

Transforming pediatric neuropsychology through video-based teleneuropsychology: an innovative private practice model pre-COVID-19

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Abstract

Objective: In pediatric neuropsychology multiple barriers such as long wait times until an appointment, insurance coverage, and limited providers who are bilingual/bicultural or who sub-specialize in pediatric neuropsychology, often slow families from receiving diagnoses and interventions in a timely and affordable manner. This paper focuses on increasing accessibility through the development of a video-based, pediatric teleneuropsychology (TeleNP) practice model that was developed in a private practice 2 years before the COVID-19 pandemic.

Method: ‘Design thinking’ methodology to problem-solving was utilized to innovate the traditional neuropsychology practice model in under-served areas who may have limited financial and healthcare resources. The practice model approach to include a virtual diagnostic clinic with increased patient and provider efficiency was created to enhance accessibility for patients and sustainability for providers.

Results: Video-based TeleNP screenings were conducted for 67 children with developmental (i.e., attention deficit hyperactivity disorder, autism spectrum disorder) and language disorders, as well as concussion and psychiatric diagnoses. Additional comorbidities were identified in 65.6% of children. Follow-up data approximately 2 months later revealed 98.5% of children were receiving new interventions as a result of the video-based TeleNP assessment.

Conclusion: Video-based TeleNP benefits the consumer as it can reduce wait times, decrease family financial burden (i.e., travel and parent time off work), expedite referrals for interventions, and provide geographically under-served populations access to providers who are linguistically and culturally responsive. For providers, this model revealed improvements with direct implications for cost-saving, thereby facilitating long-term economic sustainability within a private practice healthcare marketplace.

Keywords: Teleneuropsychology; Pediatric; Private practice; Design thinking; Neuropsychology

Introduction

Pediatric neuropsychologists are uniquely equipped to diagnose and guide follow-up care of children with complex neurodevelopmental disorders, which may alter the developmental trajectory for youth at risk of psychiatric comorbidities, academic under-achievement and social problems (Barth et al., 2003; Silver et al., 2006). However, there are multiple obstacles that can slow families in need from receiving such empirically informed interventions in a timely and affordable manner.

To illustrate, it is estimated that it takes children on average 2–3 years to receive a medical diagnosis after initial symptoms (Garrido, Carballo, Artis, & Garcia-Retamero, 2018; Ringeisen, Oliver, & Menvielle, 2002), particularly when Spanish is the primary language (Jimenez, Martinez Alcaraz, Williams, & Strom, 2017), leading to increased symptom severity, development of comorbidities, the need for more intensive treatments, as well as increased financial and family burden (Estes et al., 2009). Potential barriers which can slow a patient's presentation to treatment include provider shortage resulting in lengthy wait times (Ransom et al., in press), insurance barriers, and a dearth of accessible, and specialized providers (i.e., bilingual/bicultural neuropsychologists and/or those who sub-specialize in pediatric neuropsychology). In fact, only approximately 16% of neuropsychologists identify as specializing in pediatrics (Postal et al., 2017; Sweet, Benson, Nelson, & Moberg, 2015). From a provider perspective, it is also important to consider that the current administrative and billing requirements force providers to operate within small profit margins and the completion of most pediatric neuropsychology evaluations is time-intensive, 7–12 hr on average (Sweet et al., 2015), posing a clear threat to the sustainability of a traditional pediatric neuropsychology model.

In order to address these concerns, an innovative practice model utilizing a virtual diagnostic clinic was developed in a private practice by leveraging 'design thinking' methodology and technology. 'Design thinking' is a framework for creative problem-solving that emphasizes empathy and experimentation to obtain innovative solutions (Brown, 2008; Dam & Siang, 2020). The hypothesis was that developing a practice based on 'Design thinking' would help the practitioner implement services based on what future customers (i.e., patients and families) and providers want, through the lens of what is feasible and viable from clinical, technological, logistical and business perspectives. Further hypotheses developed through ongoing 'Design thinking' were that designing automation in the administrative and clinical workflow, in addition to the provision of teleneuropsychology (TeleNP), would (a) reduce waiting times in scheduling appointments; (b) lead to diagnostic efficiency and rapidly connect patients with treatments they need (e.g., medication management, individualized education program (IEP)/educational resources, applied behavior analysis or other therapies), thereby improving accessibility to a diverse patient base; (c) lead to cost-savings for the patient and business; and (d) increase the long-term financial solvency of a bilingual pediatric neuropsychology private practice.

