USE AND EFFECTIVENESS OF NEUROMUSCULAR ELECTRICAL STIMULATION IN CHILDREN WITH OBSTETRIC BRACHIAL PLEXUS PALSY A CROSS-SECTIONAL SURVEY AMONG OCCUPATIONAL AND PHYSICAL THERAPISTS

A Thesis submitted to the faculty at Stanbridge University in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy

by

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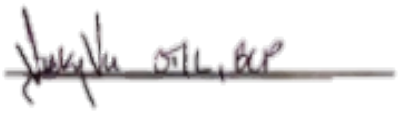
Certification of Approval

I certify that I have read Use and Effectiveness of Neuromuscular Electrical Stimulation in Children with Obstetric Brachial Plexus Palsy A Cross-Sectional Survey among Occupational and Physical Therapists by McKenzie Collins, Eleni Dimopoulos, Emily Jones, and Sivan Louria, and in my opinion, this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy at Stanbridge University.



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Abstract

Children with obstetric brachial plexus palsy (OBPP), a nerve injury due to an overstretching of the C5-T1 nerves occurring at birth, are at high risk for decreased functional skills that affect their activities of daily living. However, they have the potential to regain functional skills despite nerve damage. While there are several accepted treatment interventions, there is little research that supports neuromuscular electrical stimulation (NMES) as an intervention that promotes increased range of motion, increased use of the affected limb, and independence in functional skills with children with OBPP. Therefore, there is a lack of agreement among occupational and physical therapists on whether NMES is an adequate intervention for children post-surgery with obstetric brachial plexus palsy. This survey-based study examined the use and effectiveness of NMES for children with OBPP. An internet-based survey was used to obtain information regarding the participants' use of NMES as a treatment for children with OBPP as young as birth to 18 months of age, and 27 occupational therapy and physical therapy practitioners participated in this study. There was a statistically significant increase of reported mean Active Movement Scale scores from pre to post NMES treatment. Survey participants who answered that they do not use NMES for nerve transfer or tendon transfer treatment were excluded from this analysis. These results suggest that NMES is a useful and effective treatment for children with OBPP. Future research should utilize a case study design to further examine the effectiveness of NMES on children with OBPP through examining specific parameters that promote improved functional skills.

Keywords: Neuromuscular electrical stimulation, obstetric brachial plexus

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Use and Effectiveness of Neuromuscular Electrical Stimulation in Children with Obstetric Brachial Plexus Palsy: A Cross-Sectional Survey among Occupational and Physical Therapists

Obstetrical brachial plexus palsy (OBPP) is a rather common form of peripheral neuropathy that occurs at birth (Thatte & Mehta, 2011). It is caused by stretching of the brachial plexus during birth, and affects 3 per 100 live births (Buesch et al, 2010). The affected nerves of the brachial plexus, C5-T1, control the finger, hand, arm, and shoulder muscles (Frade, Gomez-Salgado, Jacobson, Florindo-Silva, 2019). A brachial plexus lesion causes partial loss of voluntary movement of the upper extremity (UE). Risk factors of this condition are pelvic birth, diabetes, small stature, primiparity, or prolonged second stage of labor (Frade et al., 2019). 92% of infants show partial or full recovery in the first 3 months (Berggren & Baker, 2015). However, 20-35% who do not have spontaneous recovery require reconstructive nerve surgery (Duijnisveld et al, 2016).

Children who have OBPP have certain limitations that can affect their participation in daily life. Each domain outlined in the Occupational Therapy Practice Framework (OTPF) can be affected by OBPP (2014). Domains according to the OTPF are classified as occupations which include activities of daily living, rest and sleep, education, and work. Additionally, client factors address an individual's values, beliefs, spirituality, and body functions and structures. Performance skills of the domain include motor, processing, and social interaction skills. Performance patterns refer to habits, routines, rituals and roles. Lastly, contexts and environments are classified as cultural, personal, physical, social, and temporal (American Occupational Therapy Association [AOTA], 2014).

Occupational therapists help children gain the strength and skills needed in order to be able to complete those activities through conservative interventions. An occupation is defined as a daily activity that people engage in (AOTA, 2014). Children with OBPP may have limited to no use of shoulder, elbow, wrist, and hand. Some occupations that may be affected could be activities of daily living (ADLs) such as dressing, feeding, and play. Within the client factors domain, a child's body structures and functions are impacted by an OBPP injury. A child who has OBPP has a limited range of motion and an inability to then make functional movements. While a young infant is not directly impacted, the family of the child can feel distress and limitations in daily routines. The context and environment domain can also be affected as a child grows, but also for the parents of a young infant learning how to maneuver this injury. Occupational therapists can work with the child and their families in each of these domains based on the individual clients' needs.

