EVALUATING THE ROLE OF TELEMEDICINE IN INCREASING ACCESS TO NEUROLOGICAL CARE: A RE-AIM ANALYSIS OF A NEUROLOGICAL CONSULT PROGRAM FOR DRUG-INDUCED MOVEMENT DISORDERS

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Abstract

Shortages in access to specialty care exist worldwide, especially for neurological disorders, which are a leading cause of disability. Barriers to care include an unequal distribution of neurologists in certain regions, a shortage of physicians, the distance that patients need to travel, and physical or cognitive impairment. Telemedicine has been promoted as a promising way to address these barriers and to improve access to neurological care. It has been widely used for indications such as stroke, headache, epilepsy, and movement disorders. We focus primarily on the use of telemedicine in movements disorders, where a large proportion of people are limited by mobility changes, caused by their disease progression.

To date, several studies have investigated the usability of telemedicine for movement disorders, especially in Parkinson disease (PD). The first paper is a scoping review of studies that assessed the application of telemedicine for providing care to individuals with movement disorders. The aims and outcome measures of the included papers were reviewed and summarized to describe the main focuses of the literature related to this topic thus far. We confirmed that most of the prior studies had focused on PD, and about 70% enrolled 50 or less participants. There were five main outcomes reported in every study included in the review: feasibility, acceptability, efficacy, validity/reliability, and clinical outcomes. Our conclusion was that telemedicine in movement disorders has been demonstrated as a feasible, acceptable, and effective way to provide care, and healthcare professionals adapted quickly to these visits following the COVID-19 pandemic.

We aimed to investigate if telemedicine could improve access to care in our rural state of Vermont, for patients experiencing drug-induced movement disorders (DIMDs). DIMDs reduce quality of life and can be persistent and irreversible if not recognized and addressed early on. Using the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework, we designed a study with mixed methods to evaluate the implementation of a neurological consult service for patients with DIMDs. Our findings were that patients and their mental health clinicians who were engaged in the project were satisfied with the service, and that finding ways to support both groups of respondents is critical for it to succeed and be maintained.

We further examined the feasibility, effectiveness, and acceptability of the consult service, with a focus on the telemedicine application. Completing visits remotely was feasible, with only one instance of technical issues impacting an exam, and there were high rates of adherence for the initial consult visit. The neurologists were able to effectively assess participants through telemedicine and make care recommendations, which did not adversely impact health outcomes. Lastly, participant and mental health clinician (MHC) reports of satisfaction demonstrate that telemedicine is an acceptable way to provide neurological care to people with DIMDs.

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Dedication

I would like to dedicate this work to my husband, Todd, and the best kids I could ask for, Elliot and Owen. Your support and encouragement gave me the strength to push through the toughest moments.

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Chapter 1: Telemedicine in Neurology: A Scoping Review of Key Outcomes in Movement Disorders

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Abstract

Background

Telemedicine for neurological care has been researched and practiced in various ways over the past three decades, but the recent COVID-19 pandemic has rapidly expanded its use and highlighted the need for a synthesis of the existing literature. We aim to review the methodology and outcomes of previous studies that have evaluated the use of telemedicine in movement disorders.

Methods

This scoping review was performed by searching PubMed, Ovid MEDLINE, and CINAHL databases from 1946 to November 2020. Studies that assessed the application of telemedicine for delivering care to patients with a movement disorder were included. We reported the aims and employed methodologies and categorized the outcomes from each study.

Results

The search retrieved 228 articles, and 41 studies met the criteria for inclusion in the review. The majority of telemedicine studies were case series or randomized controlled pilot trials, investigating feasibility and acceptability in Parkinson's disease (PD). Even with heterogeneity among outcome measures, they can be categorized into themes, such as feasibility, satisfaction, and efficacy.

Conclusions

Telemedicine use has grown rapidly, due to the demands of providing care during a global pandemic. This application of telemedicine has been considered a promising way to expand care in Neurology, though research evaluating the dissemination of its use is

dilatory. This review highlights the number of studies that have found telemedicine to be an acceptable and feasible way to deliver care for movement disorders. Further research is needed to expand on harmonization of outcomes, reach, adoption, and long-term use of telemedicine.

Introduction

Rationale

Telemedicine, defined here as the use of real-time, synchronous audiovisual technology to examine, monitor, and treat patients while the clinician is in a different physical location, is a promising method of providing neurological care, and potentially leads to better patient outcomes.[1-4] Telemedicine in Neurology initially gained popularity for its use in stroke care, referred to as "telestroke" in an early editorial published in *Stroke* in 1999.[5] Since its inception, telestroke has become a critical component of stroke systems of care, promoting hub-and-spoke models that facilitate physician collaboration between a stroke center and area hospitals, expediting evaluation, and improving quality of care for patients that may require time-sensitive thrombolytic treatment.[6] While telestroke has become widely accepted in advanced stroke care, other subspecialties have not adopted telemedicine into their practice, perhaps due to inconclusive data from patients and providers on feasibility and acceptability, as well as lack of reimbursement, and lower patient acuity.[7]

Telemedicine could be especially important in movement disorders, where a large proportion of patients experience limited mobility caused by disease progression, rely on

visual assessments by movement disorder specialists, and may require multidisciplinary care. [4,8,9] The vast majority of published studies evaluating telemedicine use in movement disorders focuses on its application in Parkinson's disease (PD) care. In the PD population, telemedicine has been shown as a useful tool to provide speech therapy, exercise programs, and follow-up care.[17-19,22-24,40] In contrast, few studies have reported on telemedicine for other movement disorders, such as Huntington's disease (HD), Essential Tremor (ET), drug-induced movement disorders, or Tics.[10]

For individuals with a movement disorder there are a number of barriers impacting access to health care, including travel distance, physical or cognitive impairment, an unequal distribution of neurologists, and a paucity of specialists relative to the population prevalence.[11,12] In the last year, healthcare providers and patients faced an additional, unprecedented barrier, the COVID-19 pandemic. In a matter of weeks, neurologists were forced to transition from in-person visits with their patients to telemedicine. This abrupt shift in practice has highlighted the benefits and frustrations of using telemedicine, while also increasing users' experience with the technology.[13]

With this hasty adoption of telemedicine, it is an important time to review and identify the aspects of telemedicine that have been deemed acceptable or feasible. Previous studies across neurology subspecialties indicate that visits conducted through telemedicine are noninferior to in-person visits, when comparing patient and clinician satisfaction, diagnostic accuracy, and improved outcomes.[7] However, limitations such as study size, methodology, and heterogeneity of measuring outcomes, leave gaps in our

understanding of telemedicine's full potential. The objective of this scoping review was to summarize the existing literature for real-time telemedicine contact between clinicians and patients with movement disorders, with a focus on the various study methodologies and reported outcomes.

Methods

Search Strategy

This extensive review was performed following the Preferred Reporting Items for Systematic Reviews and Meta Analyses extension for Scoping Reviews (PRISMA-ScR).[14] Original research articles were identified by searching the PubMed (1946-November 2020), Ovid MEDLINE (1946-November 2020), and CINAHL (1976-November 2020) databases. The search strategy was developed with the assistance of a medical librarian (DO) and included terms for movement disorders and telemedicine. The complete search in PubMed was a combination of movement disorder-related Medical Subject Headings (MeSH), such as "essential tremor", "Parkinson disease", "Huntington disease", and "drug induced movement disorder" along with the MeSH "Telemedicine" and other "tele-terms." Tele-terms is a phrase used by our librarian to refer to the multiple synonyms found throughout the literature to describe remote health care technologies. After submitting the search terms into PubMed, the filters for Clinical Trial and Randomized Controlled Trial were selected. A similar approach was used in the CINAHL database.

In Ovid MEDLINE, a four-step search was created by first entering the term "movement disorders" and selecting the subcategories, as well as "Parkinson disease" and "Huntington disease" on the mapping page. The next search for "telehealth" resulted in an output of "telemedicine" and subheadings "telepathology", "teleradiology", and "telerehabilitation", all of which were selected. Both groups of search terms were combined with AND, and the results were limited to the English language and in-human studies (see screenshot of search in Appendix 1).

Study selection

Studies were screened manually within each database and selected if there was an indication of real-time telemedicine associated with the delivery of care or therapy for patients with a movement disorder in the title or abstract. A data charting form was created in Microsoft Excel, and duplicates were removed by searching for keywords within each title using the Excel search tool and highlighting the articles to delete. Articles were excluded from the review if they were assessing internet-delivered therapies or remote symptom tracking but did not involve a telemedicine component. Also, articles that recommended telemedicine or that proposed a telemedicine program, but did not evaluate telemedicine use in a population with a movement disorder were excluded. Table 1.1 provides the inclusion and exclusion criteria for studies in this review.

Data extraction and synthesis

Specific data were extracted independently by one of the authors (EH) from the eligible full-text articles and organized for evaluation within the data charting form by disorder. Extracted information included title, authors, publication year, journal, purpose, methods, sample size, target disease, reported outcomes, conclusions, and limitations. Due to the heterogeneity of the study methods, outcomes, and samples, a meta-analysis was not appropriate for this review. Rather, the outcomes for each article were determined through the title, objectives posed in the abstract, and the findings that were presented in the results. The main outcomes were then categorized into themes: feasibility, acceptability/satisfaction, validity/reliability, efficacy, and clinical outcomes. The frequencies of each category are presented below.

Results

Study selection

The systematic searches of the three databases initially identified 228 studies. After duplicate articles were removed, as well as those that did not meet the eligibility criteria, 41 articles remained for the final review. The PRISMA flowchart summarizes this process (Figure 1.1).

Study characteristics

The majority of studies involving a telemedicine application for movement disorders focus on its use within the PD population. Of the articles selected for this review, 35 involved evaluation of telemedicine for PD alone (85%)[3, 15-48]. Two of the articles focus solely on telemedicine use in HD (5%)[50,51] and one study evaluated both PD and HD (2.5%).[49] The remaining articles examine telemedicine application in a pediatric

population that experiences tics (5%)[52,53] as well as participants that are at-risk for developing a drug-induced movement disorder, based on duration of antipsychotic use (2.5%).[54] A summary of study characteristics is presented in Table 1.2.

Nearly one-third of the studies included in this review employ a randomized controlled trial (RCT) design (34%); nine studies in PD[3,18,24,25,29,30,32,36,44], one HD trial[48], and both of the chronic tic disorder (CTD) studies.[50,51] This includes two PD studies that expand on the primary data analyzed as a result of a large RCT published by Beck et al. (2017).[27,28] The remainder (66%) are reported as case reports, case series, or cohort studies. Among the articles reviewed, most (71%) enrolled 50 participants or less, identify as pilot studies, or focus their objectives on feasibility. There are 12 articles (29%) with a sample size larger than 50; four of those studies enrolled more than 100 participants with a movement disorder (PD), and each one was published in the last five years.[18,26,35,36.]

Categorization of reported outcomes

Only a few of the articles included in this review explicitly stated their primary and secondary outcomes.[3,18,24,25,30,31,39,44,46,52,53] Other papers state their planned outcomes in the abstract, as well as report them in the results section. As indicated below, there are studies with multiple outcomes, which have been categorized into five themes: feasibility, acceptability/satisfaction, efficacy, validity/reliability, and clinical outcomes.

1. Feasibility

The feasibility of completing telemedicine visits and conducting the videoconferencing sessions using the necessary technology was evaluated in 21 studies. In an early study published in 2006, the authors reported that telemedicine was effective for conducting follow-up visits for PwP who lived at facilities which had an established telemedicine network with the Seattle Veterans Administration Medical Center.[15] In a three-year period, the facilities used existing equipment to complete 100 follow-up visits for 34 patients, with an internet connection speed of only 384 kbps. Following this study, an effort has been made to assess the feasibility of completing real-time video calls in the patients' homes, eliminating the need to travel.

A large RCT assessing telemedicine use in PD defined the primary outcome of feasibility by the percentage of participants that completed at least one visit (98%) and visits that were completed as scheduled (91%).[18] The authors reported that 96% of the study participants were familiar with the internet and e-mail, and that 54% had previously participated in a video call. Similarly, in 2013 Dorsey et al. examined the feasibility of providing care to people with PD (PwP) in a rural community and found no significant difference in proportion of completed visits between the in-person group and the telemedicine group ($p=.99$).[25] In an effort to report on the feasibility of a telemedicine visit with a Movement Disorder Specialist (MDS) in a large, multi-center cohort study, 277 participants were enrolled and the number of participants that completed a visit was provided (258), as well as the percentage of visits that occurred as scheduled (91%).[35] Two articles assessed the feasibility of performing the Montreal Cognitive Assessment (MoCA) through telemedicine, with one measuring the outcome as number of MoCA

items completed remotely (all of them)[43] and the other study determining feasibility by the rate and description of technological complications.[47] In 2015, Chen et al. published an initial examination of the demands for remote deep brain stimulation (DBS) evaluation and determined that there was an urgent need for DBS postoperative follow-up.[16] The results from four clinical cases indicated that telemedicine is a feasible method of conducting these visits for patients with DBS. Overall, telemedicine has been shown as a feasible and efficient means of connecting healthcare clinicians with patients of varying needs.[17]

2. Acceptability/satisfaction

The other most commonly reported outcome was acceptability or satisfaction; terms that appeared to be used interchangeably and were found in 20 of the reviewed articles. In British Columbia the application of telemedicine to predictive testing for HD was examined and the authors reported that there was no significant difference in participant satisfaction between the in-person and telemedicine groups.[49] The surveys contained questions related to participants' experience with the predictive testing process, reflecting how acceptable they found it, as well as questions directly asking about levels of satisfaction. Examples were: "Overall I was given enough support from the genetics team during the period following my genetic results" and "Overall I was satisfied with the support provided during the entire process by the health care professionals." In one of the many PD studies that looked at both feasibility and patient satisfaction, six aspects of the telemedicine visit were highlighted to determine levels of satisfaction.[45] On a scale from "very satisfied" to "very unsatisfied" participants were asked to rate items such as

quality of the connection, the specialist's ability to gather relevant information, and their ability to convey feelings, symptoms and information to the specialist. For all items, at least 90% of participants were satisfied or very satisfied.[45] Two studies of long-term follow-up care for PD reported high satisfaction with telemedicine among patients, families, neurologists, and the nursing staff, regardless of one of the studies being published early on in 2006 and noting less-than-optimal video quality in 82 out of 100 visits.[17,15] In general, studies that have assessed satisfaction with telemedicine found the majority of participants to be satisfied, likewise for clinicians that are involved.[3,19-22,24,26,34,35,39,40,45,47,48,51]

3. Efficacy

Efficacy is an outcome that overlapped with feasibility and satisfaction in a number of studies, but also became the primary outcome in most of the articles involving a therapeutic intervention. Among the PD studies, we identified seven involving the delivery of the Lee Silverman Voice Treatment (LSVT)[22-24,31,33,40,46] and 5 implementing a physical therapy or activity program.[30,32,36,41,44] In six of the articles, changes in speech from baseline to the end of a 4-week intensive program indicated the efficacy of the program. Constantinescu et al. reported in 2011 that online delivery of LSVT is non-inferior to in-person based on the mean change in sound pressure level on a monologue task.[24] This was following two preliminary studies that determined delivery of LSVT through telemedicine was effective in achieving comparable gains in speech.[22,33] Four of the physical therapy articles reported on efficacy measures, such as the Berg Balance Scale (BBS), 10M walking test, and Time Up and Go Test (TUG), following the use of a

virtual reality balance training program or a coaching program called Engage-PD.[30,36,41,44] Gandolfi et al.[30] reported a significant improvement in physical performance after seven weeks of therapy. Quinn and colleagues reported that in the context of the Covid-19 pandemic, PwP who participated in their study and received individualized exercise programs remotely had improvements in their physical activity.[41] In children with a chronic tic disorder (CTD), two studies have examined the use of telemedicine to deliver Comprehensive Behavioral Intervention for Tics (CBIT), measuring the pre- to post-treatment change with the Yale Global Tic Severity Scale (YGTSS).[52,53] Similar to physical and speech therapy in PD, the CTD studies showed that CBIT administered through telemedicine was effective for reducing tics, without a significant difference between the in-person and remote groups.