Materials and Methods

Design thinking conceptualization and practice development approach

A 1-week (40-hr) 'Design thinking' bootcamp was initially performed in December 2016. The five stages are Empathy, Define, Ideate, Prototype, and Test (Brown, 2008; Dam & Siang, 2020). These stages were completed with both a clinical neuropsychologist and senior mechanical design engineer. This methodology involves a series of brainstorming sessions in order to frame the problem in human-centric ways and then use ideas generated to develop a solution that can be tested. In the Empathize stage, the team worked to understand users and their needs. The perspective of multiple "users" was obtained (i.e., children, parents, neuropsychologists, psychometrists, trainees, receptionist, office manager, school personnel, referral sources) in order to identify the needs that are yet to be met with each user, and the problem that can be solved. The second stage is the Define stage in which the problem is more clearly defined. In this case, the problems identified focused on limited access to care, inefficiencies across the clinical and administrative workflow, affordability versus profitability, and the need to connect patients with qualified, accessible providers to deliver recommended follow-up care and interventions.

Next, the Ideate stage focuses on generating solutions. In an effort to meet the needs of a diverse and underserved community, five small focus groups with five to eight culturally diverse mothers were undertaken, as were awareness campaigns via seven mental health panel discussions at schools, eight meetings with local nonprofit organization executive directors who work with underserved ethnic minority youth, collaborations with local pediatricians and behavioral health specialists, joining local business groups such as the Hispanic Chamber of Commerce, and attending monthly meetings as a member of a local county mental health task force. The last two stages of 'Design thinking' include the Prototype stage whereby a product is created and the Test stage in which the product is tested. The remaining parts of these methods focus on the Prototype and Testing stages.

Virtual diagnostic clinical infrastructure

The virtual diagnostic clinic was set up with technology for patient-provider communication efficiency in 2017 including a HIPAA compliant website plugin where patients could directly upload information and would automatically be stored, also facilitating rapid "check-in" and connection to TeleNP video platform (i.e., Doxy). In addition, a HIPAA-compliant electronic medical record (EMR; i.e., Simple Practice) that fully automates the intake process with completion of all paperwork including a history form was utilized. Customized templates of background forms were sent to patients.

Upon receipt of records from the patient (including the comprehensive intake form), screening questionnaires that corresponded to the child's age and areas of concerns were emailed before the appointment. Spanish rating forms were sent

to monolingual or bilingual Spanish/English speaking parents based on their linguistic preference upon registration. Further assessment of bilingualism and language preference was conducted through a series of questions regarding preference in different settings, with different people, and in entertainment (i.e., music and television) consistent with what has been recommended in the literature (Canas, Bordes Edgar, & Neumann, 2020; Salinas, Bordes Edgar, & Puente, 2016). All paperwork was available in Spanish for monolingual or bilingual Spanish speaking families.

Virtual diagnostic technological infrastructure for financial monitoring

Administrative task management. We utilized a mobile app feature (i.e., “Ring Central”) to monitor call duration as well as time receiving and organizing patient’s prior records, and scanning those into a server. Data and time tracking were entered into a project management software system (i.e., “Meistertask,” “Wrike”). In a virtual environment, patients no longer were required to check in 30 min before the appointment; therefore, staff no longer needed to work for this service. The average length of comprehensive neuropsychological evaluations varied from 5–11 hr, consistent with previous literature (Postal et al., 2017; Sweet et al., 2015) while TeleNP screenings were 75–90 min. In addition, there were weekly meetings with an office manager, engineer, psychometrist, and clinical neuropsychologist to monitor efficiency.

Intake and assessment

Children older than age three with parental concerns regarding symptoms suggestive of attention deficit hyperactivity disorder (ADHD) also received an autism spectrum disorder (ASD) screening before the appointment if the parents reported any following problems on the intake form (a) history of speech/language delays or atypical language (i.e., echolalia, scripted speech), (b) difficulty with the development of social relationships, (c) history of repetitive, self-stimulatory, or self-injurious behaviors, (d) history of fixated interest or preoccupations, (e) history of sensory sensitivities, and (f) history of emotional dysregulation in association with inflexibility. All children with parental concerns related to a potential diagnosis of an ASD also received ADHD and mood screenings since they represent frequently comorbid disorders (Pritchard, Nigro, Jacobson, & Mahone, 2012; Sharma, Gonda, & Tarazi, 2018). Similarly, all children with reports of significant attentional disturbance received mood screening due to increased risk for comorbidity (van Stralen, 2016). A small portion of children was only screened for mood concerns and was excluded from analyses.