Treatment of OBPP has changed significantly in the last 25 years. Use of immobilization of the affected limb has become outdated; it is now expected for a child with OBPP to undergo rehabilitation with an occupational therapist as soon as possible (Smith, Daunter, Yang, & Wilson, 2018). Conservative interventions are currently favored if there is any spontaneous recovery in the first few months, notably in elbow or shoulder function, to avoid unnecessary surgeries for children with OBPP (Socolovsky et al., 2016). For OBPP, these interventions can vary from constraint-induced movement therapy (CIMT), an immobilizing splint, Kinesio Tape, botulinum toxin, and neuromuscular electrical stimulation (NMES) (Frade et al., 2019). As the child develops, conservative treatments for integrating the limb into the body structure are essential, as

such interventions promote normal range of motion, use of the affected limb, and independence (Frade et al., 2019). OBPP can be a treatable condition with the right interventions. However, with limits in current research for NMES within the OBPP population, the question of effectiveness and consistency of use needs to be considered. Therefore, this research was designed to answer whether: occupational therapists are using NMES as a treatment modality for children with OBPP, what age they are recommending use, whether it is used as part of a post-surgical protocol, and what parameters they use when it is used.

Literature Review

OBPP commonly affects nerves C5 and C6, which show as impaired elbow flexion, abduction, and external rotation of the shoulder (Frade et al., 2019). The available rehabilitation treatments include both conservative and surgical interventions. Nerve transfer, a primary surgical intervention, aims to reconstruct the brachial plexus by using grafts of the median and phrenic nerve (Frade et al., 2019). The damaged nerve is replaced to ensure that proper sensation and movement is restored. Nerve transfer is advocated for children with OBPP that lack bicep function or evidence of nerve root avulsion by the age of 3 months (Bade, Lin, Curtis, & Clarke, 2014).

However, surgery is contraindicated if shoulder function is partially recovered at that time (Bade et al., 2014). Tendon transfer, a secondary surgical intervention, is then considered if a child shows partial spontaneous recovery, but with deficits (Socolovsky et al., 2016). Tendon transfer can also be used if a child only moderately recovers after primary surgery (Socolovsky et al., 2016). Tendon transfers include transfers of the latissimus dorsi and teres major tendons over triceps into the rotator cuff insertion with

the focus on gain improved external rotation and abduction (Abzug & Kozin, 2014). Tendon transfers are considered a complete approach to restoring function and hindering fixed deformities of the shoulder (Aydin et al. 2011).

A multitude of tools have been used in the past to measure motor function in children with OBPP, such as the Gilbert and Tassin Scale, the Mallet Scale, and the Active Movement Scale (AMS). The AMS was, however, developed specifically for evaluating infants with OBPP. This method observes spontaneous movements, in environments where the limb works against gravity and where gravity is eliminated, to describe and quantify UE strength. To represent all 5 nerve roots and functions affected in OBPP, the AMS evaluates the active range of motion of fifteen movements (Curtis, Stephens, Clarke, & Andrews, 2002).

Contrary to the Mallet scale, where verbal instructions are required to achieve the observed movement, AMS scores are assigned while watching the infant at play. This makes the evaluation of active movement in an infant with OBPP easily discernible. The Mallet scale is a method for evaluating children with OBPP according to their ability of functional positioning with the affected UE (Curtis et al., 2002). This scale is also tailored typically for children who can follow directions and not used for infants. Therefore, the AMS is used for infants and children whereas, the Mallet can be used only for children.

In contrast, the Gilbert and Tassin scale only grants a single score for partial movement, whereas the AMS has 5 categories for classifying partial movement. That the AMS can measure multiple types of movement expands the ability of the AMS to detect partial movement. This sensitivity also supports the use of the AMS for measuring the

movement of those with OBPP. Considering this grading system can be used as an outcome measure for pre- and post-operative data of a nerve or tendon transfer, the AMS allows for considerable comparison of paired data (Curtis, 2002). The capability to statistically analyze paired AMS scores makes it the most reliable tool for studying the effectiveness of NMES.

As mentioned, there are also numerous conservative interventions used to treat OBPP. CIMT is a conservative treatment that can facilitate the use of the affected limb by constraining the unaffected limb (Cleveland Clinic Children's Hospital for Rehabilitation, 2020). After a tendon transfer for a child with OBPP, a case study showed only an 8% increase in a hand assessment and 9% increase in unilateral upper limb function after 126 hours of CIMT (Buesch et al., 2010). Similarly, an immobilizing splint holds a joint or bone of the affected limb in place during the healing process. However, this treatment causes muscle contractures which creates joint stiffness (Hoffman, 2019). Hence, this should be avoided when treating OBPP for optimal improvements in range of motion.

Kinesio Tape is a rehabilitative taping method that facilitates the body's natural healing process by providing support and stability of the upper extremity. In a study on 30 patients with neonatal brachial plexus palsy (NBPP), the control group underwent a physical therapy program while the experimental group had Kinesio Tape support their shoulder and forearm (ElKhatib, R., ElNegmy, E., Salem, A., & Sherief, A., 2013). The physical therapy program for each group consisted of heat pads and range of motion exercises. The experimental group showed greater shoulder flexion and abduction, but there was no significant difference between the two groups in shoulder extension, external rotation, and wrist-finger extension (ElKhatib et al., 2013).