4. Validity/reliability

In this review, 11 articles report assessing for validity, reliability, or both. Interrater reliability was evaluated in five of the studies by comparing in-person to telemedicine findings, typically done in tandem.[23,32,34,50,54] In 2011, Amarendran *et al*.[54] described their methods for determining if the Abnormal Involuntary Movement Scale (AIMS) could be reliably measured through telemedicine. In their study, participants in an exam room were observed by two psychiatrists face-to-face, and two psychiatrists in a nearby room, who completed the assessments through video and audio equipment. Calculating for the Intraclass Correlation Coefficient (ICC), they determined consensus of the raters and found concordance with their AIMS scores. An example of measuring validity can be seen in a study that leveraged the online registry for PwP, Fox Trial Finder, to recruit

participants and connect them with an MDS for one visit.[26] The researchers accessed the participants' self-reported data in Fox Trial Finder, including their diagnosis, which they compared to their own impressions following the telemedicine visit. They determined the validity of self-diagnosis of PD in 97% of cases.

The pilot RCT published by Dorsey *et al.* in 2010 assessed both the test-retest reliability and validity of the UPDRS motor subscale, which was completed at multiple time points via telemedicine. [3] The UPDRS Part III was initially completed at the baseline visit, and again at the Month 1 visit, following no changes to participants' medications. There was fair or better agreement for all motor items between the in-person and telemedicine assessments (Cohen's kappa = 0.20), except for rigidity and leg agility (Cohen's kappa = -0.09 and -0.30, respectively). These values improved when three motor fluctuators were excluded from the analysis. The final two sets of UPDRS motor assessments were performed two weeks apart at Month 6 and 6.1 and used to calculate test-retest reliability. The reported ICC was 0.82, signaling an excellent test-retest reliability for the UPDRS Part III performed through telemedicine.

5. Clinical Outcomes

Nine studies have reported outcomes that fall outside of the four previous categories, yet are meaningful in how they describe participant experiences with, and implications of, telemedicine. For instance, four of these studies provide data on clinical recommendations made to participants or Primary Care Physicians, by an MDS. The percentage of encounters with a care recommendation, or most common care

recommendations were reported.[28,42,43,47] In addition, Mammen et al.[37] aimed to qualitatively evaluate how PwP and physicians perceive telemedicine visits, describing how the convenience and comfort of the virtual calls were beneficial, how they experienced quality care with frequent visits and thorough assessments, and how the remote sessions allowed for interpersonal engagement. Other broad clinical outcome measures include rates of Serious Adverse Events (SAEs) and device complaints,[48] as well as Quality of Life scales, when they are not used as efficacy tools.[30]

Discussion

Summary of evidence

This scoping review aims to provide an overview of the existing literature evaluating telemedicine use in movement disorders. Since Hubble and colleagues published their accounts of using videoconferencing to interact with PD patients in 1992 and 1993[18,19], many studies have set out to demonstrate the feasibility, validity and reliability of visits completed remotely. Investigators have employed unique methodologies in their trials, while aiming for similar outcomes. We categorized these outcomes into five groups and highlighted key findings from each one.

In many of the applications of telemedicine described here, researchers are delivering therapies that have already been proven as effective in their target populations. For instance, the LSVT program has been well-established as an effective speech therapy for PwP who experience dysarthria.[20,21] Similarly, for children with CTD, CBIT has been endorsed as a first-line treatment for reducing tic symptom severity.[22] Of note, there are

data to support the importance of an in-person visit with an MDS for improving health outcomes for PwP[23,24], but the question remains: do patients who complete visits through real-time telemedicine experience these same benefits? Studies completed to-date seem to overwhelmingly endorse the use of telemedicine, with positive patient and clinician feedback, as well as favorable feasibility data. The novelty of many of the studies included in this review is the telemedicine component--the ability of clinicians to provide evidence-based therapies to patients who are not physically in front of them--while maintaining a high quality of care. Rapid technological advances from the early 2000's to the mid to late 2010's facilitated the evolution of evaluating telemedicine, from the development and testing of the systems[15,25,26] to advances in wearable technology, web-based applications, and improvements in internet connectivity.[27,28] As we continue to explore the applications of telemedicine and the potential for remote monitoring, the opportunities to expand on delivery of care will continue to grow.

Recently, and in the context of increased telemedicine use, there is concern that remote visits will diminish the connection between patient and physician.[29] Our review found that patients were satisfied with both initial consultation visits[35,45] and follow-up visits[19,41] performed through telemedicine, and some individuals may prefer a combination of remote and in-person visits.[38] Dorsey and colleagues[30] emphasize the importance of patient-centered care, which should be flexible to meet the patient's needs; this includes the ability to expand access to specialist care and minimize travel for those who would be more comfortable remaining in their own home. In movement disorders, clinicians have scrutinized ways to adequately assess a patient without being able to put

hands on them. For instance, in PD there are limitations to completing the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS)[31] motor subscale, as rigidity (item 22) and postural stability (item 30) cannot be examined remotely. [32] However, modified UPDRS motor examinations have been proposed and reported as potentially reliable and valid clinical outcomes for PD patients[33,34] further establishing outcomes that may be conducted at a distance and compared to the standard assessments, especially in the context of consistently missing values. [35]

The COVID-19 pandemic has disrupted many neurological services worldwide.[36] It has also created an opportunity for evolution of our care models, with a large focus on the incorporation of telemedicine. Chen and Hemmen[37] state that by addressing gaps in care we may "develop a feasible telehealth system for a high-quality standard of care post-pandemic." At present, thousands of patients and healthcare professionals are using telemedicine to conduct clinic visits, research visits, and to participate in therapy sessions. In March- April 2020, the International Parkinson and Movement Disorder Society (MDS) Telemedicine Study Group launched a survey across 40 countries to assess four domains of telemedicine: legal regulations, reimbursement, clinical usage and tools, and barriers within each region.[38] Their report confirmed a global increase in all forms of telemedicine, including telephone calls, messaging apps, and video visits. Even though the rise of telemedicine use was consistent across low- and high-income countries, there is a wide spectrum of regulations and infrastructure support. Reimbursement also ranged from none to partially or fully covered by insurance in some countries. Members from 12 countries reported changes in national policy related to

telemedicine during the pandemic, including South Korea, where it was previously illegal to use video calls for clinical care.[38] Shalash et al[39] recently reported on varying levels of patient comfort and acceptance of telemedicine among different socioeconomic and cultural groups. There continues to be ongoing concerns with communicating sensitive information and loss of privacy, and barriers to uptake, such as limited computer literacy, and poor audio/video quality due to internet connectivity issues.[38,39]

On a positive note, movement disorder specialists attest that during the COVID-19 pandemic patients and clinicians have gained experience with telemedicine, promoting equity of access to specialized interdisciplinary care.[39] To ensure continuity of care, as well as clinical research efforts, telemedicine became the safest way to complete visits for chronic diseases such as PD, which can entail frequent medical management and therapeutic adjustments.[40,41] Worldwide, clinicians and investigators have been sharing their experiences with telemedicine during the pandemic, reporting on factors that support their transition to remote care. In the first five weeks of the COVID-19 pandemic, 60% of previously scheduled in-person visits successfully converted to telemedicine visits at a large academic movement disorder center, with distant patients more likely to make the switch, as well as males, and more PD patients completed telemedicine visits than the patients with other movement disorder diagnoses .[17] It was also noted that patients with DBS chose to transition to telemedicine visits at a higher rate than patients without DBS. Some neurologists are skeptical that a remote examination is well-suited for a new diagnosis, especially in complex cases, and prefer to conduct follow-up visits with established patients [39,42,43] Additional researchers believe that smartphone

applications and wearable sensors for remote patient monitoring can provide objective data that may be used to supplement the MDS-UPDRS or virtual examinations, as well as to complete outcome measures.[40,41,43]

In summary, there's been an unexpected shift towards remote visits, and the combination of research evidence and real-life experience should continue to promote the utilization of telemedicine moving forward. Future studies can help investigators determine if there has been any change in patient and physician perceptions of telemedicine since the pandemic, as well as the preferred methods of completing visits and collecting data. These insights would enable the implementation of telemedicine, addressing barriers to accessing healthcare, while disseminating specialized neurological care, especially in rural areas and regions with limited connectivity.

Limitations

In this scoping review, we did not intend to assess the quality of the literature through a critical appraisal, but instead aimed to provide a comprehensive summary of the studies and key outcomes. The outcomes could not be compared, due to the different study designs, samples, and interventions. The initial article screening and data charting were performed independently by one rater, which could have biased the articles chosen or the details that were selected from the articles.

Conclusion

Telemedicine use in movement disorder populations, especially PD, is a feasible, acceptable, and effective way to provide care in many settings. Healthcare professionals and patients have quickly adapted to remote visits during the COVID-19 pandemic, and this may shape how we deliver care in the future. Additional research into implementation of telemedicine services will be essential in guiding decisions for patient-centered care, and researchers could harmonize the way they evaluate it through developed frameworks.

Table 1.1 Inclusion and exclusion criteria

Inclusion Criteria	1) Articles published in English in peer-reviewed journals 2) Patient populations affected by neurological movement disorders 3) Studies that evaluate a telemedicine intervention or delivery of care 4) The telemedicine session is synchronous (performed in real-time) 5) Outcomes have been reported
Exclusion Criteria	1) Studied population was not clearly specified 2) Review articles, study protocols, letters to editors and conference papers 3) Interventions made by other methods of remote communication (e.g. by telephone) 5) Remote therapy (such as speech or physical therapy) without real-time telemedicine connection with clinicians or study team 6) Models of telemedicine care, or forward-thinking statements, without evaluation of a telemedicine protocol

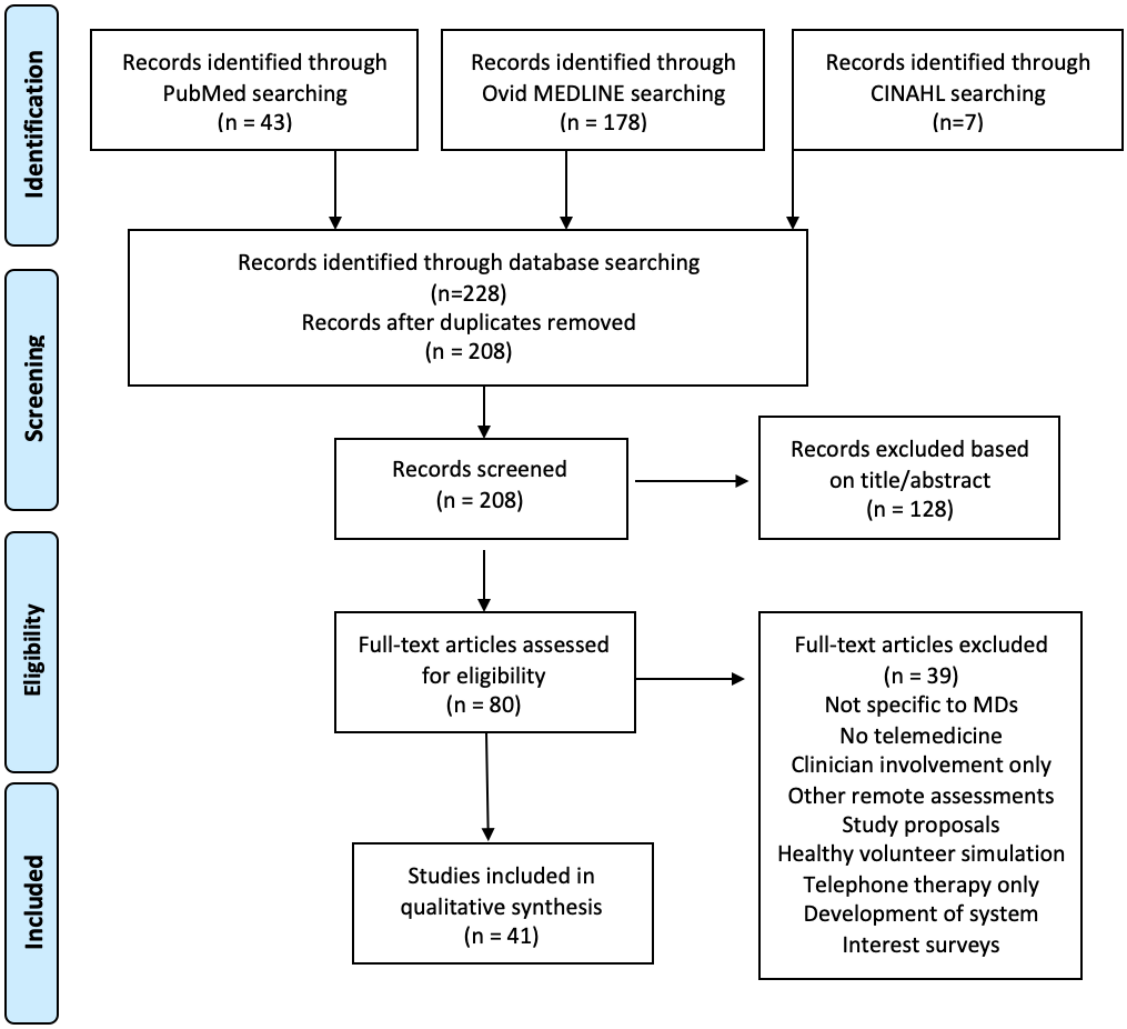

Figure 1.1 PRISMA flow diagram of study identification

Table 1.2 Characteristics of eligible studies

First Author, Year	Objective	Methods	Sample Size	Population	Reported Outcomes
Parkinson's Disease					
Agarwal S, 2018[44]	To explore preliminary effects of remotely supervised-transcranial direct current stimulation (RD-tDCS) paired with cognitive training in PD	Open-label study, 10 tDCS sessions over 2 weeks through video conferencing	16	PD	Change in UPDRS total and motor scores and Grooved Pegboard Test completion time
Arora S, 2015[45]	To determine a PD diagnosis and predict the modified UPDRS motor scores	Pilot cohort study- assessments completed on a smartphone app 4x/day for one month, with once/week TM visits with MDS	20 (10 PD, 10 controls)	PD	Adherence to daily tests; ability to discriminate between a control and PwP; mean error in predicting score on UPDRS motor
Barbour PJ, 2016[46]	To demonstrate the benefit of TM for long-term care for PwP living in a facility	Retrospective cohort study - data collected from previous TM visits done over a 3-yr period	16	PD	Change in UPDRS scores; cost of TM visit; patient, family, specialist, and nursing satisfaction
Beck CA, 2017[47]	To determine if providing remote neurological care to PwP in their homes is feasible, beneficial, and valuable	1year RCT; usual care vs usual care + 4 virtual visits via TM	195	PD	Primary: feasibility (% visits completed and on time) and efficacy-change in PDQ-39; secondary: quality of care, caregiver burden, 12-month change in MDS-UPDRS, time and travel savings

Biglan KM, 2009[48]	To report on experience with completing visits via TM to a PwP living in a nursing home	Case report- six TM visits between Oct 2007 and June 2008	1	PD	Technical findings; patient satisfaction; medication adjustments; other clinical outcomes
Cancela J, 2013[49]	To summarize the technical performance of PERFORM (a TM system for remote monitoring) and patient feedback on usability and wearability	Iterative design process to develop PERFORM; last phase included the evaluation of the system and TM visits	24	PD	Technical performance, participant feedback, system wearability
Chen Y, 2015[16]	To explore the required components of a DBS TM program	Case series- one remote session with a neurosurgeon to make DBS adjustments	3	PD	Feasibility (# of visits completed); the # of instructions delivered through the system and implementation time (in sec); patient satisfaction (ASQ)
Constantinescu G, 2010[50]	To evaluate the validity and feasibility of online delivery of the LSVT to a PwP	Case report- delivery of LSVT via videoconferencing system over 16 sessions (4/wk for 4 wks) by a SLP	1	PD	Improvements in speech outcomes; participant satisfaction; adoption of TM for future care
Constantinescu G, 2010[51]	To investigate the validity and reliability of a TM app for assessing speech and voice disorder among PwP	Case series of subjects assessed simultaneously in an online and face-to-face environment	61	PD	% close agreement between the in-person and online rater
Constantinescu G, 2011[52]	To investigate the validity and reliability of online delivery of LSVT for PD	Single-blinded randomized controlled noninferiority trial; LSVT conducted online or face-to-face, 1 hr/day, 4d/wk, for 4 wks	34	PD	Primary: mean change in sound pressure level on a monologue task; secondary: acoustic parameter, perceptual voice

					parameters, participant satisfaction
Dorsey ER, 2010[3]	To evaluate the feasibility of providing specialty care to PwP via TM in a remote community	RCT; TM care with movement disorder specialist (3 TM visits over 6 months) vs usual care	10	PD	Primary: feasibility (completion of TM visits); secondary: QOL (PDQ-39), patient satisfaction (MGHAA-CSS), motor performance (UPDRS III), mood (geriatric depression scale short form), cognition (MoCA)
Dorsey ER, 2013[53]	To evaluate the feasibility, effectiveness, and economic benefits of using TM to provide specialty care to PwP in their homes.	RCT; care from specialist through TM or in-person, 7 months	20	PD	Primary: feasibility (% visits completed), PDQ-39; secondary: economic value (time and travel costs)
Dorsey ER, 2015[54]	To assess the feasibility of TMresearch visits for PwP; collect phenotypic data; validate self-reported diagnosis; gauge interest in remote research visit	Case series-participants recruited through Fox Trial Finder; TM visit conducted with MDS	166	PD	MoCA and UPDRS motor scores; likely diagnosis of PD; physician and participant satisfaction; reported experiences with the TM visit
Dorsey ER, 2016[55]	To report on interest, feasibility, barriers to enrollment	1 yr RCT (see Beck, 2017)	195	PD	Enrollment, study population characteristics, remote assessment completion rates