Upon completion of the questionnaires, verbal instructions were provided to families by telephone regarding how to create a distraction-free environment with the greatest chance to facilitate a child’s engagement in in-home testing procedures. It was determined which room or seating area may be the best based on the child’s behavioral presentation (e.g., sit on parent’s lap in a living room or set up bedroom to have preferred toys on the ground). Notably, the examiner asked the parent about preferred toys and any fixations during appointment scheduling to help facilitate rapport building, clinical impressions and reduce the likelihood of emotional outbursts.

After the 20- to 30-min child interview and observation period, the examiner subsequently engaged in a rapid 20- to 30-min diagnostic interview (with the parent) focused on Diagnostic statistical manual 5th edition criteria (American Psychiatric Association, 2013) verifying important relevant details and symptoms. The examiner completed all clinical interviewing and testing, after which she presented a preliminary clinical impression based on this consultation alone and was always blinded to the questionnaire data. The same examiner performed all interviews and testing with all patients. Subsequently, the examiner presented the questionnaire data to the parent in real-time of reviewing the results via-share screen features on the telehealth platform and would ask additional information regarding symptoms typically occurring in the context of real-world scenarios (e.g., interactions on a playground or responses during a social event) to help with diagnostic clarification and intervention planning. Upon completion of reviewing the questionnaire data and gathering the additional history, the examiner would complete additional rating scales and neuropsychology subtests.

When ASD was suspected, the following were administered via video-based TeleNP: Childhood autism rating scale, 2nd edition (Schopler, Bourgondien, Wellman, & Love, 2010); NEPSY-II word generation (Korkman, Kirk, & Kemp, 2007) or Delis-Kaplan executive function system verbal fluency (DKEFS; Delis, Kaplan, & Kramer, 2001); and verbal aspects of the Autism diagnostic observation scale, 2nd edition (ADOS-II; Lord et al., 2012): cartoons, friends, and conversation. The DKEFS has also since been used in TeleNP (Harder et al., 2020). The Vineland adaptive behavior scale—comprehensive interview form, 3rd edition (Vineland-3; Sparrow, Cicchetti, & Saulnier, 2016) was also completed in order to obtain data regarding the child’s current adaptive functioning. To facilitate remote administration of the Vineland-3, the examiner had two computer monitors. One screen was for video conferencing with the parent. The second screen was used to access Q-global (2020) to view the Vineland-3 Interview Form content and score responses. The other measures were administered with paper and pencil format. The sole examiner would then confirm a diagnosis and provide a treatment plan in real-time.

Upon completion of the assessment, the clinic utilized an automated table generation based on the input of test scores via an internally developed HIPAA-compliant app. Report writing templates and dictation were embedded within a HIPAA-compliant EMR.

Results

Screening and assessment

Sixty-eight children out of 70 who were offered the TeleNP screening option scheduled an appointment. Of those who were scheduled, 98.5% of the patients showed for their appointments (one patient canceled). All 67 patients completed the questionnaires as required before the appointment. Roughly three percent (2.9%) required the initial video-based TeleNP appointment to be rescheduled until materials were completed. The average time between first patient contact to the practice, the parents' completion of screening questionnaires and receiving a diagnosis with a treatment plan via video-based TeleNP was 3 days (range = 0 to 7 days). All 67 patients who were scheduled for the TeleNP screening completed the entire 75- to 90-min appointment. All screenings were completed in a one-time visit.

The mean age of the children (37 boys/30 girls) was 10.2 years (range = 2 to 18). Nineteen percent of the patients were monolingual Spanish-speaking or bilingual Spanish/English Latino, 2.1% of the patients were Pacific Islander, 2.1% of the patients were Asian, and 5.8% of the sample were Black, with some ethnic minority groups served at a higher rate than county demographics (i.e., 10.9% Latino; 0.1% Pacific Islander; per [US Census Bureau, 2019](#)).