In another study conducted by Michaud et al. (2014), active botulinum toxin A was injected into 59 patients with NBPP. Botulinum toxin A is a protein that inhibits the release of the neurotransmitter acetylcholine in order to cause temporary flaccid paralysis of antagonistic muscle. Injection procedures for this study included 51 to shoulder internal rotators, 15 triceps, 15 pronator teres, 9 biceps, and 1 flexor carpi ulnaris. There was a statistically significant improvement in shoulder external rotation ($P = 0.0003$) of the affected limb. Only 67% of patients showed improved active elbow flexion ($P = 0.005$) and passive elbow extension by an average of 17 degrees ($P = 0.004$).

NMES utilizes a device that sends an electrical impulse to nerves through electrodes on the skin. This impulse causes muscles to contract and offset the effects of disuse. In a literature review on NMES as a treatment for NBPP, average scores in active range of motion for shoulder abduction increased from 26 to 63 degrees, shoulder flexion from 150 to 180 degrees, elbow flexion from 10 to 51 degrees, and wrist extension increased from 8 to 46 degrees, over a 12 week period (Justice, Awori, Carlson, Chang, & Yang, 2018). Even with limited quantitative data regarding the treatment for OBPP, electrical stimulation shows implications for the best conservative intervention by preventing muscle atrophy, joint deformities, and muscle contractures (Justice et al., 2018). In accelerating nerve regeneration, NMES also promotes improvements in muscle strength and range of motion (Justice et al., 2018).

A retrospective case study used therapeutic and surgical interventions for two years on a child with global right OBPP and a positive Horner's sign. The study found the combined use of NMES and CIMT amplified muscle activation and active movement in the affected arm to promote functional recovery (Berggren & Baker, 2015). The case

study analyzed AMS scores taken at intervals throughout the two years of treatment. The initial score recorded at two weeks of age indicted no movement throughout the arm and hand. At age 7 months, four months post-surgery, palpable contractions arose in the shoulder, elbow, and finger flexors. By age 20 months, movements against gravity had appeared in the elbow, fingers, shoulder, wrist and thumb.

To treat spasticity in patients with cerebral palsy (CP), botulinum toxin injections have been studied in conjunction with other treatments, such as traditional occupational and physical therapies, as well as neuromuscular electrical stimulation (NMES) (Rodriguez-Reyes, Alessi-Montero, Diaz-Martinez, Miranda-Duarte, & Perez-Sanpablo, 2010). This particular study found that while each treatment has independently proven to be efficient, there appears to be a trend towards clinical improvement with all patients when NMES was added to the treatment, despite the lack of statistical significance (Rodriguez-Reyes et al., 2010). The lack of significant and current research supports the importance for providing more data on the effectiveness of NMES through this survey study.

Survey research is a method that can be used to gain insight on a variety of topics. This method is able to reach a large number of participants, data collection is easier than other methods, and surveys allow the use both quantitative or qualitative analysis. In the past, large sample populations were primarily used to gather an abundance of information within a quick time frame. More recently, survey research has been more meticulous as a source for informal and formal information. Surveys also provide a representative sample, specific methodology, and reduction in errors by the use of follow-up questions, which ensures high quality research and outcomes (Ponto, 2015).

Implementing diverse recruitment strategies when using survey research expands the number of participants in the sample and ensures there is sufficient coverage of the population targeted. The most common forms of data collection are questionnaires and interviews. Questionnaires can be taken independently and can include a series of questions that are geared to the research goal (Ponto, 2015). Survey research is also flexible and dependable, as it can be administered online, and the anonymity of the online environment encourages participants to answer more truthfully (Ponto, 2015). A survey was chosen as the research tool for this study as no other method provides the broad capability of reaching occupational and physical therapists across the world.

Statement of Purpose

Upon completing an extensive literature review, we found there to be a lack of evidence to support the effectiveness of NMES as an intervention for OBPP. Hence, there is a lack of accord amongst occupational therapists on whether NMES is an adequate intervention for children post-surgery with OBPP (Justice et al., 2018). Therefore, NMES is not typically used when therapists provide conservative interventions due to therapist uncertainty and the rareness of the condition (Alon, 2019). The underuse of NMES is exacerbated by the fact that a standardized protocol for the delivery of NMES does not exist. A protocol for NMES must include frequency, amplitude, pulse duration, and electrode placement (Justice et al., 2018). The data from this survey can help to answer the question that surrounds NMES as the best conservative treatment for infants with OBPP.