Elson MJ,2018[56]	To determine 1) did clinicians receive recommendations from remote specialists 2) were recommendations implemented 3) what barriers to specialty care did local clinicians perceive 4) would they recommend video visits	Following an RCT (Beck, 2017), survey sent to clinicians	183	Clinicians who care for PwP	% survey response rate; % received recommendations and %of clinicians that implemented them; was it beneficial to patients
Fincher L, 2009[57]	To evaluate the usefulness and usability of follow-up medication counseling via TM	RCT; one educational session to review medications, either by telephone or TM	49	PD	Patient and nurse usefulness and usability of intervention-PPTQ and NPTQ; patient satisfaction; themes from open-ended questions
Gandolfi M, 2017[58]	To compare improvements in postural stability in PD after remote-home VR balance training and in-clinic sensor integration balance training	Single blind RCT: In-person vs home-based TR 3d/wk for 7 wks	76	PD	Primary: BBS; secondary: ABC, 10M walking test, DGI, PDQ-8, # of falls, satisfaction, costs
Griffin M, 2018[59]	To compare recorded speech variables between traditional in-person LSVT and remote treatment (using iPad)	Noninferiority cohort study; LSVT remote treatment through an iPad vs In-person	29	PD	Primary: efficacy-LSVT task variables
Hoffmann T, 2008[60]	To determine the validity, intra- and inter-rater reliability of the TR system in measuring ADL and hand function	RCT; face-to-face compared to TR	12	PD	ADL: FIM, select items from UPDRS; Hand function: nine hole peg test, Jamar dynamometer and Preston pinch gauge
Howell S, 2009[61]	To determine the feasibility of delivering the LSVT remotely	Case series-four one-hour sessions per week for four weeks (16 sessions total);	3	PD	Difference between pre- and post-scores;

		one session /wk completed in-person			comparisons to a previous study of in-person therapy
Hubble JP, 1993[19]	To assess the validity of evaluation through TM for PwP	Case series- independent UPDRS examination was completed in-person and through interactive videoconferencing for each participant on the same day	9	PD	Inter-rater reliability (difference in scores per rater); participant perceptions of this use of technology
Korn, Ryan E., 2017[62]	To assess the feasibility and benefits of a one-time consultation between a remote MDS and a PwP at their home	Noncontrolled cohort study with one TM visit with MDS	277 patients; 14 physicians	PD	Feasibility (% visits completed), QOL (PDQ-39), satisfaction with visits and interest in future visits
Lai B, 2020[63]	To examine the uptake and implementation of two remote exercise training methods	Randomized pilot study of telecoach-assisted exercise (TAE) compared to self-regulated exercise (SRE); 8 wks	10 TAE; 10 SRE	PD	Adherence (# of sessions performed, min/wk of exercise, time at moderate intensity/wk, attendance), program perception (focus on equipment, setting, coaching, and rationale)
Mammen JR, 2017[64]	To determine how patients and physicians perceive virtual visits; to identify components contributing to positive and negative perceptions	12-month RCT; usual care, or usual care + 4 virtual visits	149	PD	Qualitative analysis themes: personal benefits of virtual visit, perceived quality of care, perceived quality of interpersonal engagement
Pretzer-Aboff, 2015[65]	To evaluate the implementation of multidisciplinary care to PwP in a state lacking a Movement	Case series, one comprehensive visit with multidisciplinary team through hybrid	36	PD	Savings (travel time, distance, wait time for appointment);

	Disorder Center (Delaware)	model (TM connection to MDS and MHC, as well as in-person visits with other members of care team)			types of referrals
Qiang JK, 2015[66]	To evaluate user satisfaction and predictors of use of TM among PwP	Case series of a survey- satisfaction questionnaire was sent to users of TM and non-users	34 users; 103 non-users	PD	Cost reduction for users; user and non-user interest in TM; user satisfaction; factors associated with interest in TM
Quinn R, 2019[67]	To determine the feasibility of delivering a group speech maintenance program (eLoud and Proud) remotely	Case series: pre-post comparisons of speech following LSVT; two 90-min sessions/wk for four weeks through TR	8	PD	Primary: speech pressure level (SPL) from pre to post; secondary: participant satisfaction
Quinn L, 2020[68]	To describe a physical activity coaching program (Engage-PD) for PwP	Single cohort implementation study; up to 4 TM coaching sessions in 3 months	27	PD	Recruitment rate; physical activity and self-efficacy measures
Samii A, 2006[15]	To report on experiences with TM, including acceptability and cost-effectiveness	Case series- three-year follow-up period through TM, across 8 facilities by the Veterans Health Administration	34	PD	Video quality, number of visits with recommendations made by MDS, resource savings
Schneider R, 2016[69]	To examine the types of medical recommendations made to PwP during a TM visit with a MDS	Retrospective review of encounter note for a TM visit with a MDS	69	PD	Proportion of Parkinsonism diagnosis, % of encounters with a care recommendation; mean # of changes recommended; types of medical recommendations
Seidler, KJ, 2017 [70]	To assess a TR approach to group tango	Non-randomized controlled study; group tango in-person vs. remote,	10 TR; 10 in-person	PD	Primary: feasibility (retention, adherence, AEs);

		two 1-hr sessions/wk for 12 wks			secondary: balance, motor sign severity, and gait
Stillerova T, 2016[71]	To assess the feasibility of cognitive screening in PwP using TM	Case series-participants complete the MoCA one time in-person, and one week later through TM	11	PD	# of MoCA items completed over TM; Median score change between F2F and TM; satisfaction with TM
Theodoros DG, 2016[72]	To investigate the noninferiority and validity of an intensive speech treatment for PD delivered remotely; to assess effect of location on online delivery	Single-blinded randomized controlled noninferiority trial; LSVT online or face-to-face; 16 one-hour sessions of speech treatment (1hr/day, 4d/wk, for 4 wks)	51	PD	Primary: change in monologue SPL; secondary: perceptual and acoustic measures, QOL- DIP and PDQ-39
Venkataraman V, 2014[73]	To characterize recommendations and feedback from a MDS to PwP	Case series of a one-time consultation with specialist through TM	55	PD	% of visits completed; most common care recommendations; patient satisfaction
Willows T, 2017[74]	To determine the feasibility of TM for LCIG home titration, evaluate resources used, as well as patient, neurologist, and nurse satisfaction	Case series of TM for LCIG titration (from start of NJ titration period until PEG/J placement or end of treatment)	15	PD	Mean time from LCIG start to end of titration; median length of time for each contact; technical problems, satisfaction, SAEs and device complaints
Huntington Disease					
Abdolahi A, 2016[75]	To evaluate the feasibility of administering the MoCA remotely in participants with movement disorders	Case series-baseline assessments in-person, follow-up MoCA completed remotely (3 months later for HD; 7 months later for PD)	9 HD; 8 PD	HD/PD	Feasibility: description and rate of technology complications; change in MoCA scores from BL to

					follow-up; difference in BL scores between groups; predictive value, internal consistency, and reliability in each group
Bull MT, 2014[76]	To determine the feasibility of conducting virtual visits with individuals with HD, to assess the reliability of conducting remote versus in-person motor assessments, and to determine the test-retest reliability of conducting motor assessments remotely	Randomized pilot study- randomized to receive 3 virtual visits over 4 months from one of two MDS	13	HD	% of visits completed; reliability UHDRS motor scores between remote and in-person scores
Hawkins AK, 2013[77]	To evaluate if predictive testing for HD via TM improves access while maintaining quality of care and support	Cohort pilot study- participants completed the predictive testing process either in-person or via TM	28 (15 telemed, 13 in-person)	HD	Participant satisfaction, travel time, participant perceptions of quality of care, education, counseling and support
Chronic Tic Disorder					
Himle MB, 2012[78]	To examine the effectiveness of CBIT delivered over videoconference.	Randomized controlled pilot trial- videoconferencing vs in-person, 8 sessions of CBIT over 10 weeks with pre- and post- treatment assessments and a 4-month follow-up visit	20	CTD	Primary: effect of treatment on YGTSS Total Tic Score
Ricketts EJ, 2016[79]	To examine the efficacy, feasibility and acceptability of VoIP (voice over internet protocol) CBIT (comprehensive behavioral intervention for Tics)	Randomized controlled pilot study- randomized to CBIT or WL; CBIT consisted of two 1.5 hr sessions, then six 1 hr sessions over a 10 wk period; WL group were to receive CBIT at end of study	20 youth (8-17 yrs) (12 CBIT and 8 WL)	CTD	Primary: pre- to post-treatment change in tic severity (YGTSS); secondary: CGI-I

		period, met for baseline and post-treatment assessments			
Durg-Induced Movement Disorders					
Amarendran V, 2011[80]	To determine if the AIMS can be measured reliably through TM	Case series- for each participant, two raters assessed AIMS F2F, and two raters observed through TM, in tandem	50	at-risk for DIMD	Interrater reliability (ICC)

ABC= Activities specific balance confidence, ADL=Activities of Daily Living, AEs= Adverse Events, AIMS=Abnormal Involuntary Movement Scale, ASQ= IBM after-scenario questionnaire, BBS=Berg Balance Scale, CTD=chronic tic disorder, CSQ=client satisfaction questionnaire, DBS= Deep Brain Stimulation, DIP= Dysarthria impact profile, DGI=dynamic gait index, F2F=face-to-face, FIM= functional independence measure, ICC= intraclass Correlation Coefficient, MDS= movement disorder specialist, MHC=mental health clinician, MGHAA-CSS=Modified Group Health Association of America's Consumer Satisfaction Survey), MoCA=Montreal cognitive assessment, NJ=nasojejunal, NPTQ=nurse post-telehealth questionnaire, PEG-J= percutaneous endoscopy gastrostomy with a duodenal/jejunal expansion tube, PDQ-8=Parkinson's disease questionnaire-8 items, PDQ-39= Parkinson Disease Questionnaire-39 items, PPTQ= patient post-teleheath questionnaire, PT = predictive testing, PTQ=parent tic questionnaire, PwP= people with PD, QOL= Quality of Life, SLP=speech language pathologist, TAQ=treatment acceptability questionnaire, TM= Telemedicine, TR= Telerehabilitation, UHDRS=Unified Huntington Disease Rating Scale, UPDRS=Unified Parkinson's Disease Rating Scale, VR=Virtual Reality, VSQ=videoconferencing satisfaction questionnaire

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Chapter 2: Evaluating the Implementation of a Neurological Consult Service to Rural Patients with Drug-Induced Movement Disorders using the RE-AIM Framework

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Abstract

Background

Individuals exposed to medications such as antipsychotics, dopamine receptor blocking agents (DRBAs), and other medications with CNS effects are at risk for developing a drug-induced movement disorder (DIMD). An accurate diagnosis and appropriate plan for reducing the symptoms are crucial, but access to specialist care and provider knowledge about the risks and types of abnormal movements caused by medications is limited in more rural areas. The goal of this study is to evaluate the implementation of a neurological consult service to aid mental health clinicians in diagnosing and managing patients who may have developed a DIMD.

Methods

The Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework guided our design of this study, and mixed methods were used to examine each dimension. Participants were randomized to an in-person or telemedicine group and had two visits with a movement disorders neurologist. Descriptive statistics were used to examine the quantitative outcomes in this pilot study, and qualitative data from interviews were coded in grounded theory.

Results

Over two years, 20 mental health clinicians referred 45 patients to this study. There were 28 participants enrolled and 64% completed two visits with a neurologist. Satisfaction levels were high in both participant groups, and among the mental health clinicians. Feedback for Adoption, Implementation, and Maintenance indicated that communication and resources are imperative for successful implementation of a similar service.

Conclusions

A neurological consult service is recommended to improve care for patients and facilitate collaboration with area mental health clinicians in a rural area. A larger study is warranted to expand on our evaluation with increased participation, feedback, and opportunities for different settings. Additional examinations surrounding the method of the consultations and a standardized clinical measure for DIMDs is recommended before translating these findings into clinical use.

Trial Registration

This study was registered at clinicaltrials.gov, NCT06060444.

Background

Prevalence and impact of DIMD

Drug-induced movement disorders (DIMDs) are characterized by abnormal or bothersome movements that are considered hypokinetic, with reduced magnitude and speed, or hyperkinetic, identified as excessive movements [1-3]. Drug-induced Parkinsonism is a serious hypokinetic disorder in patients typically 50 years and older, due to slowness and rigidity that contributes to an increased risk for gait changes, falls, and functional impairment that can lead to placement in long-term care facilities [4]. Tardive dyskinesia (TD) is a common example of a potentially irreversible hyperkinetic DIMD that commonly presents as repetitive, spontaneous orofacial movements, often with additional choreiform movements of the extremities [3]. Tardive syndromes, such as akathisia, tics, tremor, myoclonus, or dystonia, can co-occur with the dyskinetic movements and become difficult to effectively manage [5,6]. TD, parkinsonism, and other

DIMDs can be challenging to differentiate between, due to the heterogeneity of the uncontrollable, involuntary movements between cases, commonly generalized with the term "extrapyramidal symptoms" [7]. Patients who suffer from TD have reported worse quality of life, increased social withdrawal, and higher mortality than individuals who are also treated for bipolar disorder, major depressive disorder, and schizophrenia, but do not have TD symptoms[8-10]. Early recognition of a DIMD and an accurate diagnosis is crucial for prompt intervention and lessening the impact of these disorders on patients' lives [11-13]. DIMDs, especially tardive syndromes, can be persistent and irreversible.

The extrapyramidal symptoms associated with movement disorders are caused by the use of dopamine receptor blocking agents (DRBAs), such as antipsychotics and antiemetics, selective serotonin reuptake inhibitors and serotonin norepinephrine reuptake inhibitors, calcium channel blockers, and other medications [2,11]. Second generation antipsychotics (SGAs) have been reported in clinical trials as superior to first generation antipsychotics (FGAs) for treating psychotic symptoms related to schizophrenia, with greater response, less relapse, and fewer extrapyramidal symptoms than FGAs [14-16]. The perceived improvement in tolerability with SGAs has led to greater prescribing, especially off-label [2]. In the United States, a three-fold increase in antipsychotic prescriptions between 1997 and 2011, resulted in at least five million people having antipsychotic exposure each year [2,17].The trend also impacted children and adolescents, who saw almost a ten-fold increase in SGA prescriptions from 1993 to 2010, with 65% of prescriptions for off-label uses [18]. The expanded use of SGAs raised concerns about the risks of developing a movement disorder, as this was not eliminated or reduced as expected [19]. Carbon *et al* conducted a

meta-analysis of 57 head-to-head randomized controlled trials measuring the annual TD risk between FGAs and SGAs, and reported the incidence of TD to be reduced among those taking SGAs (2.6%) compared to FGAs (6.5%), but still clinically relevant [20]. The risk of developing a DIMD has persisted, due to the expanded use of antipsychotics and other DRBAs [2,11,21].

