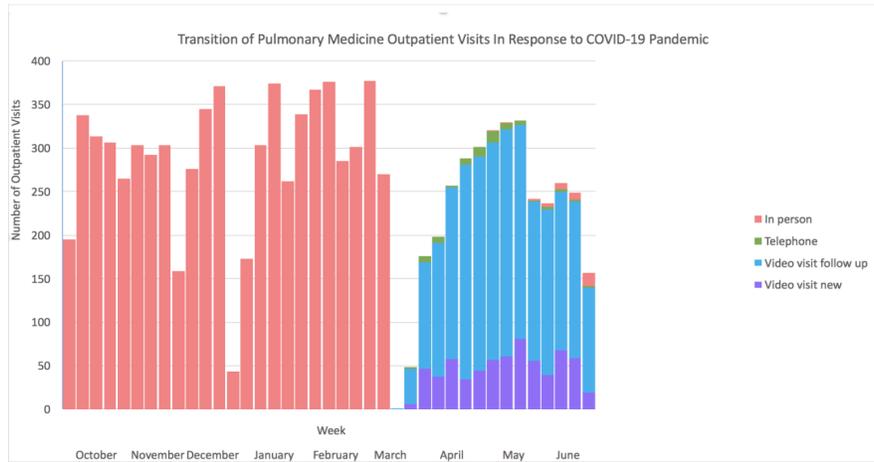
## REFERENCES

1. Fiks AG, Jenssen BP, Ray KN. A defining moment for pediatric primary care telehealth. *JAMA Pediatr* . July 13, 2020. doi: 10.1001/jamapediatrics.2020.1881
2. Burke BL, Hall RW. Telemedicine: pediatric applications. *Pediatrics*. July 2015;136(1):e293-308.
3. Hersh WR, Wallace JA, Patterson PK, Shapiro SE, Kraemer DF, Eilers GM, Chan BK, Greenlick MR, Helfand M. Telemedicine for the medicare population: pediatric, obstetric, and clinician-indirect home interventions. *Evid Rep Technol Assess (Summ)* . 2001 Aug;(24 Suppl):1-32.
4. Maurrasse SE, Rastatter JC, Hoff SR, Billings KR, Valika TS. Telemedicine during the COVID-19 pandemic: a pediatric otolaryngology perspective. *Otolaryngol Head Neck Surg* . May 26, 2020; [published online ahead of print]. 194599820931827. doi:10.1177/0194599820931827
5. Rametta SC, Fridinger SE, Gonzalez AK, Xian J, Galer PD, Kaurman K, Prelack MS, Sharif U, Fitzgerald MP, Melamed SE *et al* . Analyzing 2,589 child neurology telehealth encounters necessitated by the COVID-19 pandemic. *Neurology* . Jun 9, 2020; [published online ahead of print] 10.1212/WNL.000000000010010. doi:10.1212/WNL.000000000010010
6. Kasle DA, Torabi SJ, Savoca EL, Judson BL, Manes RP. Outpatient otolaryngology in the era of COVID-19: a data-driven analysis of practice patterns. *Otolaryngol Head Neck Surg* . 2020;163(1):138-144. doi:10.1177/0194599820928987
7. Deshmukh AV, Badakere A, Sheth J, Bhate M, Kulkarni S, Kekunnaya R. Pivoting to teleconsultation for paediatric ophthalmology and strabismus: our experience during COVID-19 times. *Indian J Ophthalmol*. 2020;68(7):1387-1391. doi:10.4103/ijo.IJO\_1675\_20
8. Panda PK, Dawman L, Panda P, Sharawat IK. Feasibility and effectiveness of teleconsultation in children with epilepsy amidst the ongoing COVID-19 pandemic in a resource-limited country. *Seizure* . Jul 18, 2020; [published online ahead of print]. 81:29-35.
9. Institute of Medicine (US) Committee on Quality of Health Care in America. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington (DC): National Academies Press (US); 2001.