Considering the emphasis on evidence-based practice in occupational therapy and OBPP being a very common peripheral neuropathy at birth, finding the most effective

post-surgical intervention is imperative. A meta-analysis that compared the statistical significance of different interventions, the greatest impact on OBPP although the sample size was limited in quantity was found to be from NMES (Frade et al., 2019). There is, however, a lack of current research that determines if NMES is a statistically significant intervention for children with OBPP. Our analysis of survey responses from occupational and physical therapists was designed to assess the effectiveness following NMES using AMS scores.

Theoretical Framework

Occupational therapists must use appropriate frames of reference to guide their research and practice. The biomechanical frame of reference is ideal for clients with impairments related to their capacity for movement in daily occupations (McMillan, 2016). This frame of reference (FOR) is primarily concerned with an individual's competency for muscle strength, movement, and endurance during occupations, or the future occupations of a child (McMillan, 2016).

Brachial plexus palsy weakens and limits the range of motion of the affected joint. The biomechanical FOR focuses on the impairment level that is affecting or limiting occupational performance and aims to repair the affected limb or stop further damage. (Gillen & Nilsen, 2019). The biomechanical approach is based on a few different assumptions. The first assumption is that the underlying impairment is responsive and open to remediation. The second assumption is that engaging in occupations and other therapeutic activities has the potential to remediate the impairment. The last assumption is that after remediation, occupational performance will improve (Gillen & Nilsen, 2019). To ensure the success of this approach, the impairment must be linked to the loss in

occupational performance. Through the remediation of the affected limb, occupational and physical therapists can improve this deficit. The intentions of the biomechanical FOR that guide this survey include prevent deterioration, restore, maintain existing movement, and adapt for loss of movement.

Due to the effects of OBPP, a child's growing body systems and structures that create motion can be compromised (McMillan, 2016). This theoretical framework relates to a person's capacity for movement throughout daily occupations and can be used for the re-integration of purposeful activities (McMillan, 2011). The goal of the intervention is to teach compensatory techniques to prevent injury recurrence and then facilitate the joint or muscle movement in their occupational performance (Frost, 2010). Occupations that incorporate movement and potential restoration are key to understanding the use of the biomechanical frame of reference throughout this survey analysis and professional practice. This survey lends itself to look at the limitations of the UE and how the biomechanical frame of reference can help restore function to the affected limb. By studying each client's occupations and occupational performance, therapists can see how to incorporate the biomechanical frame of reference into their treatment interventions.

The biomechanical frame of reference is used in this research topic to help remediate the affected extremity and provide exercises and options for the client to work on to improve their strength and range of motion. With OBPP, a child's upper extremity is limited for functional use in ADLs and instrumental activities of daily living (IADLs). Weakness and loss of active movement in the shoulder, arm, hand, and fingers ultimately affects a child's ability to play, and "play has been identified as one of the primary occupations in which people engage" (Case-Smith, 2015, p. 483). Using the

biomechanical FOR, the research aimed to look at the value of NMES in regaining motion and strength in the affected upper extremity to facilitate increased independence in occupational performance such as dressing and play.

This frame of reference analyzes all-encompassing joints, muscles, and nerves affected and then also the relationship between all of these on their functions. The biomechanical approach also uses qualitative evaluation data to measure the effectiveness of the intervention, such as the degree of range of motion. The purpose of this survey is to see if incorporating NMES as an intervention can elicit greater functional mobility of the affected extremity, as seen by the sample of pre and post AMS scores.

Methodology

Design

An internet-based survey was used to obtain information from a sample of occupational therapy and physical therapy practitioners. The online format was chosen to maximize participation and to have consistent data capture. The original format for this study was going to be a case-study on a child who had just undergone a brachial plexus nerve transfer surgery. Research was to take place at a hospital where the child received weekly NMES and the child's range of motion scores would be recorded monthly. However, due to the coronavirus pandemic this study was changed to a survey format for the health and safety of all those involved. An advantage to this methodology is that a wider range of rehabilitation professionals were able to provide their input and expertise on this topic rather than the case study, which would have just looked at one child's experience with NMES.

Participants

This survey was conducted on healthcare professionals (*N*=27). The inclusion criteria for this study required that the participants be occupational therapists, occupational therapy assistants, physical therapists, or physical therapy assistants. For recruitment of the participants, the researchers posted the survey link on the AOTA website. The survey was also posted on occupational therapy social media pages and was sent to department heads of various hospitals and clinics via email. The participants of the survey either must have or must currently work with patients with obstetric brachial plexus palsy. The survey was optional, and only those professionals who were interested in participating took the survey. At the beginning of the survey, participants consented to participate by selecting yes on the consent form (see Appendix). The survey was anonymous, and the participants were not required to disclose any identifiable information throughout the process. The cost to participants is the time and effort required to take the survey. The survey only took up to 5 minutes to complete, and as stated before, taking the survey was optional. There were 27 total participants who took the survey.