Early detection, accurate diagnosis, and appropriate treatments are the best ways to improve the chances that a DIMD is transient and reversible [3,13]. It is advised that a Neurological consultation should be incorporated into a practical care strategy to assist other clinicians with diagnosis and recommendations for a treatment plan, including medication selection [12,22,23]. The treatment options can differ between types of acute and subacute DIMDs, and it is crucial to avoid worsening the movement symptoms or the concurrent psychiatric disorder [24]. Unfortunately, access to movement disorder specialists is challenged by a national shortage of neurologists, an increase in demand, and an unequal distribution of healthcare professionals between urban and rural areas [25,26]. This has created long wait-times following referrals, and has left healthcare professionals, some with limited knowledge of DIMDs, to make decisions surrounding care for emerging or troublesome extrapyramidal symptoms [8]. Researchers have been optimistic that expanded use of telemedicine in movement disorders could allow for improved diagnosis, timely follow-up, and education for patients [27,28]. Interprofessional consultations have been shown as an effective way to facilitate communication between clinicians, aid in diagnostic decisions, and reduce the number of outpatient encounters in a number of neurological subspecialties, like headache, pediatrics, and neuro-

ophthalmology [29-31]. Our study aims to examine the factors that contribute to implementing a consult service, utilizing telemedicine and in-person formats, that connects patients who exhibit suspected DIMD symptoms to a movement disorder specialist, who will review medications and their impressions for final diagnosis with the patient and their mental health clinician (MHC).

RE-AIM Framework

There have been numerous program evaluation frameworks that span from focusing on a single aspect of a telemedicine service, such as the technology or integration, to comprehensively assessing multiple factors that impact the success of a program [32,33]. The RE-AIM framework is an example of an all-encompassing evaluation framework which seeks to incorporate both process and outcome measures, and was developed specifically for public health and community-based interventions [34]. The RE-AIM framework focuses on how beneficial (Reach and Effectiveness) a program is, as well as the perceived success and sustainability (Adoption, Implementation, and Maintenance) within real-world community settings [32,35,36]. In a previous systematic review of grant applications that reported utilizing RE-AIM, fewer than 10% of proposals incorporated all domains or included qualitative methods [37]. It is recommended that studies assess all five domains and use mixed methods to improve the comprehension and reporting of the findings [36]. This project employed the RE-AIM framework to guide program evaluation, including the measures that would be utilized and a data collection plan. It was important to develop methods that would allow a more detailed understanding into how a neurological consultation for DIMDs could be implemented, specifically in our region. To our

knowledge, this study is the first to formally assess the implementation of a neurological consult service for DIMDs involving a movement disorder specialist, other care team members, and two modes of delivery, in-person and telemedicine.

Methods

Design

This pilot study aimed to evaluate the implementation of a neurological consultation service in the rural state of Vermont, using the RE-AIM framework (Table 2.1)[34]. Participants were randomized 1:1 to either the telemedicine or the in-person arm. Patient participants had an initial consult visit (Visit 1) with a neurologist specializing in movement disorders, who assessed their abnormal movements and reviewed medications. The neurologist shared their findings with the referring MHC, and a few months later had a follow-up visit (Visit 2) with the participant. The participants and MHCs were asked to give feedback through questionnaires and interviews. Mixed methods were used to allow for examination of RE-AIM components through a variety of sources, such as surveys, scales, and interviews. This study was approved by the University of Vermont Committees on Human Research (STUDY00001579).

Data Collection and Procedures

The neurology study team (NST) contacted 16 mental health agencies or practices throughout Vermont to recruit mental health clinicians (MHCs). The MHCs were

provided with recruitment materials, including cards to share with their patients and posters to hang in their clinics. By the end of the enrollment period, the MHCs had referred 45 patients with a suspected DIMD. Patient participants were eligible if they were 18 years or older, had been diagnosed with, or were suspected to have, a DIMD, were not currently hospitalized, and were able to either travel to the University of Vermont Medical Center for in-person visits, or connect to the videoconferencing application, Zoom (Zoom Video Communications, Inc., San Jose, CA). After the participants provided their consent to join the study, a referral form or clinic notes, along with the MHC's assessment of the severity of their patient's abnormal movements, were sent to the NST. Severity of abnormal movements was scored by the MHC using the Clinical Global Impression- Severity[38] and the groups were stratified by low severity (1-4), and higher severity (5-7) before being randomized to their study arm.

Patient participants in both the telemedicine (TM) and the in-person (IP) arms had an initial one-hour appointment with one of two movement disorder neurologists at the University of Vermont Medical Center (JTB, LDB). The neurologist followed standard practice of reviewing medications, discussing symptoms with the participant, and evaluating their movements. Without having a universally agreed upon examination or scale to differentiate between varying symptomologies, the choice of assessment was up to the specialist's discretion; however, the Abnormal Involuntary Movement Scale (AIMS) was used when TD was considered and modified for remote encounters. The neurologist completed a visit note, which was shared with the MHC, and they arranged time to discuss the patient's care when necessary. As the primary provider for the

patient's psychiatric care, the MHCs decided if they would follow the recommendations from the neurologist, and then communicated any changes to treatment plans with their patients. Following Visit 1, the participants were sent a link to complete surveys electronically through REDCap electronic data capture tools hosted at the University of Vermont, including a demographics questionnaire, the Clinical Satisfaction Questionnaire (CSQ-8), and the PROMIS®29+2 Profile V2.1[39-41].

At Visit 2, the neurologist determined if their treatment recommendations were applied, and to what extent, as well as if they had additional care changes to consider. They evaluated the participant's abnormal movements and mental health status, evaluating if their recommendations had an impact on their care plan or health. The neurologist documented their findings to again share with the MHC. The participants were sent a second REDCap link to complete the CSQ-8 and PROMIS®29+2 Profile V2.1 after their second visit.

Throughout the study, the NST conducted two rounds of qualitative interviews with the MHCs through Zoom, and audio was recorded to convert the interview into a written transcript. The first round of interviews posed three questions to address themes from the RE-AIM framework: 1) Effectiveness: Are you satisfied with the consultation program? 2) Adoption: What factors impact your adoption of the program, or its usability? 3) Implementation: What do you see as barriers to implementation and how could we address these? The final interview was comprised of questions to build on data from the first round, and included a question related to the RE-AIM component, Maintenance:

"What reinforcing factors would be necessary to maintain a consultation service with Neurology?"

Table 2.2 details the specific questions posed to evaluate each RE-AIM component, the data collection tools used and the timepoint for collection. The RE-AIM framework guided the plan to examine the effect of implementing telemedicine neurological consultations for patients with DIMDs, as well as choosing the evaluating factors that impact the use and success of the telemedicine service offered. *Reach- In this study, are we able to enroll a sample that is representative of the patient population that experiences DIMDs?* Reach was measured using reports and referral forms sent from the MHCs to the NST, which provided data about the practice or agency's population, and what percentage of eligible patients joined the study and received a consultation. *Effectiveness- Is the program piloted in our study impacting important outcomes related to patient care, as well as patient and clinician satisfaction?* The satisfaction of participants was assessed utilizing the CSQ-8 after Visits 1 and 2. Participants also filled out the PROMIS®29+2 V2.1, to allow for the NST to deduce if there were any impacts on the participant health status. The MHCs completed their own six-item survey for program satisfaction and completed qualitative interviews with open-ended questions related to satisfaction with the consult service. Notes between the MHCs and the NST, including the referral form, were used to generate data on the impact of the recommendations to a patient's care plan. *Adoption- Are there factors that determine whether a clinician will initiate participation in this program?* Adoption of the neurological consultation program was evaluated by feedback provided during the qualitative interviews,

specifically asking what factors impacted the MHC's use of the consults, and the characteristics of the MHCs that chose to adopt the program. *Implementation- What barriers exist that may determine the feasibility of the study and neurological consultation?* Implementation of the service was analyzed through visit completion data showing how feasible the two services were, based on rates of successfully completed visits, and any challenges that impacted visit occurrence. Information was also collected during the qualitative interviews about barriers that challenged the implementation, and potential costs between the two groups were compared. *Maintenance- Could a telemedicine program similar to the one we developed for this study become a part of the routine organizational practices?* The maintenance components of a neurological consult service were discussed during the qualitative interviews, in an open-ended format, and quantitatively measured with the MHC survey at the end of the study, which used a 5-point Likert scale to determine how likely they are to use a similar program in the future.

Data Analysis

Reach was analyzed using descriptive statistics to summarize the demographic data of the study group, including age, sex, race, education, marital status, employment status, health insurance type, and movement disorder diagnosis (by neurologist). The number of referred patients and successfully evaluated participants were compared to the number of patients that are cared for by the MHCs and could be eligible, as well as the overall MHCs' number of total of patients who present with possible movement disorders.

To quantify effectiveness, a number of measures were calculated and compared. Participant satisfaction, as indicated using the CSQ-8, provided mean scores for participants following Visits 1 and 2. The two scores were compared using a Wilcoxon rank sum test, with two-tailed significant tests and alpha set at 0.05. Impact on patient health was calculated using the Wilcoxon rank sum test for the difference in mean T scores of each domain of the PROMIS®29+2 Profile V2.1 repeated from Visit 1 to 2. MHC satisfaction was reflected as a percentage of MHCs that answered "satisfied" or "very satisfied" on question #6 of their satisfaction survey, asking "Overall, how satisfied were you with the consultation service?". Their responses from the qualitative interview were coded by one member of the Neurology team (EH), who independently performed open-coding of the responses, following grounded theory methodology [42]. Coding in grounded theory, which involved an in-depth analysis of each line of interview transcript was performed after the initial round of interviews to generate categories and refine questions for the final interview. The data collected from the second interview was coded into categories and analyzed for parallel relationships, leading to a conceptual model of the categories and themes.

To examine the adoption, implementation, and maintenance outcomes, descriptive statistics were used. The proportion of regional practices that used the service was calculated, as well as the characteristics of the MHCs (type of clinician/education, and years in practice). Factors that impact the MHC's adoption of the program, shared during the interview, were qualitatively analyzed as previously described. The frequency of successfully completed visits was compared from Visit 1 to 2 for all participants. Costs to

the participant was estimated by a number of factors, such as time spent travelling to the Neurology clinic, mileage, and cost of the visit based on Medicaid reimbursement schedules. The total costs were analyzed, and normality of the data was verified, in case a log transform was required before running a t-test. For maintenance, the proportion of MHCs who responded "Yes" or "Yes, definitely" to the question "Would you use a consultation service like this in the future?" was measured, and the themes related to this concept were coded in grounded theory, as described above. The statistical analyses for this study were conducted in SPSS (IBM SPSS Statistics, Version 29.0.2.0).

Results

Participants

Figure 2.1 shows the number of individuals referred to the study (n=45), how many were not eligible or chose not to participate (n=7), the number of patients that were not able to be contacted (n=8), and how many were lost to follow-up contact (n=2). There were 28 patient participants randomized and 23 (82%) completed at least one visit. The demographic data of the participants is presented in Table 2.3.

RE-AIM Components

Reach

Seven out of the twenty MHCs that referred patients to the study submitted data regarding the number of individuals that they care for that either have a DIMD diagnosis or symptoms consistent with a DIMD. In total, they report having 57 patients with a

DIMD or symptoms. Out of those 57 patients, 28 would have been eligible for the study (49%), and only 8 out of the 28 (28%) completed the first consult visit. From this subset of MHCs, 14% of their patients with a suspected DIMD were enrolled in our study and assessed by a movement disorder neurologist.

Out of the 45 referred patients, 28 (62%) were randomized to the IP or TM groups. About half of the referred participants completed Visit 1 (51%) and received a consult.
All participants had a history of a psychiatric disorder, and the frequencies are reported in Table 2.3; multiple patients had more than one co-occurring disorder. Participants presented to the neurology clinic primarily with TD (62%), followed by drug-induced parkinsonism (24%). Nine participants showed signs of mixed movement disorders.

Effectiveness

Table 2.4 shows that there was no significant difference in satisfaction between Visits 1 and 2 for all of the participants (p=0.23). The mean CSQ-8 scores for Visit 1 and 2 were 28.76 and 27.72, respectively, out of a maximum of 32 points on the scale. The T scores for seven of the eight domains of PROMIS®29+2 Profile V2.1 had a slight change in the direction of improvement from Visit 1 to 2; cognitive function was unchanged. Figure 2.2 illustrates that for each question on the CSQ-8, more than 80% of participants were satisfied or very satisfied. A majority (88%) of MHCs that responded to the final survey (n=8) were satisfied with the consult service (figure 2.3). The three main themes related to MHC satisfaction identified through the interview were collaboration with colleague, satisfaction byway of patient experience, and timeliness. One MHC statement that

highlights two of these themes was “the recommendations were written in a way that was very accessible to me and I was able to translate it to the person.”

Adoption

Out of 16 practices that were sent site interest surveys, 11 adopted the program (69%), and 20 MHCs within those practices were involved in the study. Forty percent were MHCs practicing in a county mental health agency, 30% work in an academic medical center, 15% of MHCs were based in a community health center, and the remaining 15% of MHCs were from a private practice or University Student Health Center. The MHC group had equal proportions of Psychiatrists and Nurse Practitioners, and seven of the MHCs had a mean 12.6 years in practice (Table 2.5). During the interview, two themes related to the factors that impact adoption of the program or its usability were practice limitations and patient population factors. Many MHC responses fell into categories related to staffing and resources, as well as concerns over the level of care that this patient population necessitates. A MHC working in the community health center remarked that “the morbidity of our patients is very high. People are addressing so many issues and I think there’re patients with movement disorders that are not referred, because providers may think they are not going to be able to do this study, or are not reliable.”

Implementation

Of the 28 participants that were randomized, 23 (82%) successfully completed Visit 1, but only (64%) completed Visit 2. Figure 2.1 shows the details for visits attended and number of participants that completed surveys following each visit for the IP and TM

groups. In the TM group, one person withdrew before Visit 1, due to concerns over their ability to join the call, and another person did not have sufficient quality during the synchronous call to have an exam with the specialist. No one else in the TM reported difficulty with joining the remote appointment. During the interview, MHCs reflected on barriers to the implementation of the study at their site, and the methods to address them. Study operations was identified as one theme, which included categories for the time required to complete tasks, and the need for other staff support at practices. Communication was a theme that encompassed both barrier and resolution categories, such as the lack of a shared electronic medical record (EMR), but flexibility in sharing information using different methods. The third theme became the neurology team role, comprised by codes such as persistence, patient outreach, and flexibility. A clinician commented that their practice "uses completely different documentation systems, and I don't always have access to everything. So sometimes there is an entirely separate system for me to log onto to sort of prep for the visits of these folks and to stay abreast of the situation. It would be so nice if everybody was on the same EMR. It does take some time and digging when preparing to see those patients."

The IP participants would have had the highest potential costs to them, based on the time they spent travelling to our clinic (mean=51.3 min (SD=27.4)), and the estimated mileage cost (mean= $22.76 (SD=$21.49)). Based on the current Vermont Medicaid reimbursement schedules, the In-Person group could incur a cost of $186.47 for the initial consult (Visit 1), and $109.24 at follow-up (Visit 2). Depending on the reimbursement

modifications for telemedicine visits, this amount would either be the same or lower for the remote visits.

Maintenance

The MHCs who responded to the final survey (n=8) all reported that “yes” or “yes, definitely” they would use a consultation service like this in the future. In their interviews, one of the main themes related to maintaining a consult service was support, notably between the MHC and neurology staff, including a contact person to assist them and the patients they refer. The other was flexibility, with examples of a flexible process to place referrals and share notes, as well as flexibility for patients to choose whether to be seen in-person or through telemedicine. A psychiatrist within our academic healthcare center proposed that “it’d be helpful to identify one support person that could act as a go between. Every time you make a referral, if there’s extra paperwork to do, it makes it more challenging for the provider."

Discussion

The aim of this study was to evaluate the implementation of a neurological consult service for patients experiencing movement disorders in a rural state. Through examining each component- Reach, Effectiveness, Adoption, Implementation, and Maintenance, we were able to gain a better understanding of the strengths and weaknesses of our approach to create this service and provide better access to neurological care. The results highlight that there are challenges with engaging this patient population and busy MHCs, but there

is high satisfaction from both groups and potential to build on the feedback provided to develop a program that might better meet their needs.