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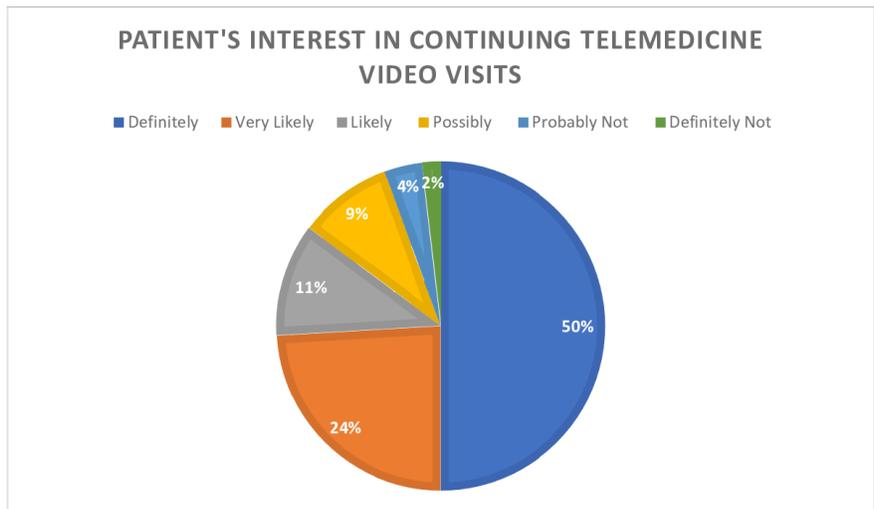
**Figure 1**



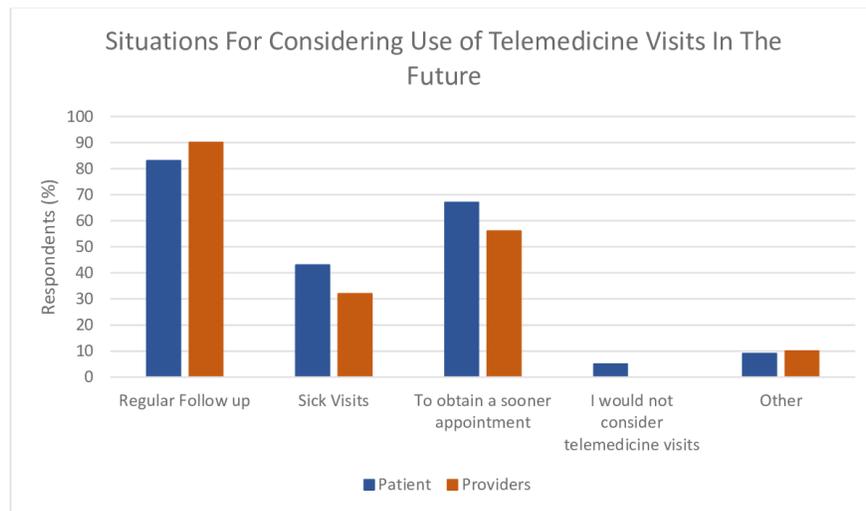
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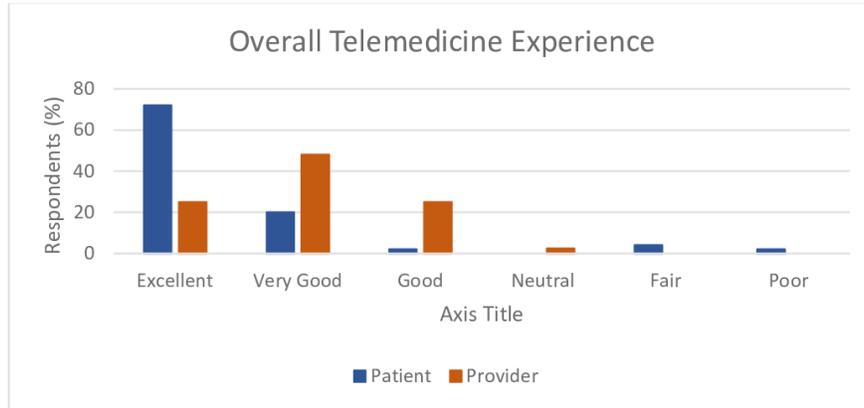
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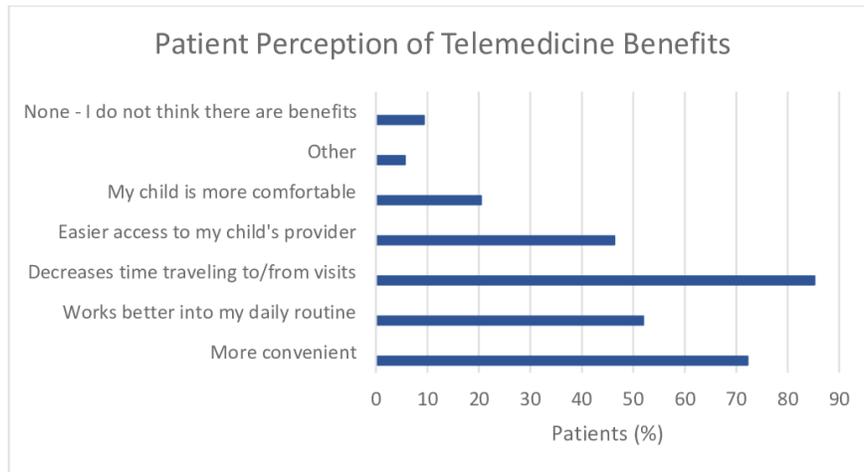
**Figure 3**