Ethics

In compliance with the AOTA Code of Ethics, the core values of freedom, dignity, truth, and prudence were taken into consideration in the creation of this study (AOTA, 2015). Approval for this survey was received from Stanbridge University's Institutional Review Board. Prior to beginning this survey, informed consent was obtained from participants (see Appendix). Cost to participants was time and effort, and to reduce these costs to participants, the survey was kept as brief as possible, only taking

3-5 minutes to complete. At any time, participants could exit the survey and choose not to submit their answers. Participants also had the option to leave answers blank if they did not want to answer any of the questions. The survey maintained participant confidentiality by not asking any identifying questions. Survey results were anonymous and stored password protected on a secure internet site only accessible by the four researchers, our thesis advisor, and the advising statistician.

Data Collection

Prospective participants received a link and short statement asking for their participation in completing the survey (see Appendix A). Participants were asked to give their consent to participate before beginning survey items. All responses remained anonymous and contained no identifiable information. Data was collected through Survey Monkey and Google Forms. Data was collected from May 30, 2020 to June 15, 2020. Whenever possible, closed-ended questions were used in the survey to increase the reliability of responses. The survey consisted of 13 items: 2 regarding demographics; 2 about the general use of NMES; 5 more specific NMES questions (e.g., AMS baseline and end scores after use of NMES); and 4 items about NMES parameter settings (e.g., electrode placement, pulse duration, frequency, and amplitude).

Data Analysis

Responses were checked for potential data entry errors and missing data. Data was summarized using SPSS statistical software. Demographic data was summarized by using graphs and charts to see common responses to certain questions. The paired sample *t*-test was used to evaluate average AMS scores pre and post NMES treatment.

Results

As shown in Figure 1, 74.1% of the survey participants were occupational therapists. The most common intervention used with patients with OBPP was CIMT at 24% (see Figure 2). Regarding the participants' level of experience, 41% have more than 16 years of experience in treating OBPP (see Figure 3). According to Figure 4, the most common response to the question: *"Do you use NMES for a nerve transfer, tendon transfer, both, or neither?"* was Neither: 12, 44%. 32% of therapists answered they would consider NMES treatment in patients 18 months or older (see Figure 5).

To test the main hypothesis that NMES is an effective treatment modality for OBPP, a *t*-test of means between baseline AMS scores (M=2.71, SD=1.11) to post AMS scores (M=3.71, SD=1.70) was performed.

Table 1

A *t*-Test of Means Between Baseline and Post AMS Scores

	Baseline AMS Score	*Post AMS Score*
Mean	2.71	3.71
SD	1.11	1.70
Sample size	7	
Degrees of freedom	6	
t-value	-2.29	
p-value	.031	

Note. Participants who selected "Neither" for the question: "Do you use NMES for a nerve transfer, tendon transfer, both, or neither?" were excluded from this analysis.

Survey participants who answered that they neither use NMES for nerve transfer or tendon transfer treatment were excluded from this analysis. According to Table 1, after excluding participants who endorsed "neither" from the question: *"Do you use NMES for a nerve transfer, tendon transfer, both, or neither?"*, there was a significant increase from baseline AMS scores to post AMS scores, $t(6)=-2.29$, $p = .031$. A graphical representation of the means is displayed in Figure 6.

Discussion

The participants recorded their typical AMS baseline scores and typical AMS total end scores during the survey. Clinically, AMS scores are defined in a range with the numbers identifying different levels of movement. In general, scores of 0-15 mean an arm that is significantly affected with no shoulder, elbow, or forearm movement with some possible finger movements. The scores that range from 16-30 typically mean that there would be partial finger movement and some possible wrist movement. In addition, there would likely be minimal movement of the shoulder, forearm, and elbow. Scores of 31-45 indicate that there is minimal to no shoulder movement, but fingers and wrists are functioning. At the 46-60 range therapists begin to see antigravity movement of the shoulder and elbow, and scores from 76-90 patients would achieve around 50% antigravity movement for the shoulder with good function of the elbow and fingers. Finally, in scores in the 91-105 range, patients demonstrate minimal involvement to normal upper extremity function. The results showed that NMES as a treatment intervention had an average of a one-point increase in AMS scores from pre to post treatment, reflecting a cumulative increase of 15 AMS points (see Figure 6). Therefore, a child with OBPP could see an increase in UE movement and potentially also gain the ability to move against gravity.

The participants of this study reported that baseline AMS scores varied depending on the patient. There was one participant that stated their typical baseline score is in the 0-15 range and two participants reported typical baseline scores in the 16-30 range. Two other participants started at the 31-45 range and there were two others who began at 46-60. These baseline scores are dependent on the client and the severity of their OBPP. In

the majority of the participants' answers, they all stated that they saw an increase in AMS scores after using NMES as a treatment intervention. Three participants reported that average scores stayed within the same score range.