Reach

In the beginning of the two-year enrollment period, there were efforts to connect primarily with the mental health agencies in Vermont, which provide care to many underserved patients suffering from severe psychiatric disorders, like schizophrenia. Out of the ten county mental health agencies, an MHC from only five of them referred at least one patient, which was lower than we had anticipated, due to our perceived need for additional services among this patient population. This study used a regularly reported reach criterion of percentage of individuals who participated, out of the total number of patients with DIMDs [43]. As indicated by the *reach* results, 14% of individuals receiving treatment with medications that could contribute to abnormal movements were seen by a neurologist at Visit 1. Fewer patients would have been good candidates for this study, as indicated by reports from the MHC, and the proportion doubled to 28% completing an initial visit when eligibility is considered. These numbers are lower than what has been reported in the literature for other movement disorders consultation services, albeit for Parkinson's disease[44,45]. In general, participants were female and older in age, both known risk factors for developing DIMDs. Data was not gathered on how long each participant was exposed to an antipsychotic, DRBA, or other implicated agent. Mentzel *et al.* published DIMD prevalence data in younger patients (mean age=27.1 yrs) and found drug-induced parkinsonism to be the most common disorder, followed by akathisia and TD[46]. In our study sample, the majority of cases exhibited TD, then parkinsonism and

drug-induced tremor. We cannot conclude that the study participants who received a consult were representative of the overall practices involved, due to the small sample size and low response rates from MHCs and their practice staff regarding their overall patient data.

Effectiveness

We anticipated high satisfaction levels from both participant groups, as the study offered improved access to a movement disorder neurologist at a time when a standard referral could take months at our hospital. Indeed, the mean CSQ-8 score for Visit 1 was 28.76, and none of the responses fell below "neutral/indifferent." This dropped about 1 point to 27.72 at visit 2. A couple of the positive comments from the participants were "The doctor was very attentive and explained my issues in detail" and "I feel like a weight has been lifted off my shoulders." Our findings are in-line with previous studies examining satisfaction levels with telemedicine services in neurology, for indications such as stroke and headache, and patient satisfaction with the use of telemedicine to expand psychiatric care to rural regions[47,48] Four participants that gave scores lower than a 3 (mostly satisfied or yes, generally) for at least one question on the CSQ-8, either did not leave a comment about their overall experience, or responded "it was ok" and "I didn't find a solution." The scores for the PROMIS®29+2 Profile V2.1 showed that most health status outcomes had a slight change of less than 2 points in the favorable direction, while fatigue and sleep disturbances had a three and four-point change on the mean T score towards improvement. While this does not reach the 5-point meaningful change threshold, it does bring our sample's T score closer to the mean of the general

public(50)[49]. Overall, the PROMIS®29+2 Profile V2.1 scores show that within this study, our participants are facing a slightly poorer health status, with all values within one SD of the general population T scores, and the study did not have any negative consequences on their health. A larger study with a longer follow-up period could be warranted to evaluate the long-term impacts of the neurology consultations.

The majority of MHCs were satisfied with the consult service in general, and one MHC reported feeling "neutral." The neutral MHC reported difficulty with the referral process differing from standard practice at our institution, requiring a message to be sent to the NST. Similar sentiments were echoed during the qualitative interviews. Most MHCs gave very positive remarks, as shown through some of the quotes in the results section, and there was also constructive feedback provided. It was clear to us from these interviews that the MHCs appreciated the opportunities for collaboration and education surrounding care and medication choices for the patient participants. One MHC did comment on a lack of communication following a visit and had hoped for the opportunity to discuss the recommendations with the Neurologist over the phone. Another MHC received a few of the visit notes, but not all of the summaries for their patients, as our EHR had automatically sent them to the patient's primary care provider, and not to the MHC, who is outside of our network. Regardless, the MHC did indicate that they felt the neurologist's recommended treatment plan was appropriate for the patient. In general, this service was effective in satisfying the MHCs and participants, by providing support from the NST and access to evaluations and recommendations from movement disorder neurologists.

Adoption

Adoption was fairly high at 69%, when we compare the number of practices that had at least one MHC refer a patient. This is within range of previously reported RE-AIM studies of physical activity promotion and positive psychology interventions, which had adoption rates of 11.1% and 84%, respectively[50,51]. When we initially reached out to agencies and MHCs, there was a mix of a robust interest in joining the study, or no response to our attempted communications. Based on MHC feedback from the qualitative interviews, practice limitations, such as a lack of support staff, influenced their decision to adopt the consult service. Alternatively, some practices were not limited by staffing, and had case managers or administrative assistants that could help to send notes or coordinate visits for the patients, which eased adoption. In Vermont, each county has a designated agency that provides the Department of Mental Health's programs for adults and children. Their volume, range of services, and patient population made the agencies seemingly ideal settings to launch our pilot study, but after our efforts to engage them resulted in half of the state's agencies referring at least one patient, we widened our focus to include other practices. From the five county agencies, five Nurse Practitioners and three Psychiatrists adopted the study and referred 16 patients, while the Community Health Center had three Nurse Practitioners refer nine patients, and at the University of Vermont Medical Center six Psychiatrists referred 12 patients. While our initial goal was to enroll more participants from the county agencies, we discovered through conversations with the clinicians, their staff, and the qualitative interviews, that they were concerned that patients would not be able to travel to clinic, have the capacity to

understand the logistics of the study, or be willing to consider changes to their psychiatric medications. These concerns highlight the patient population factors that influence whether or not their MHCs adopt a study that involves them. Future studies could improve adoption by interviewing MHCs in the designing phase of the study, to ask about their patients' specific needs to develop methods to better support them, and the workflow or needs of the MHC and/or practice. Unlike other RE-AIM studies, we did not include characteristics of the MHCs that did not adopt the project, which could improve evaluation in future studies[43].

Implementation

A high percentage of Visit 1's were implemented according to the study protocol, but the number of successfully completed Visit 2's dropped to 64%, largely due to four participants in the TM group, and one in the IP group, withdrawing or ending contact with the NST. Only one patient reported technical difficulties that affected the Zoom call, while other patients in the TM arm reported a preference for remote visits to save time and for the convenience of not having to travel. We found that the costs associated with travelling to clinic and the clinician fees are greater for the IP group. There's growing evidence that telemedicine visits can be implemented to diagnose patients with movement disorders, with better video quality and more reliability[28,52,53]. However, others caution that remote visits can be difficult for patients with communication or cognitive impairments, or that some patients will need to be examined in clinic before moving to telemedicine for follow-up visits [54]. As we consider translating the study findings to clinical use, we recommend that clinicians discuss the preferred method of

care delivery with the patient and/or MHC, and consider any limitations that may affect the ability to carry out a visit, such as patients not having access to a computer or device.

The qualitative interviews with MHCs were an important tool in discussing barriers to implementation, and actions that the NST could take to address them. Initially, it was identified that the referral process was cumbersome to the MHCs; they did not like filling out the study-specific form and each practice was tasked with finding a secure way to submit it. We decided to follow the standard referral process, which is done through our EMR. Not only did this allow for staff to follow a familiar process, saving them valuable time, but clinic notes became readily available to the NST in a more flexible process. The most frequently mentioned barrier was the absence of a common EMR, which would allow for seamless bidirectional sharing of information. Similar to the referral form, the process to send and receive notes over fax or through secure online systems was not always reliable. To address this, the NST would arrange for a peer-to-peer discussion or confirm delivery of notes sent through secure methods. In general, we found that delegating extra tasks to the MHCs, or introducing unfamiliar processes, made it challenging for them to implement study activities. Future work will need to be done to investigate the most efficient way to promote communication and reduce the burden on the referring MHCs.

Maintenance

Themes that emerged when discussing the implementation of the consult service were echoed in comments related to maintenance. For instance, when communication was

strong between the NST and MHC, the MHC could envision this type of service being maintained moving forward with minimal updates. It was also recognized that the NST would need to continue to be flexible in its approach to working with patients and practices, as they all have unique sets of needs and processes and these can change with different patients or staff turnover. Whenever possible, it would be imperative to involve more members of the mental health practices to support the clinicians and their patients with complex needs. Each MHC clinician that completed the survey expressed an interest in continuing to use a consult service in the future, but proposed adding supports for the patients, including for transport and the cost of the visits, as well as a designated contact person. If our clinic were to continue offering this consult service following study completion, there would need to be additional clinical time for the neurologists, including availability to see new patients, as well as administrative support, as indicated in the surveys. We did not collect data on the continuation of care in neurology for participants that had completed the two study visits and continue to be seen by the movement disorder neurologists.

Study Limitations

This study was limited by the small sample size and the number of participants that responded to the surveys, especially in the TM group. Future studies could address the low number of enrolled patients by expanding outreach to additional mental health practices in the region. Surveys could be completed over the phone or at the end of the visit on paper or through Zoom, rather than sending links for patients to navigate. Study recruitment was also limited by the random assignment to IP or TM, as some MHCs were

concerned that their patient would be placed in a group that they couldn't adhere to, either due to travel difficulties or discomfort with technology. Further work with this population will need to weigh the drawbacks and benefits of utilizing a randomized study, or allowing patients to choose which method of meeting with a neurologist best suits their needs. The evaluation of reach was limited by how few practices returned reports on their patient population and number of eligible patients. To achieve a higher response rate in the future, involving a practice supervisor or other practice support person who has access to this data would take the burden off the MHC. Another limitation is that we invited MHCs who had referred at least one participant to complete surveys, but if we included MHCs that did not refer patients, they might've provided a different perspective on what impacted adoption. Lastly, our evaluation of impact on care was limited by the length of follow-up time. Most of the neurologist's recommendations included multiple steps and by Visit 2 there wasn't enough evidence or time to determine if the changes were improving patient health outcomes. This could be addressed with additional assessments over an extended period of time.

Conclusions

Access to specialist care in Vermont and nationwide is being impacted by clinician shortages, complex care needs, and long wait times. Our study shows that there is an interest among MHCs and patients with DIMDs to have the opportunity to consult with a movement disorder neurologist on symptom presentation, diagnosis, and care recommendations. In general, there was high satisfaction among both MHCs and patients. We received valuable feedback from MHCs that will shape care delivery in this

population and across practices, such as the importance of sharing communication preferences, having a dedicated support person, and considering the needs of the patient population. More can be done to expand reach in our region to foster collaboration with colleagues and to engage patients, including examining novel ways to simplify the processes of sharing information and supporting patients in preparing for their visits.

Table 2.1 RE-AIM Elements and Definitions

RE-AIM element	Definition
Reach	The number and percent of people from the targeted population who participate and their representativeness.
Effectiveness	The change in outcomes observed over the duration of the intervention.
Adoption	The number and percent of setting and staff who are expected to use this intervention and who participate
Implementation	The extent to which the intervention is delivered consistently, and the time and costs associated with implementation
Maintenance	The long-term effects on key outcomes, and the extent to which a program is sustained, modified, or discontinued

Table 2.2 Consultation Program RE-AIM Evaluation data

RE-AIM Element **Evaluation question**	**Tool**	**Variables**
Reach		
What percentage of eligible patients received a consultation?	Report from MHC/practices	# of study patients seen/ total # of eligible patients seen by MHC
Were patients who received a telemedicine consult representative of the overall practice?	Referral form/report from MHC/practices	proportion of DIMD diagnoses in study compared to proportion of DIMD diagnosis in practice
What is the diagnostic profile and symptomology of the patient participants?	Referral form/demographics questionnaire	age, sex, race, highest level of education, marital status, employment status, health insurance type, diagnosis, primary psychiatric symptoms, primary neurologic symptoms
Effectiveness		
How satisfied are patients with the program?	CSQ-8	total scores
What are the impacts on patient health status?	PROMIS®29+2 Profile V2.1	*T* scores
Was there concordance in diagnosis between the MHC and movement disorder specialist?	Referral form/visit notes	diagnosis concordance

Was there an impact on care plan?	Referral form/visit notes	medication changes, referrals/diagnostic tests
Were the MHCs satisfied with the program?	MHC survey/Qualitative interviews	total score, percentage of MHCs satisfied (4 or 5 on question #6); themes
Adoption		
What is the percentage of Practices that use the service?	Site Interest Form	# of practices that join the study / # of practices and that were sent the form
What are the characteristics of the MHCs that use the service?	Site Interest Form	clinician type, years in practice
What factors impact the MHC's adoption of the program?	Qualitative Interviews	themes
Implementation		
How feasible is the telemedicine consultation service?	Visit completion data	visits completed, # of visits with technological issues
What barriers to implementation were identified and how were they addressed?	Qualitative Interviews	themes
What are the potential costs to the patient?	Cost data	travel time, distance travelled, Neurology visit fee
Maintenance		
How likely are MHCs to use a program like this in the future?	MHC survey	# of MHCs that respond 4 or 5
What reinforcing factors would be necessary to maintain a consult service?	Qualitative Interviews	themes

Abbreviations: CSQ-8 = Client Service Questionnaire 8-item; DIMD = drug-induced movement disorder; MHC = mental health clinician; PROMIS® = Patient Reported Outcomes Measurement Information System

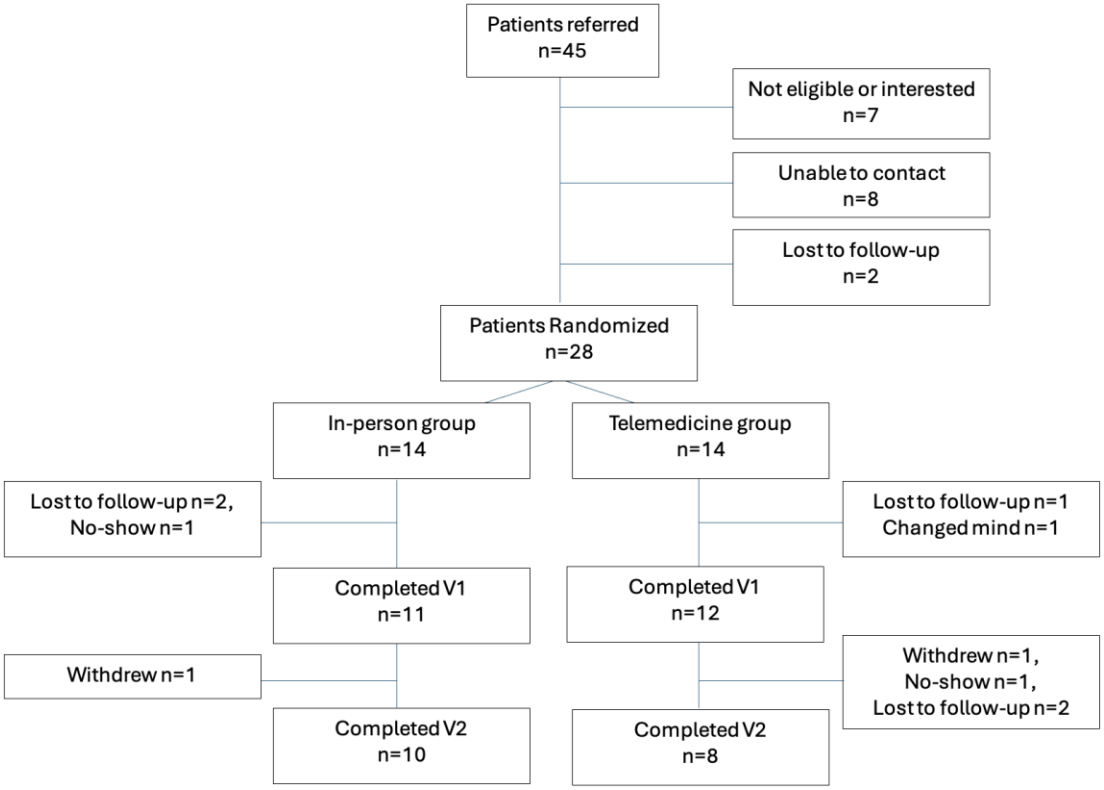

Figure 2.1 Recruitment and visit completion of study participants

Table 2.3 Characteristics of participants at Visit 1

	All Participants n=21
Age	55.4 (12.6)
Female [n (%)]	16 (76)
Caucasian [n (%)]	19 (90)
Bachelor's degree or higher [n (%)]	12 (57)
Currently married [n (%)]	5 (24)
Presently employed [n (%)]	7 (33)
Private insurance	7 (33)
Medicaid or Medicare	13 (62)
Movement disorder diagnosis [n (%)]	
Drug-induced parkinsonism	5 (24)
Tardive dyskinesia	13 (62)
Drug-induced tremor	5 (24)
Drug-induced akathisia	2 (9)
Primary parkinsonism	1 (5)
Essential tremor	1 (5)
Restless leg syndrome	1 (5)
Other	4 (19)
Unable to assess	1 (5)
Psychiatric Disorders [n (%)]	
Schizophrenia	5 (24)
Schizoaffective disorder	5 (24)
Psychosis	1 (5)
BPAD I	4 (19)
BPAD II	2 (9)
MDD	4 (19)
Depression	4 (19)
ADHD	2 (9)
Anxiety	4 (19)
PTSD	2 (9)
SUD	3 (14)
Other	3 (14)