The examiner was able to provide ADHD, ASD, psychiatric, language disorder, and concussion diagnoses by video-based TeleNP 100% of the time without the need to conduct follow-up in-person testing. Of note, approximately 10% of the sample had a previous diagnosis of epilepsy, and 2% had neurofibromatosis. Although parent's concerns were confirmed by the examiner 91.1% of the time (i.e., the parent was concerned about attention and an ADHD diagnosis was given), the added-value from the neuropsychological screening was that the examiner identified "hidden" comorbidities 65.6% of the time (e.g., the parent initially reported concerns about ADHD but the results of the screening also indicated comorbid ASD or a mood disorder).

Recommendations for follow-up in-person testing were always given when concerns regarding a learning disability were present. Of those with ASD, follow-up in-person testing was determined to be indicated only 1.5% of the time to increase parental confidence in the virtual ASD diagnosis (i.e., parent expressed skepticism regarding the accuracy of this diagnosis via telehealth platform); in-person testing was concordant with the video-based TeleNP screening.

Patient follow-up contact

The examiner called and successfully reached 98.5% of the patients approximately 2 months following their assessment completion in order to determine the utilization of feedback to make tangible changes in the child's care, both at school and at home. A total of 98.5% of families reported receiving new interventions (not previously in place at the time of the assessment 60 days prior) as a result of the brief, video-based TeleNP service. Approximately 40% (40.3) of the children were receiving psychiatric care for medication management and 17.9% were receiving medication management with their pediatrician. About 20.8% had already received an IEP or 504 plan, 37% were pending, 3% were accepted into a private school that specialized in teaching ASD students, and 3% were receiving academic tutoring. Almost 19.4% were receiving psychotherapy, 8.9% were receiving ABA therapies, 1.5% were receiving speech therapy, and 3% of the patients were either receiving or had obtained vocational rehabilitation counseling since the assessment.

Financial implications for private practice

The technological infrastructure designed for efficient patient-provider communication in advance of the appointment led to (a) a $\times 10$ reduction of time with the online scheduling process compared to the traditional model in which a receptionist called a patient to schedule an appointment (i.e., an average of 2 min online scheduling process versus 20 min call, on average with direct savings of nearly \$2,000 for this process (i.e., based on employee hourly wages \times time spent per patient for a total of 67 clients); (b) a completely paperless service, saving administrative time and costs associated with collecting and scanning previous records; and (c) reduced check-in times (i.e., saved 30 min per patient or 33.5 hr across the sample), saving an additional \$837.50 in administrative costs. The video-based TeleNP appointment also significantly reduced assessment time compared to traditional pediatric evaluations ([Sweet et al., 2015](#)), ranging between 75 and 90 min for completion of the entire process. Overall, the new program development led to an 18% increase in profits and led to \$67,000 in cost savings due to the reduction of personnel (i.e., administrative and psychometrist time). Although all patients had insurance, the patients chose this service fully out of pocket. It

should be noted that this was before the pandemic when TeleNP was not routinely covered by insurance. Due to the cost savings and increase in profits, the practice transitioned from 62% managed care to 100% self-pay model within 1 year of introducing this new service.

Discussion

‘Design thinking’ (Brown, 2008; Dam & Siang, 2020) with diverse stakeholders was leveraged in order to implement a novel TeleNP approach to private practice development, management, and infrastructure 2 years before the severe acute respiratory syndrome coronavirus 2 (COVID-19) pandemic. This methodology, in combination with a commitment to socially responsible neuropsychology (Suárez, Casas, Lechuga, & Cagigas, 2016) to increase access to patient care within a federally identified mental health professional shortage area (Health Resources & Services Administration, 2020), was the “mother of invention”. The first step in ‘Design thinking’—Empathy—or relating to the needs of patients and their social systems, in this case, can be informed by the literature evaluating TeleNP in children and adults (Harder et al., 2020; Hodge et al., 2019; Sutherland, Trembath, Hodge, Rose, & Roberts, 2019; Waite, Theodoros, Russell, & Cahill, 2010). Sociodemographic variables specific to the practice location, as well as medical insurance data, the practice parameters described in existing provider surveys and practice guidelines were reviewed (Cullum, Hynan, Grosch, Parikh, & Weiner, 2014; Wadsworth et al., 2018) and interviews with both patients and colleagues were conducted. The resultant data made clear that brief video TeleNP screenings accelerated the time to diagnosis and treatment interventions and is more financially feasible (which can have both direct and indirect impact on patient accessibility and provider income). Anecdotally, patients frequently reported choosing the brief TeleNP screening in a self-pay private practice model in lieu of lengthy waiting times with alternate providers in a hospital or traditional outpatient setting even when those services would be covered by insurance plans. By utilizing all of the information gleaned during the Empathize stage to define the “problem” of financial and geographic “attainability”, the “problem” of why a more conventional neuropsychological model would not be effective was defined (Define stage).