The survey discovered that occupational therapy and physical therapy practitioners are using NMES as a treatment for OBPP. However, there was some discrepancy in terms of electrode placement and parameters. There were only two participants who responded to the questions on parameters used for electrode placement, pulse duration, frequency, and amplitude when using NMES as a treatment intervention. For electrode placement, a participant stated that they use rotator cuff, biceps, triceps, and wrist extensors. The other participant who answered the electrode placement question said they place the electrodes wherever they are anatomically directed and then move around from that position to where they need to. For pulse duration, one participant stated that 5 seconds with a 10 second rest with a 350-pulse width are given. The other participant stated they use a 250-pulse width. Frequency of treatment was stated as 50 and 35 pulses per second by the two participants. Lastly, for amplitude, one participant stated 12 and the other stated that the intensity varies by machine. Despite this, both of these participants reported increased AMS scores from baseline to end scores. This increase in scores shows that with NMES as a treatment intervention for OBPP, a child can gain the ability to move their UE against gravity within an average of 2-10 months.

Children with OBPP have a lack of mobility in their UE and therefore often need assistance in completing their ADLs such as bathing, getting dressed, playing with their toys, and feeding themselves. An improvement in UE range of motion allows children to participate in their daily activities with greater independence. The results of this survey

showed that therapists reported an increase in UE range of motion after NMES treatment which leads to an increase in a child's functional skills. After NMES, infants and children with OBPP could gain independence in activities such as manipulating bottles, rolling, sitting up, donning and doffing their shirt, reaching for toys, reaching for food or family members, engaging in midline play, and increasing UE function. Overall, this survey found that the practitioners surveyed find NMES to be a beneficial rehabilitation treatment to increase children's functional skills.

Limitations

While this study contributes information on the use of NMES on children with OBPP, it is limited in generalizability by a relatively small sample size. A small sample size was expected due to the number of children born with OBPP. As stated earlier, 3 in 1000 live births are born with OBPP. Within that population up to 90% have spontaneous recovery, which eliminates the need for surgical intervention (Thatte & Mehta, 2011). Furthermore, Frade et al. (2010) reiterated that surgical intervention was only necessary if there was no spontaneous recovery after three months of age. Because of these small incidences, OTs and PTs have limited exposure to OBPP which was reflected in this survey. Due to this small sample size, the data lacks a complete understanding of AMS scores as described by the participants. It was unable to be determined how many clients were being referred to when answering the survey, therefore variability within the research is unable to be accounted for. Additional limitations of this study include completeness of survey. While a total of 27 responses were received, this number does not accurately reflect the amount of data received. When asked about the use of NMES for tendon or nerve transfers, a majority responded with neither or did not complete this

portion of the survey. All participants responded to the demographic questions in the beginning of the survey. Of the 27 responses, 13 chose to complete the section that asked about NMES specifically. In fact, only two participants chose to complete the entire survey. Future research would benefit from utilizing a case study design to better examine the effectiveness of NMES on children with OBPP. Another limitation of this study is that pre and post AMS score questions were recorded as ranges while if specific scores could have been selected a more significant increase may have been found. This would make give the results more accuracy as the individual scores would be more precise and exact than ranges.

Conclusion

OBPP is the most common peripheral neuropathy (Frade, et al. 2019), affecting 3 out of 1000 newborn children (Buesch et al, 2010). This specifically inhibits the nerves of the brachial plexus, which limits functional use. Some children achieve a full recovery, but for some the process to recovery includes surgery (Duijnisveld, Steenbeek, & Nelissen, 2016).

There are many interventions that have been proven to be efficient. One of the newest interventions is the use of NMES. Currently, there is a lack of research to support the use of NMES as an intervention for clients with OBPP. There are many current unknowns with regard to NMES, such an established standardized protocol. The purpose of this study is to see the effectiveness of NMES as a conservative intervention, as well as gauge the most effective parameters used by therapists. Using a survey method, the effectiveness and use of NMES on overall AMS scores for OBPP was examined. The intended outcome of conducting this survey was to provide further evidence in support of

using NMES efficacy for the OBPP population. The survey was taken by professionals such as occupational and physical therapists, as well as OT and PT assistants. The survey gathered information that looked at how often NMES was used in therapy, as well as the effectiveness as shown by improvements in AMS scores. A total of 27 participants submitted surveys. Upon analysis of the completed surveys, there was a statistically significant increase in baseline AMS scores to post AMS scores. Evidence from the survey supports the use of NMES as an effective intervention for post-surgical cases. For occupational therapists, this can be promising, as it opens the potential for other uses of NMES with OBPP clients.

In summary, this study found that NMES is an effective treatment modality for increasing range of motion in children with OBPP. When clients gain an increase in range of motion, they are able to increase their engagement in functional tasks and therefore gain independence. It is suggested that occupational and physical therapists working with clients with OBPP consider using NMES as a post-surgical treatment to increase range of motion and therefore functional ability.