Abbreviations: ADHD = Attention-deficit/hyperactivity disorder; BPAD I = Bipolar I disorder; BPAD II = Bipolar II disorder; MDD = major depressive disorder; PTSD = post-traumatic stress disorder; SUD = substance use disorder

Table 2.4 Efficacy Outcomes at Visits 1 and 2 Among Patient Participants

	V1 (n=21)		V2 (n=18)		
	Mean	SD	mean	SD	p-value
CSQ-8	28.76	5.05	27.72	5.22	0.23
PROMIS®29+2 Profile V2.1					
physical function	44.65	10.28	46.44	9.50	0.77
anxiety	56.87	10.18	55.08	8.40	0.61
depression	54.75	9.00	53.55	8.51	0.93
fatigue	53.81	6.72	50.71	8.14	0.12
sleep disturbance	54.18	10.22	50.22	8.26	0.06
participate social roles	46.64	10.40	49.01	9.41	0.86
pain interference	55.14	10.51	54.19	10.30	0.46
cognitive function	48.71	7.92	48.70	6.30	0.86

Abbreviations: CSQ-8 = Client Service Questionnaire 8-item; PROMIS® = Patient Reported Outcomes Measurement Information System

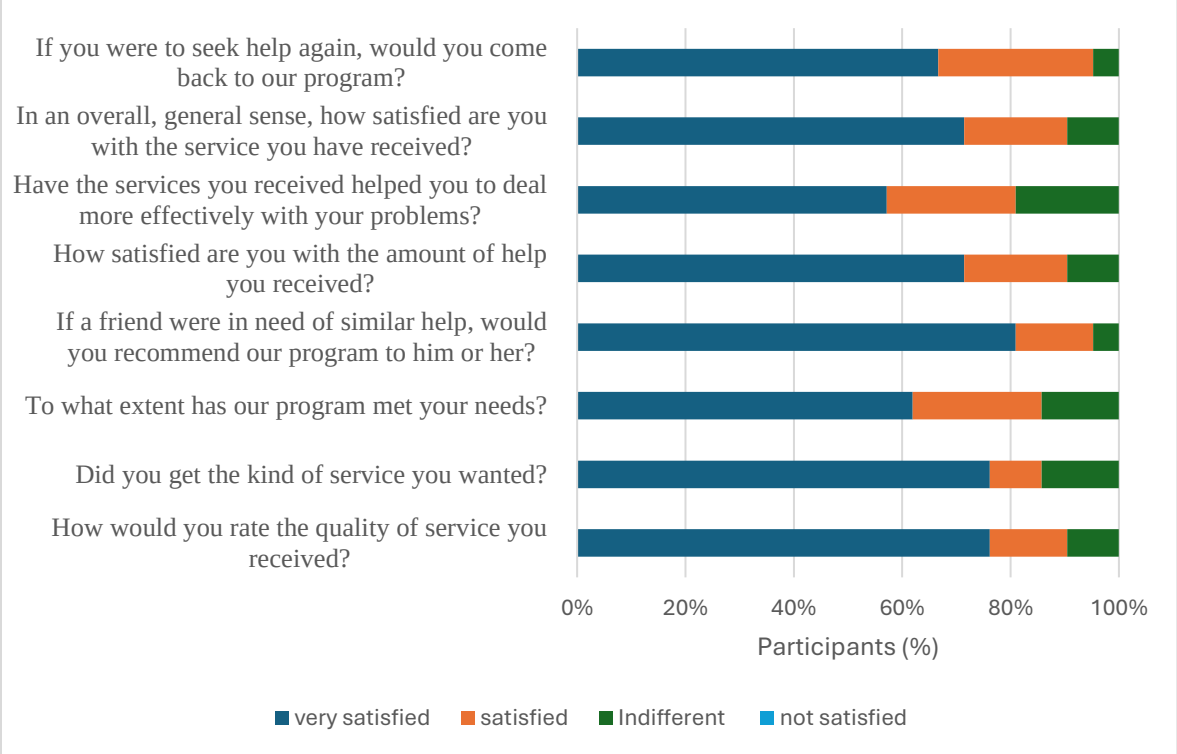

Figure 2.2 Participant Satisfaction with Visit 1 (n=21)

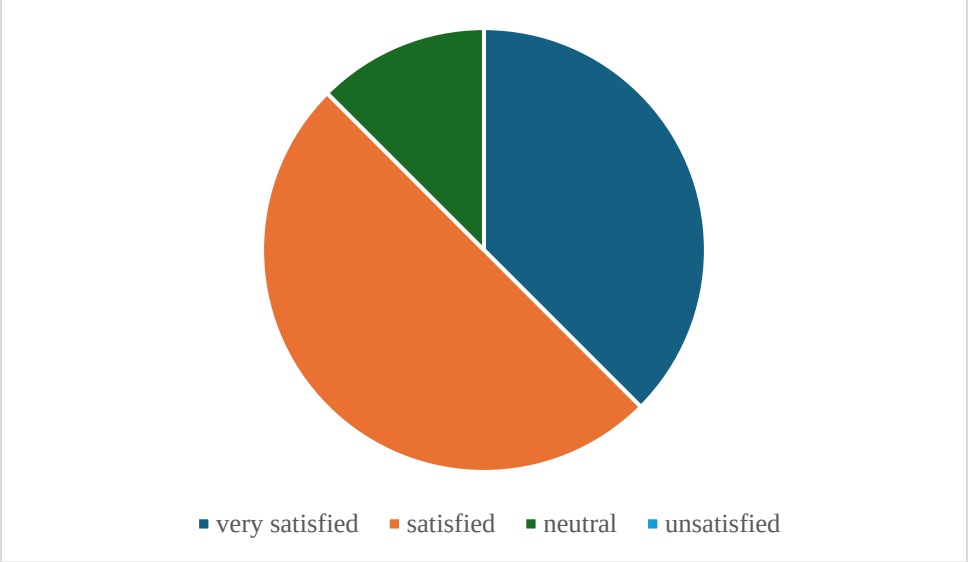

Figure 2.3 MHC Satisfaction with the Consult Service (n=8)

Table 2.5 Characteristics of MHCs that Adopted Program

	total n=20
Type of Practice [n (%)]	
County Mental Health Agency	8 (40)
Community Health Center	3 (15)
Academic Healthcare Center	6 (30)
University Student Health Center	1 (5)
Private Practice	2 (10)
Type of Clinician [n (%)]	
Psychiatrist (MD)	10 (50)
Nurse Practitioner (NP, APRN, MHNP)	10 (50)
Years in Practice (n=7) [mean (SD)]	12.6 (10.5)

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Chapter 3: Feasibility, Effectiveness, and Acceptability of a Telemedicine Neurological Consult Service for Community Members with Drug-Induced Movement Disorders; a Randomized Pilot Study

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Abstract

Objective: Individuals exposed to neuroleptics are at risk of developing a drug-induced movement disorder (DIMD). Early identification and appropriate management are necessary to minimize the risk of DIMDs worsening and becoming irreversible. Movement disorder neurologists can assist other clinicians in assessing the cause of the DIMD and make care recommendations. This aim of this study was to evaluate if telemedicine can be used to provide a neurological consultation service to patients with DIMDs.

Methods: Patients referred by mental health clinicians (MHCs) in a rural state were randomized to have a neurological consult in-person (IP) or through telemedicine (TM). Participants completed two visits with a neurologist and completed surveys about their experience and well-being. MHCs provided feedback on the service through a survey and qualitative interviews.

Results: In the IP group, 79% or participants completed Visit 1 and 71% attended Visit 2, as compared to 86% of participants completing Visit 1 in the TM group and 57% were present for Visit 2. Satisfaction scores were slightly higher for the IP group at both visits. MHCs were satisfied with the consult, reporting that it was helpful and improved care for the patients.

Conclusion: Providing a consult service through telemedicine is feasible, effective, and acceptable, and can be improved further following feedback provided by the MHCs. Overall, participants and MHCs were pleased to have the opportunity to meet and collaborate with a neurologist.

Introduction

Drug-induced movement disorders (DIMDs) are uncontrollable, spontaneous, and disruptive hypokinetic or hyperkinetic movements, most commonly caused by the use of dopamine receptor blocking agents (DRBAs), primarily antipsychotics, but have also been linked to serotonin reuptake and serotonin norepinephrine reuptake inhibitors, calcium channel blockers, and illicit substance use [1,2]. There is a long-standing history of antipsychotic therapies causing extrapyramidal symptoms (EPS), beginning with reserpine in the late 1940s [3]. Initially, abnormal movements were thought to be associated with the antipsychotic effects of the first-generation antipsychotics (FGAs), and it was challenging to differentiate EPS such as akathisia from possible psychopathology, like agitation. In 1987, it was recommended that clinicians first rule out the possibility of EPS in patients taking a neuroleptic agent before attributing the symptoms to behavioral changes [4]. The frequently observed and burdensome EPS related to FGAs prompted efforts to develop better tolerated antipsychotics, leading to second and third generation antipsychotics (collectively, SGAs). A study published in 1988 reported that clozapine, an SGA, had better efficacy for patients with schizophrenia, with minimal EPS [5]. Subsequent clinical trials and systematic reviews supported the notion that SGAs, with atypical receptor-binding properties, were effective for treating psychotic and mood disorders, with a lower incidence of EPS than FGAs [6-9].

Expanded off-label use of SGAs and other DRBAs has contributed to a high prevalence of DIMDs [1,2,10]. A meta-analysis of 41 randomized controlled trials (RCTs) conducted from 2000 to 2015, found the global mean prevalence of tardive dyskinesia (TD), a

common DIMD characterized by hyperkinetic movements, to be 25.3% among the 11,493 patients [11]. The rates for TD were lower for SGA (20.7%) than FGA (30.0%) treatment, but not negligible [11]. In the Netherlands, a longitudinal study published in 2017 investigated the prevalence, incidence, and persistence of DIMDs in 1120 younger patients (mean age 27.1 years) with nonaffective psychosis [12]. The mean illness duration for these patients was 4.3 years, and many were primarily treated with SGAs. Of the 828 patients who developed a DIMD, the most prevalent was parkinsonism (32%), followed by akathisia (9%) and TD (4%). During the three-year study period, it was reported that the persistence of these DIMDs was relatively high, with parkinsonism persistence rates at 53%, akathisia at 17%, and TD at 20%. The authors concluded that even in a younger population with a recent onset of psychosis and treatment with SGAs, it is important to monitor for DIMDs [12].

Clinicians have agreed that prevention of DIMDs is imperative, as they can become persistent, disruptive, and irreversible [13-15]. In a study comparing patients with schizophrenia, bipolar disorder, and major depressive disorder, it was found that the co-occurrence of TD was linked to significantly worse health-related quality of life and social withdrawal, and the severity of the movement disorder was associated with greater decline of these outcomes [16]. To reduce the deficit in physical and mental functioning, clinicians must accurately diagnose the DIMD, determine which medication has contributed to the symptoms, and select appropriate treatment options [17]. Determining the diagnosis has been challenging for clinicians, due to overlapping presentations of certain DIMDs, limited knowledge about the spectrum of symptoms for each disorder, not

enough general training focusing on DIMDs, and delayed symptom reporting by patients who may be ashamed or lacking insight [13,15,18]. Psychiatrists and other mental health clinicians (MHCs) managing DIMDs have been tasked with making a number of pharmacological decisions that may require multiple steps for their patients, such as reducing or changing their antipsychotic treatment, or adding on adjunctive therapy [17]. Collaborating with a movement disorder specialist for an in-depth evaluation is advised, as some of the differential diagnoses of TD and Parkinsonism are rare and not routinely seen in psychiatric practice [13,17].

While including a movement disorder specialist is recommended for diagnosing and providing treatment recommendations, there are currently issues impacting access, such as an increase in patient referrals, a nation-wide shortage of neurologists, and more specialists based in urban settings [19,20]. Telehealth, which has been widely studied in movement disorders, particularly Parkinson's disease (PD), and saw a massive expansion of use in psychiatry during and after the COVID-19 pandemic, could potentially remediate some barriers to specialty care [21,22]. For instance, among patients experiencing hyperkinetic movement disorders, many of the features of tremor, tics, dystonia, dyskinesia, and myoclonus have had the potential to be evaluated through telehealth [23]. However, there may be limitations with video quality, symptoms not being present at the time of the event, standardized assessments needing modification to accommodate a remote exam, and other site-specific challenges that require further investigation [23]. The robust research and clinical experience with telemedicine in Parkinson's disease (PD) has led to a growing interest in the feasibility, effectiveness, and acceptability of remotely

evaluating other movement disorders[23,24]. This study hopes to contribute to the literature by comparing in-person (IP) to telemedicine (TM) neurological consultation visits for patients suspected to have a DIDM, especially in the context of multidisciplinary care, which is necessary for many complex DIMD cases.

Methods

Trial Design

This randomized pilot study was designed to investigate the feasibility, effectiveness, and acceptability of a statewide neurological consultation service for patients who have a suspected DIMD. Participants were referred to the study by their MHC, who agreed to provide feedback throughout the study. Participants were randomized 1:1 to the in-person or telemedicine group. Implementation of the service was evaluated using the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework and mixed methods. Here, we have presented on the RE-AIM components and outcomes related to reach, effectiveness, and acceptability.

This study was registered at clinicaltrials.gov, NCT06060444.

Participants

Participants were eligible if they had a suspected DIMD or had received a DIMD diagnosis, but diagnostic confirmation and treatment recommendations were requested. They needed to be referred by a MHC that was agreeable to participating in the study by contributing data related to themselves, their practice, and their experience with the

consultation service. Participants and MHCs were located throughout the state of Vermont, and at the time of consent, participants needed to be able to travel to the University of Vermont Medical Center for in-person visits and have the ability to connect to the videoconferencing application, Zoom (Zoom Video Communications, Inc., San Jose, CA). Eligible participants were 18 years or older, willing to complete surveys after each visit, and not currently hospitalized.

Interventions and Procedures

The Neurology study team (NST) compiled a list of Vermont's mental health agencies, as well as other community and private mental health practices, to send information to about the study. As part of recruitment and outreach efforts, the NST sent introductory emails or spoke on the phone with medical directors, support staff, and the MHCs. The NST offered to explain the study in more detail at staff meetings, virtual meetups with groups or individual MHCs, and provided recruitment materials for them to give their patients.

Participants that were referred to the study and interested in participating were sent a link via email to the electronic consent form, along with a unique code. Once consent was obtained, the NST reached out to the MHC for relevant clinical notes, and their impression of the participant's movement disorder severity, using the Clinical Global. Impression-Severity (CGI-S) scale. The groups were stratified based on the GCI-S score, with 1-4 as lower severity and 5-7 as higher severity, before participants were randomized to the in-person or telemedicine arm. Participants were then scheduled to have their initial consult visit (Visit 1) with a movement disorder specialist at our

Neurology clinic, or through Zoom. The telemedicine participants were sent the link to the Health Insurance Portability and Accountability Act- compliant platform, Zoom (Zoom Video Communications, Inc., San Jose, CA), either through email or their electronic health record patient portal. They were able to receive technical support from case workers, other clinicians, hospital information technology, the NST, or family and friends, if needed. The neurologist performed a set of assessments specific to the reported symptoms and in-line with standard examinations (e.g. AIMS, MDS-UPDRS), and modified for the remote group. They documented their findings and shared them with the MHC. If more information was needed, they would arrange a phone call or discuss the case through secure written communication. Following Visit 1, participants were emailed a REDCap link to complete surveys which included a demographics questionnaire, the Clinical Satisfaction Questionnaire (CSQ-8), and the Patient Reported Outcomes Measurement Information System (PROMIS®29+2 Profile V2.1)[25-27].