**Figure 4A**



**Figure 4B**



**Figure 4C**

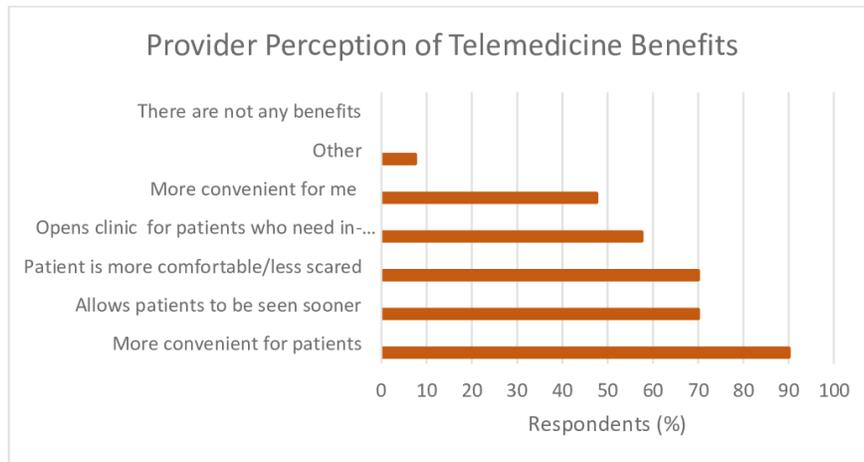


Figure 5A

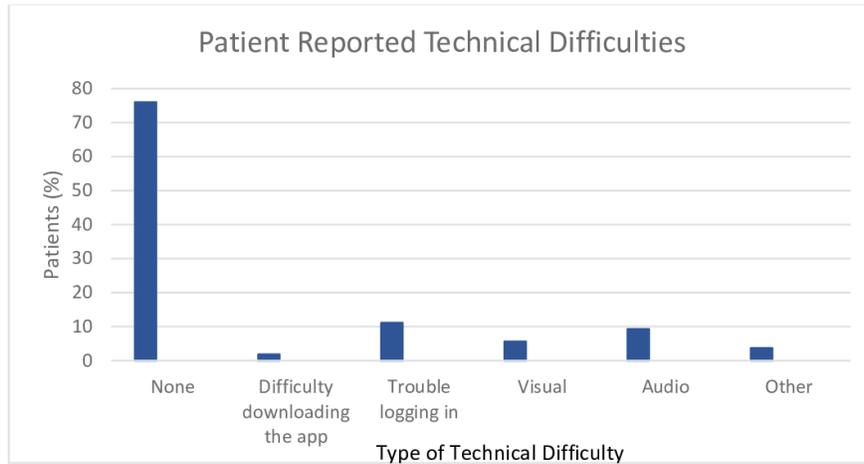


Figure 5B