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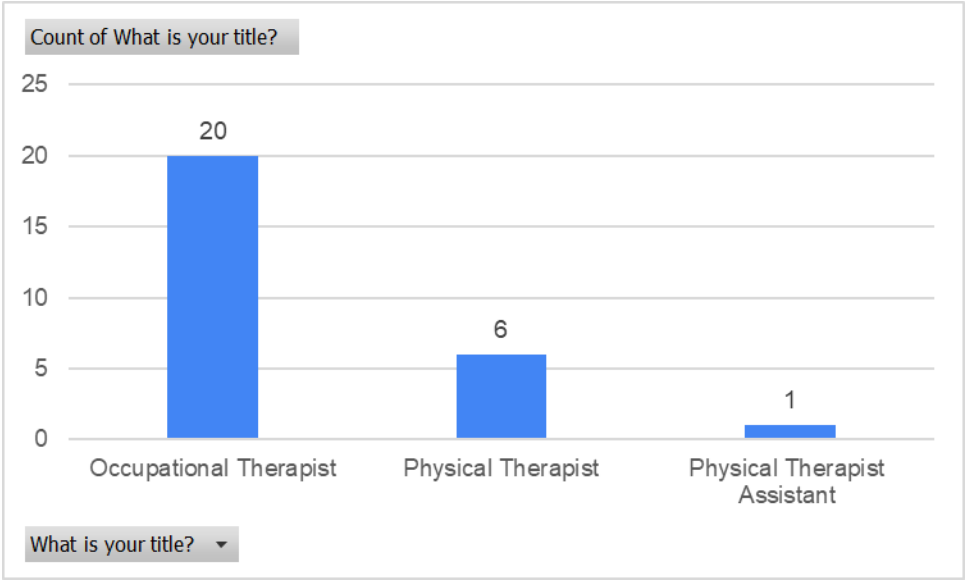

Figure 1. The most common title of the survey participants was Occupational Therapist.

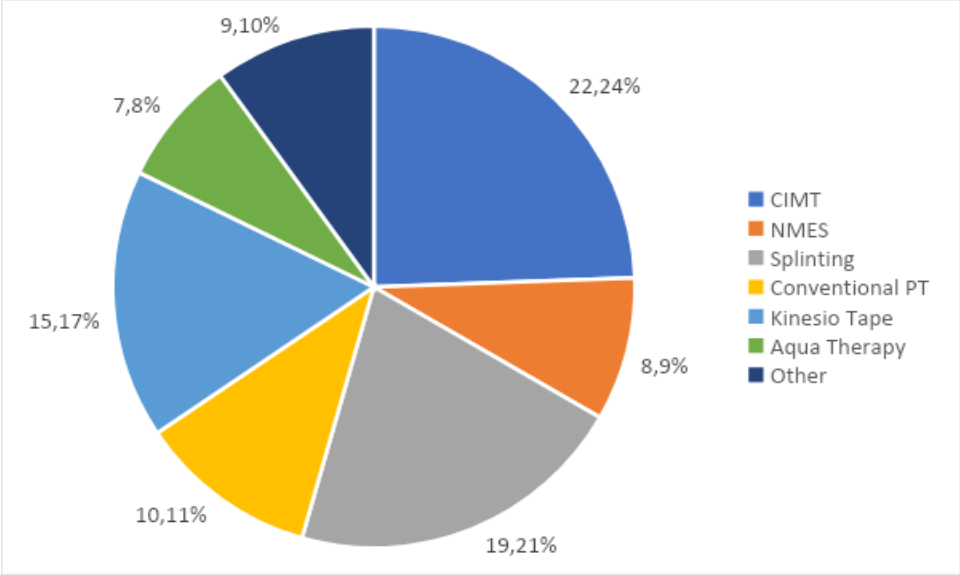

Figure 2. The most common modality used with patients with OBPP was CIMT.