Participants returned a few months later for Visit 2, either in-person or remotely. The neurologist repeated examinations of their abnormal movements and evaluated if there were any changes to physical or mental health. They determined if their treatment recommendations were applied, to what extent, and if they'd advise on any additional care changes. The neurologist documented their findings to again share with the MHC. The participants were sent a second REDCap link to electronically complete the CSQ-8 and PROMIS®29+2 Profile V2.1 following their visit.

The NST conducted two rounds of qualitative interviews with the MHCs who had referred enrolled participants. The interview asked about satisfaction with the consultation service, and other components of RE-AIM (adoption, implementation, and maintenance). The interviews were completed over Zoom with audio recording, then converted into a written transcript using Microsoft Word. At the end of the study, the MHCs were sent an electronic five-item survey that included a question about overall satisfaction.

Outcomes

Feasibility was measured by comparing the proportion of participants who successfully completed at least Visit 1, and the proportion of participants that completed Visit 2. We compared the visit completion rates between the two groups, along with the proportion of surveys that were completed after Visits 1 and 2. Any technical issues that affected the occurrence or quality of a visit were summarized for the telemedicine group, while any barriers to arriving for an in-person visit were also reported.

Effectiveness, as defined by the impact on patient health status, was quantified by the change in PROMIS®29+2 Profile V2.1 scores from Visit 1 to Visit 2. We also measured the rate of concordance between the DIMD symptoms reported by the MHC and confirmation or recategorization by the movement disorders specialist. We evaluated the impacts to the care plan in the two categories: medication changes and diagnostic test/ referrals. Effectiveness was also measured from the MHC's perception of improvement, using the MHC survey, question #3 "Did the consultation improve care for the patient?"

Acceptability for both the participants and the MHCs was quantified using satisfaction measures. We compared the participant-completed CSQ-8 means between the in-person and telemedicine groups. The MHC satisfaction survey allowed us to determine the proportion of MHCs that were satisfied, based on the number of positive responses to the six questions.

Sample Size

For this pilot study, the sample size required to determine a statistical significance between the two groups for the CSQ-8, using previously reported differences in means and standard deviations [28] was not feasible for this project. We decided an enrollment goal of 28 participants, assuming a 21% dropout rate, would result in 12 participants in each arm. This is a small sample size, designed to capture preliminary, pilot data, and it does not ensure adequate power to detect a true effect.

Randomization

The study's Principal Investigator (EH) generated a random allocation sequence using Excel, with block sizes of 4, then uploaded it into REDCap. Once the consent form was signed, participant data was entered into REDCap, including the CGI-S for stratification. This produced the unblinded group assignment, which was shared with the participants, the movement disorder specialist, and the MHC.

Statistical Methods/Analysis

Feasibility outcomes were summarized using descriptive statistics. The percentages of completed visits and surveys for both groups were calculated and compared. Within the telemedicine group, the percentage of visits with technology challenges was calculated. The characteristics of the participants in the two study groups were compared using a Fisher's exact test (for dichotomous variables) or a t-test (continuous variables).

To analyze effectiveness as impact on patient health outcomes, each of the PROMIS®29+2 Profile V2.1 eight domains (physical function, anxiety, depression, fatigue, sleep disturbance, satisfaction with participation in social roles, pain interference, and cognitive function) had the raw score calculated per participant and converted into *T* scores. The *T* scores were used to calculate the mean for each domain within the IP and TM groups. The non-normally distributed PROMIS®29+2 Profile V2.1 data were analyzed using the Mann-Whitney U test for both Visit 1 and 2. The Wilcoxon signed rank test was used to examine the difference in mean *T* scores of each domain for the repeated PROMIS®29+2 V2.1 measure within both groups. Due to multiple comparisons, a Bonferroni correction was used to adjust the significance level from 0.05 to 0.006. For symptom concordance, the terms or diagnosis on the MHC notes from prior to the study were compared to the main symptoms or diagnosis reported by the neurologist to determine a dichotomous yes/no outcomes. The proportion of diagnoses that were in agreement were compared between groups. The changes to the care plans were summarized by creating nominal categories for each change and presenting the rates study-wide. The proportion of MHCs who responded positively on question 2 of the MHC survey, asking "Did the consultation improve care for the patient?" was calculated.

The satisfaction measures were a proxy for acceptability. The mean scores were calculated for the CSQ-8 and compared between the IP and TM groups using a Mann-Whitney U test. We used two-tailed significance tests and set alpha at 0.05 when running the statistical analyses. We determined the percentage of MHCs that were satisfied with the consultation program, based on the number of positive responses to the six questions of the MHC survey. The qualitative interview data were coded in grounded theory by a member of the NST (EH) who individually open coded the responses, then compared the data and identified concepts and categories. Axial coding allowed for organization of the categories to identify connections and similar themes, which were used to develop a theory about the acceptability of a neurological consult service form the MHCs' perspectives.

Results

Feasibility

A total of 45 patients were referred to our study from twenty MHCs at eleven practices throughout the state of Vermont (Figure 3.1). Fourteen patients were randomized to each of the two arms, but after five people were either lost to follow-up, withdrew, or no-showed for Visit 1, 23 (51% of referred) participants successfully completed Visit 1. In the IP group, three participants withdrew before Visit 1 (79% of randomized), while 86% of the randomized participants in the TM group completed V1. Visit 1 surveys were completed by 11 IP participants (79%) and 10 TM participants (71%). Between Visit 1

and 2, one person in the IP group withdrew, leaving 71% of the randomized sample to complete the visit and surveys; while the TM group had two people drop-out, resulting in only 8 participants (57%) completing Visit 2 and surveys. Only one participant in the TM group withdrew because they did not have sufficient quality during the synchronous call. No one else in the TM reported difficulty with joining the remote appointment or with video quality.

Participants were mostly female (IP=73%, TM=80%), white (IP=82%, TM=100%), and at least half had completed a Bachelor's degree or higher (IP=64%, TM=50%). The two groups only varied significantly on marital status, as shown in Table 3.1. A large proportion of both groups had a history of schizophrenia (IP=45%, TM= 40%), and a range of other psychiatric disorders, including bipolar affective disorder I or II (IP=37%, TM=20%) and major depressive disorder (IP=9%, TM=30%). Other psychiatric disorders that participants experienced were anxiety, attention-deficit/hyperactivity disorder (ADHD), substance use disorders (SUDs), and post-traumatic stress disorder (PTSD). The most common movement disorder diagnosis was TD (IP=45%, IM=80%). Table 3.1 provides the frequencies of the movement disorder diagnoses, with multiple participants presenting with mixed movement disorders.

Effectiveness

At Visit 1, the IP and TM groups were very similar on levels of anxiety, depression, fatigue, satisfaction with participation in social roles, and cognitive function (Table 3.2). At the first and second visits, there was more variation on the *T* scores for physical

function, sleep disturbance, and pain interference, but there was no significant difference between any of the PROMIS® outcomes. There was not a significant difference in means from scores at Visit 1 to 2 for all domains. Interestingly, satisfaction with participation in social roles increased for the IP group, and decreased for the TM group (IP=3.78, TM=-3.99, p=0.02). Three other outcomes had changes in means that went in different directions between the two groups: physical function (IP=0.89, TM=-1.27), depression (IP=-1.46, TM=0.96), and cognitive function (IP=1.60, TM=-1.89).

In both groups, there was high concordance between the diagnosis or description of the motor symptom phenotype given by the MHC and the movement disorder identified by the neurologist (IP=73%, TM=92%). The most common recommendations were to reduce or stop taking a medication (IP=82%, TM=42%), and to add a new medication (IP=54%, TM=67%). The frequencies of pharmacological and non-pharmacological recommendations are provided in Table 3.3. When asked "Did the consultation improve care for the patient?" 63% of MHCs responded either "yes, a lot" or "yes, a little" and the remainder (37%) were neutral; no negative responses were given.

Acceptability

Following Visit 1, the mean CSQ-8 scores were fairly high among the two groups (IP=29.91, TM=27.50) (Table 3.2). The proportion of responses is shown in Figure 3.2, with most participants reporting high satisfaction or agreement, one person in the IP group was neutral, and one to three people were neutral on a few questions in the TM group.

The IP group had an increase in CSQ-8 scores from Visit 1 to 2 (Mean diff=0.8), but the TM group had a -3.12 decline in score. Comments at the end of the survey were all very positive in the IP group, stating how excellent and helpful the service was for their care, while comments in the TM group were mixed between statements of benefit and support, to frustration of their health problems still existing, or having to wait for the neurologist to join the Zoom call. The majority of MHCs (n=8) responded favorably to each question of the MHC survey (Figure 3.3). All MHCs agreed that they would use a consultation service like this in the future, and over 60% agreed strongly that the consultation was helpful. Two themes emerged from the qualitative interviews, regarding acceptance within the MHCs' practice and among patients. The first was resources, as related to their staffing support, their workload, and the ability to easily share information with the neurology team. A second was patient factors, which was built off categories such as complex care needs, mistrust of healthcare professionals, and unwillingness to change medications.

Discussion

Remote consultations in Neurology have expanded since the COVID-19 pandemic and telemedicine is widely used by psychiatric clinicians in rural areas[29]. This pilot study investigated the potential for telemedicine consultation visits to be feasible, effective, and accepted, when comparing it to in-person visits. To our knowledge, this is the first prospective randomized study to compare IP and TM visits among patients with DIMDs.

Previous studies examining telemedicine use for movement disorders, primarily Parkinson disease, have reported higher rates of attended visits; but earlier studies utilizing telepsychiatry and comparing this method to in-person consultation had similar rates of visit adherence to our project, above 70% [24,30,31]. Our Visit 1 attendance rates were good for this population in both groups, with 11 participants in the IP group and 12 in the TM group. The IP group saw better retention at follow-up than the TM group, as the latter had four participants drop-out before Visit 2. Two of the TM participants that dropped out were not compliant with completing the Visit 1 surveys, indicating that they were not engaged, and attempts to communicate with them following their visit were unsuccessful. Another TM participant experienced technical difficulties at their first visit, with poor camera quality and resolution; they opted not to retry a remote visit, and preferred meeting with a neurologist closer to where they lived than traveling to our clinic for evaluation. This was the only case of technological challenges affecting the neurologist's ability to complete an assessment. In general, the two neurologists felt confident performing an examination remotely, even in the absence of testing tone, strength, and postural stability. There is concern that patients with disabilities, low health literacy, or living in low socioeconomic areas may have reduced access to equipment or other resources necessary for telemedicine visits, but we found that the majority of participants in this study had access to the necessary technical tools- a working camera and microphone, email or access to an EMR account, and internet[32]. Our findings suggest that telemedicine is a feasible method of performing neurological consults for people

with DIMD, and the likelihood of patients attending the visits is influenced by their willingness to engage, rather than technological or clinician concerns.

We used the PROMIS®29 instrument to measure and compare physical and psychological health statuses of the study participants, as the values also give a sense of the participant's health compared to the US general population[26]. For each PROMIS®29 domain, 50 is the average score for the general population and 10 is the standard deviation[33]. A higher T-score represents more of what is being measured, for instance, a higher score for depression indicates more feelings of depression, while a higher score for physical function means the respondents are able to be more ambulatory. At Visit 1, the participants were similar in all domains, except the TM group had more pain interference and scored lower on physical function. We did not see any robust changes in mean values for the health outcomes, other than sleep disturbance, which was the only domain to change by half a standard deviation[34]. Both groups also had a slight decrease in anxiety and fatigue, but then demonstrated opposing changes from Visit 1 to Visit 2 across the other domains. Based on our statistical tests, the only change that was significantly different between the two groups was the ability to participate in social roles and activities, likely related to the IP group improving in this domain and the TM group dropping their T-score by four points. Overall, there was no clinically meaningful change in health-related quality of life for participants seen remotely, in either direction. We wouldn't expect health outcomes to change dramatically in a short period, based on recommendations that can take time to implement and then monitor for the effects. In 42% of the TM cases, the neurologist recommended that the participants reduce or

discontinue a current medication, and also recommended that 67% of the TM participants initiated a new medication such as a vesicular monoamine transporter type 2 (VMAT2) inhibitor. As many of the adjusted medications were for psychotic disorders, it was important to ensure that these changes did not cause detrimental effects. It appears that we were able to effectively make care recommendations through telemedicine for participants that had varying movement disorder symptoms, without negatively affecting their health-reported wellbeing. Additionally, a large proportion of the MHCs at the end of the study reported that the consultation improved care for their patient(s), while close to a third were neutral.

We saw high levels of satisfaction in both groups following Visit 1, with 90-100% of participants in the IP group reporting that they were "satisfied" or "highly satisfied" on each of the eight CSQ-8 questions, and 70-90% of TM participants also gave satisfied responses on the CSQ-8. Interestingly, the three TM participants that gave the lowest scores on the CSQ-8 also had the lowest T-scores on the physical function and ability to participate in social roles and activities domains of the PROMIS®29. While the IP participants remained highly satisfied in Visit 2, there was a three-point decline in mean CSQ-8 score for the TM group. This was largely due to mixed responses in a small sample, where half of the participants reported satisfaction with the information they were given, but the other half was more indifferent. One comment from a TM participant was that they had a "generally ok experience, but problems still existing." This illustrates that the delivery of care through telemedicine is acceptable to patients, but our study participants had not gotten the resolution they had hoped for their movement disorder by

the second visit. The MHCs were accepting of a consultation service and noted that the telemedicine option gave their patients flexibility and made it easier for the ones that don't have transportation. To support a consultation service in the future, the feedback from MHCs was that we need to identify easy and secure ways to share information, as well as have a designated contact person for them and their patients. Based on the responses from the MHCs and participants, they are accepting of telemedicine visits, but would like to have the option to be seen remotely or in clinic, based on their needs and comfort levels.

This study was limited by the small sample size, conducted by one neurology clinic in a non-diverse region, as well as low response rates on the surveys by both the participants and MHCs. A future study could address this by having multiple neurology sites, each interacting with mental health practices in their area. The surveys could be performed in different ways to improve compliance, or incentivized. Our effectiveness results were limited by the short follow-up period, and extending this timeline, or adding assessments further out would give more opportunity to determine if the care recommendations influenced health outcomes long-term.

Conclusion

There is a high demand for specialist care and telemedicine could minimize barriers for DIMD patients to be evaluated by a neurologist. A consult service through telemedicine is feasible, based on the low rates of technological issues and the ability of the neurologists to assess the participants remotely. The neurologists were effectively able to confirm

diagnoses and make recommendations to participants through telemedicine, without any negative impacts on their health statuses. We cannot endorse that telemedicine is as effective at providing care and improving outcomes in this population as in-person visits, due to the small sample size. Telemedicine as a mode of care delivery is acceptable, based on satisfaction scores and feedback from participants, but further research will need to investigate if this patient population prefers to receive information and care in a clinic setting, remotely, or as a combination of in-person and telemedicine visits.