Once the “problem” was thoroughly defined, the third step of ‘Design thinking’—Ideate—was employed in order to rapidly brainstorm potential ideas and solutions, with a specific emphasis of refining both practice innovations and business models. To this end, technology was utilized to streamline neuropsychological testing procedures, which, traditionally, were, at times, cumbersome for both patients and providers (Postal et al., 2017). Such barriers had the potential to limit a family’s ultimate decision to seek—and complete—a neuropsychological evaluation. Furthermore, in-office neuropsychological evaluations can also result in substantial secondary parental stressors, including transportation limitations (i.e., lack of car, limited funds for parking/tolls/gasoline) and the potential for lost wages. During the Ideate phase, modifications for implementation of neuropsychological evaluations via telehealth were developed and piloted in an effort to “think outside the box” to challenge these traditional views and assumptions of in-office neuropsychological evaluations. To this end, video-based TeleNP assessments were regularly employed. Additional innovations included the use of more abbreviated screenings of ADHD, ASD (using a modified version of the ADOS-II), mood problems (i.e., anxiety or depression) and developmental delays (i.e., speech/language). Although this remains to be validated, limited in-person evaluations conducted to confirm a diagnosis in this initial sample were all consistent with diagnoses made in the abbreviated screening.

Through Prototype and Testing, the final two stages of ‘Design thinking’, the described model was practically refined to ensure that methods were desirable for the user (in this case, the pediatric patient and their families), viable for the business (the pediatric neuropsychologist/private practitioner), and technologically feasible for both parties. Follow-up contact with the patient, as well as the provider’s own financial data, were critically examined as both qualitative and quantitative “outcome” variables for the innovations ultimately pursued during the prototype and testing phases (i.e., HIPAA compliant platform development, unique strategies for patient engagement and involvement).

There are potential limitations to this work including patients who may have limited access to technology. However, in the current county where this took place, the median income is \$54,359 and 11% of the population is in poverty (US Census Bureau, 2019). Another limitation is that families may prefer more in-depth or in-person evaluations. Those options could still be offered while at the same time opening opportunities and decreasing wait times for those who may be interested in an expedited evaluation.

Several key takeaways emerged that demonstrated “proof of concept” for these unique conceptualizations and practice advancements, including (a) video-based TeleNP immediately benefits the consumer and reduces the length that patients would wait for an assessment (from several months to 4–6 weeks); (b) it removes the financial burden of travel and parental stress for taking time off from work; and (c) provides geographically under-served populations with options of seeing providers who are linguistically and culturally diverse. Moreover, the length of assessment can be streamlined by video-visit, without sacrificing for the ability to make well-informed, data-driven clinical recommendations in pediatric populations with the potential for multiple neuropsychological and psychiatric comorbidities. Despite the deviation from more “traditional” pediatric neuropsychology

practice models, follow-up data suggest that streamlined, targeted video visits have the capability to generate data-driven recommendations, leading to quantifiable “real world” intervention and treatment plans (i.e., more accurate academic placement, initiation of therapies). From a provider perspective, the described private practice model also yielded multiple quantifiable improvements with direct implications for cost-saving, thereby facilitating economic viability. Although this allowed the practice to reduce costs by reduction of administrative and psychometrist personnel, we are not arguing for the reduction of use of psychometrists, but are suggesting that reducing their time spent on administrative tasks including scoring can be better used on direct clinical work. Innovation such as these required collaborations across disciplines, leveraging expertise in leadership, technology, engineering, and business development, in order to reduce potential barriers to care including financial burden, accessibility, and equitable service delivery.

Conflict of interest

None declared.

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