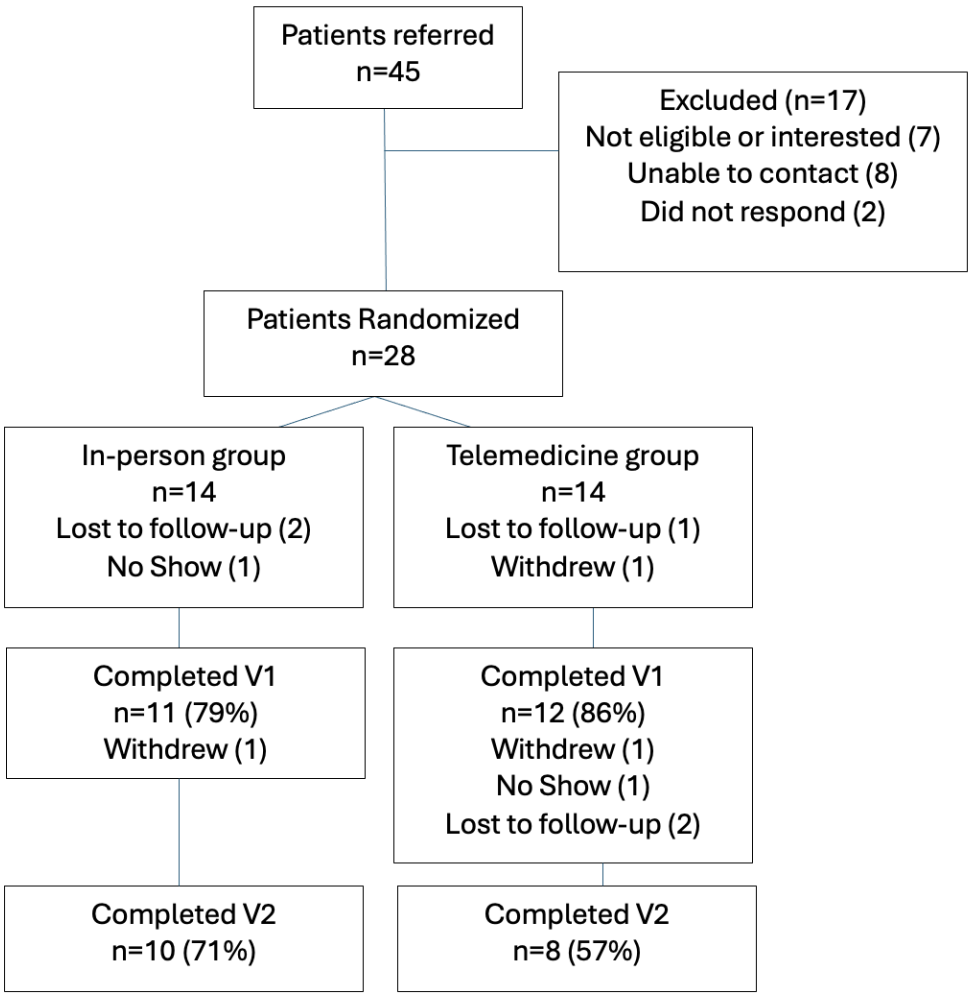


Figure 3.1 Flowchart of Study Participants

Table 3.1 Participant Characteristics at Visit 1

	In-person n=11	**Telemedicine n=10**	**p-value**
Age	52.4 (15.1)	58.7 (8.7)	0.26
Female [n (%)]	8 (73)	8 (80)	0.34
Race [n (%)]			0.13
Caucasian	9 (82)	10 (100)	
Other	2 (18)	0 (0)	
Bachelor's degree or higher [n (%)]	7 (64)	5 (50)	0.21
Marital status [n (%)]			0.05
Never married	3 (27)	6 (60)	
Currently married	5 (45)	0 (0)	
Divorced	2 (18)	4 (40)	
Widowed	1 (9)	0 (0)	
Employment Status [n (%)]			0.46
Employed Full or Part time	4 (37)	3 (30)	
Retired	5 (45)	4 (40)	
Unemployed	2 (18)	3 (30)	
Insurance Type [n (%)]			
Private insurance	4 (37)	3 (30)	0.34
Medicaid or Medicare	6 (54)	7 (70)	
Other	1 (9)	0 (0)	
Distance from Neurology Clinic [miles (mean (SD))]	17.2 (15.9)	22.5 (16.9)	0.55
Psychiatric Disorders [n (%)]			
Schizophrenia	5 (45)	4 (40)	
BPAD I or II	4 (37)	2 (20)	
MDD	1 (9)	3 (30)	
Other	6 (54)	4 (40)	
Movement disorder diagnosis [n (%)]			
Tardive dyskinesia	8 (80)	5 (45)	
Drug-induced parkinsonism	2 (20)	3 (27)	
Drug-induced tremor	3 (30)	2 (18)	
Drug-induced akathisia	1 (10)	1 (9)	
Primary parkinsonism	0 (0)	1 (9)	
Other	3 (30)	3 (27)	
Unable to assess	0 (0)	1 (9)	

Abbreviations: BPAD I or II= Bipolar I disorder, Bipolar II disorder; MDD = major depressive disorder

Table 3.2 Change in Efficacy and Acceptability Outcomes Among Patient Participants

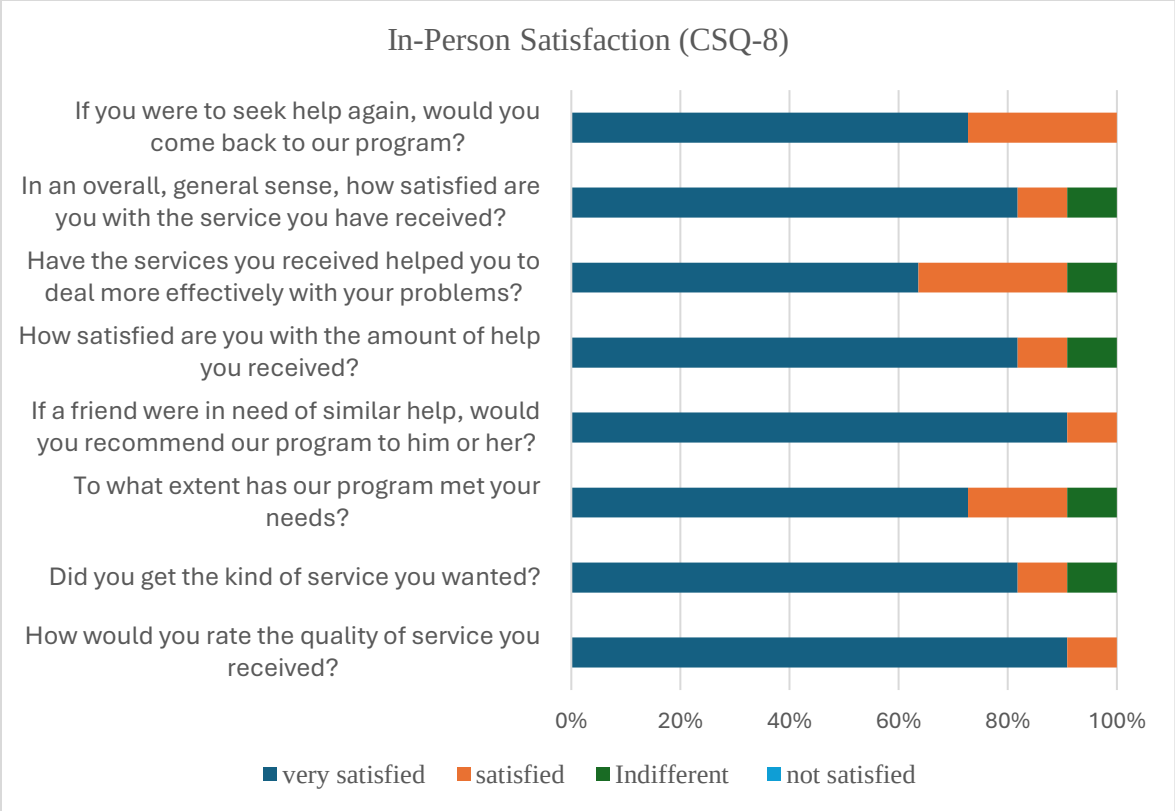
	V1 (n=21)			V2 (n=18)			Difference in means		
	IP (n=11)	**TM (n=10)**	**p-value**	**IP (n=10)**	**TM (n=8)**	**p-value**	**IP (n=10)**	**TM (n=8)**	**p-value**
CSQ-8	29.91 (4.10)	27.50 (5.89)	0.25	30.50 (2.27)	24.25 (5.90)	0.01	0.8 (2.90)	-3.12 (4.12)	0.02
PROMIS®29+2 Profile V2.1									
physical function	48.52 (9.83)	40.40 (9.44)	0.10	50.38 (9.24)	41.52 (7.72)	0.06	0.89 (6.22)	-1.27 (5.98)	0.34
anxiety	56.95 (10.71)	56.78 (10.14)	0.92	54.79 (8.90)	55.45 (8.32)	0.93	-0.73 (10.17)	-2.09 (3.92)	0.42
depression	53.95 (10.60)	55.62 (7.34)	0.94	51.46 (8.44)	56.16 (8.38)	0.21	-1.46 (8.62)	0.96 (3.80)	0.26
fatigue	54.11 (6.60)	53.48 (7.18)	0.60	49.57 (7.19)	52.14 (9.49)	0.72	-3.48 (9.07)	-3.21 (7.50)	0.96
sleep disturbance	52.29 (10.88)	56.26 (9.56)	0.42	46.73 (6.35)	54.59 (8.65)	0.07	-5.47 (10.93)	-4.42 (7.30)	0.79
participate social roles	46.76 (11.58)	46.52 (9.57)	0.83	52.05 (10.12)	45.20 (7.33)	0.15	3.78 (7.78)	-3.99 (4.22)	0.02
pain interference	52.15 (11.32)	58.43 (8.94)	0.19	51.49 (11.21)	57.57 (8.51)	0.22	0.67 (7.25)	2.01 (6.13)	0.86
cognitive function	48.24 (8.48)	49.23 (7.67)	0.80	50.56 (6.26)	46.37 (5.91)	0.30	1.60 (7.49)	-1.89 (9.12)	0.44

Abbreviations: CSQ-8 = Client Service Questionnaire 8-item; PROMIS® = Patient Reported Outcomes Measurement Information System

Table 3.3 Diagnostic Concordance and Care Recommendations

	IP (n=11)	**TM (n=12)**
Diagnosis Concordance, Yes [n (%)]	8 (73)	11 (92)
Impact on Care		
Medications [n (%)]		
Reduce/stop	9 (82)	5 (42)
Add new med	6 (54)	8 (67)
No change	1 (9)	3 (25)
Diagnostic/referrals [n (%)]		
Imaging	2 (18)	2 (17)
Labs	1 (9)	1 (8)
EMG/NCS	1 (9)	1 (8)
Sleep eval/SLP swallowing eval/OT	2 (18)	2 (17)
Genetic testing	1 (9)	0 (0)

Abbreviations: EMG = electromyography; NCS = nerve conduction study; OT = occupational therapy; SLP = speech-language pathology



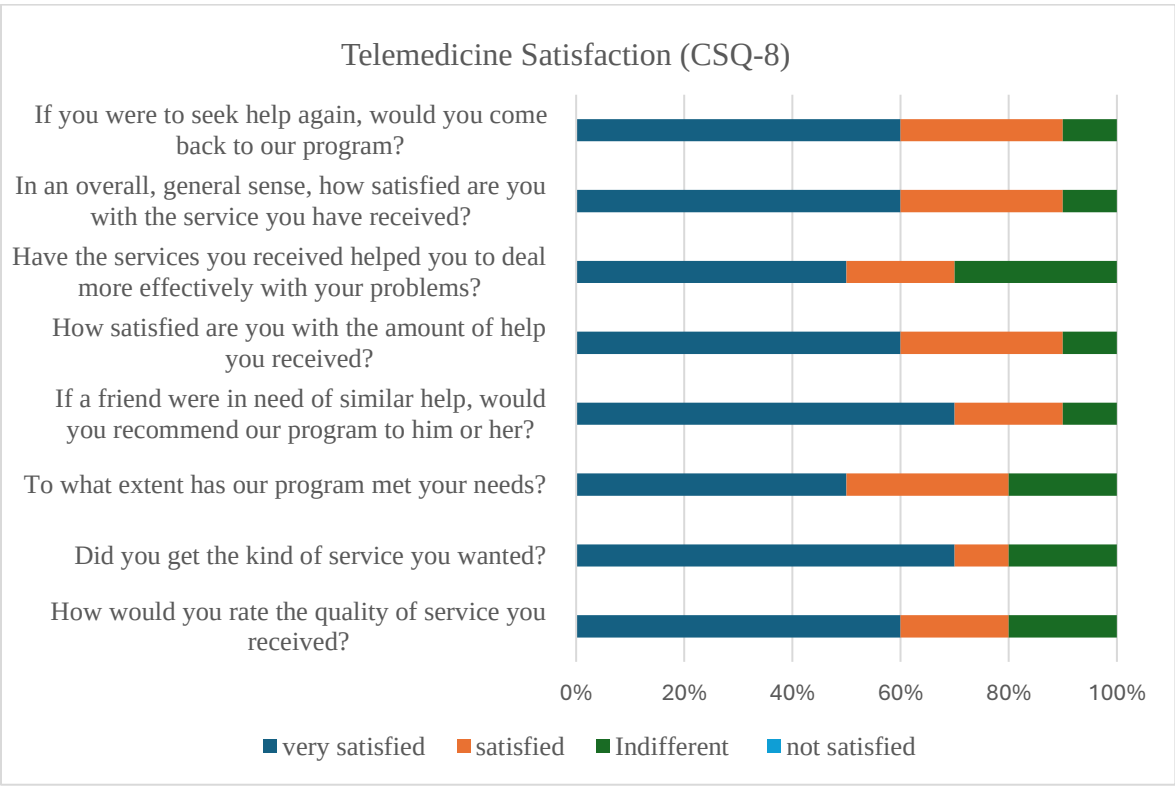


Figure 3.2 Participant CSQ-8 Responses Per Group

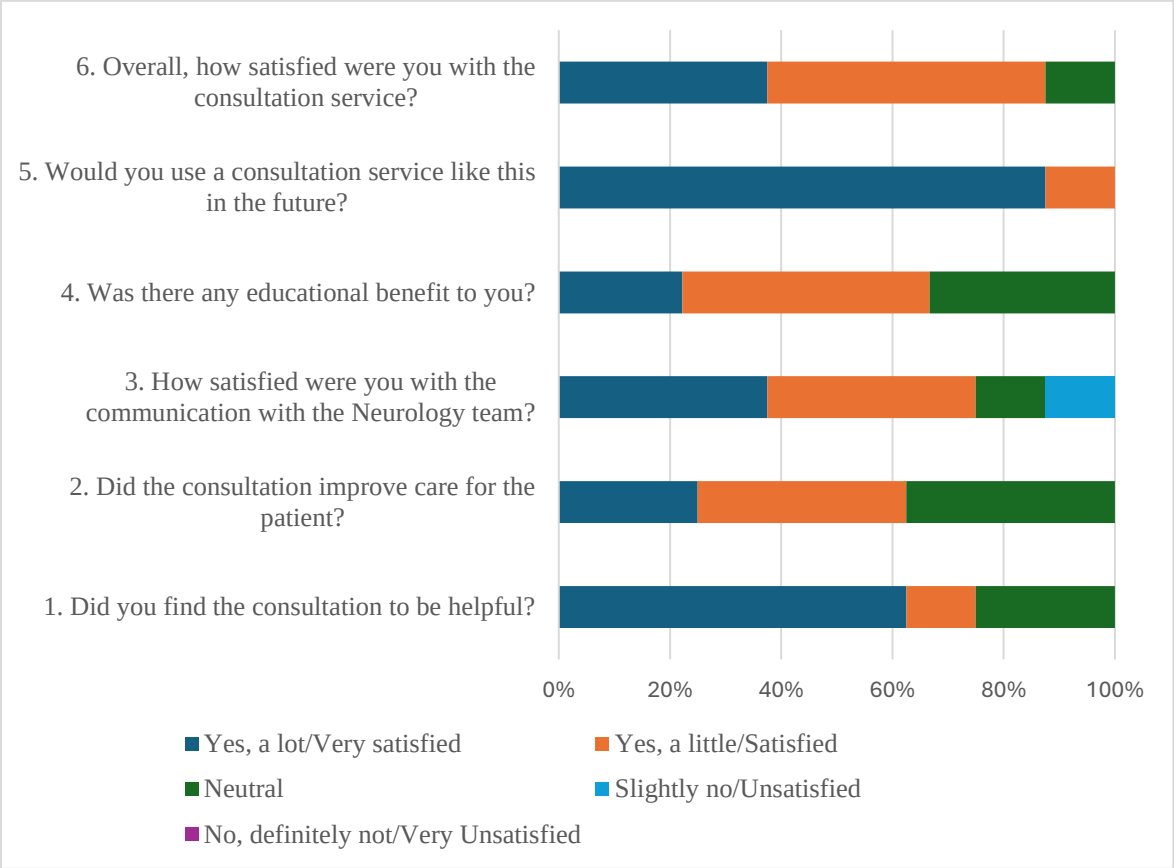


Figure 3.3 MHC Survey Responses

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