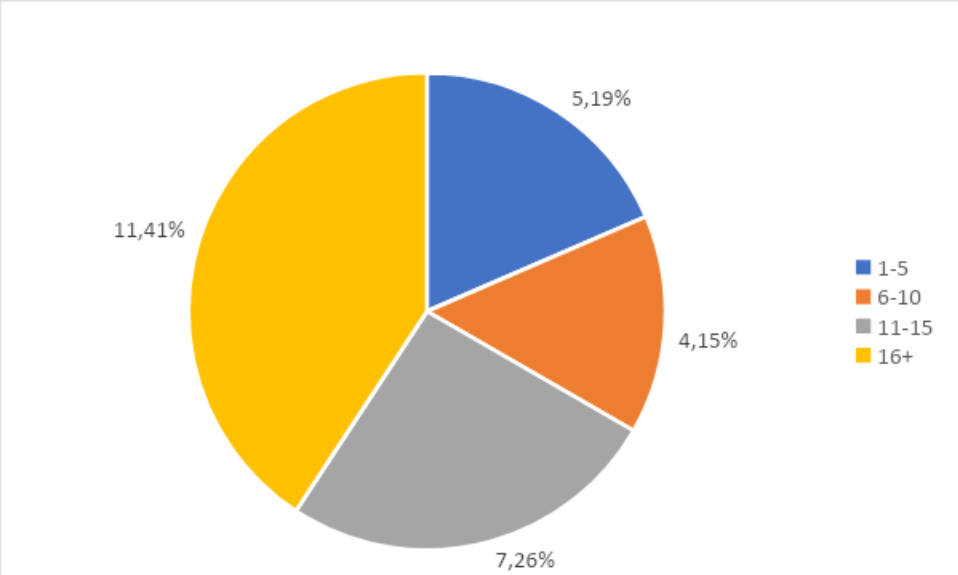

Figure 3. The most common number of years that participants had been working with patients with OBPP was 16+.

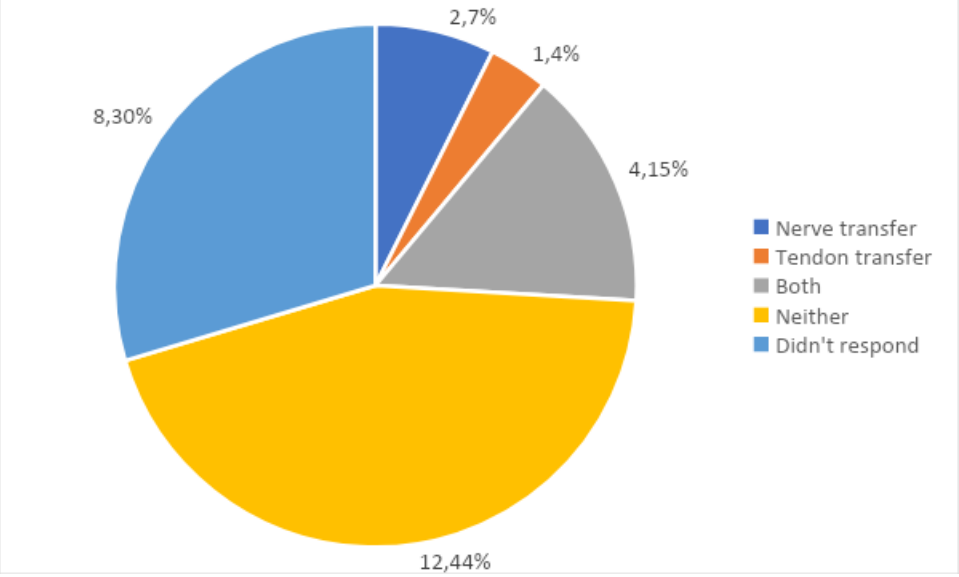

Figure 4. The most common response to the question: *"Do you use NMES for a nerve transfer, tendon transfer, both, or neither?"* was Neither. The least common response was Tendon Transfer.

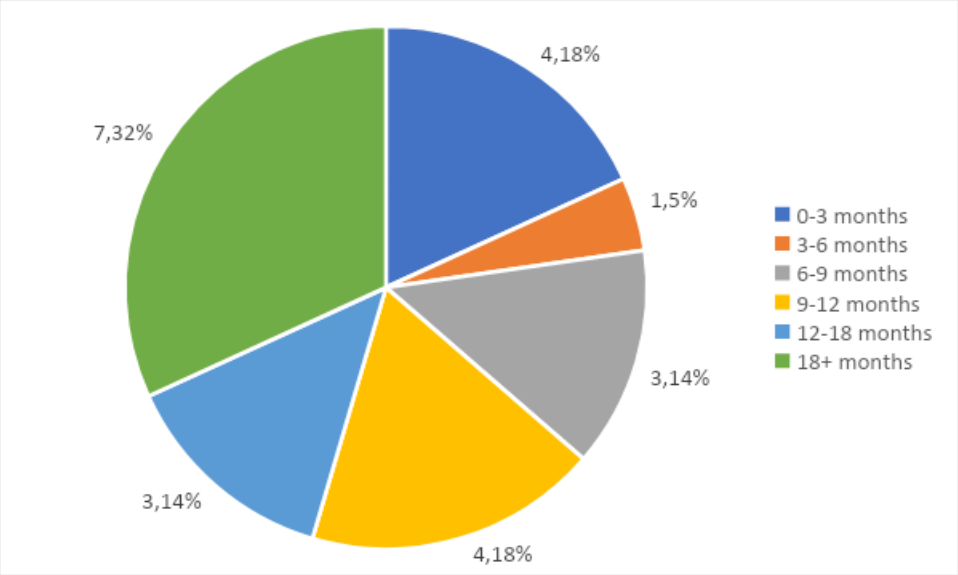

Figure 5. The most common response to the question: *"At what age do you consider using NMES?"* was 18+ months.

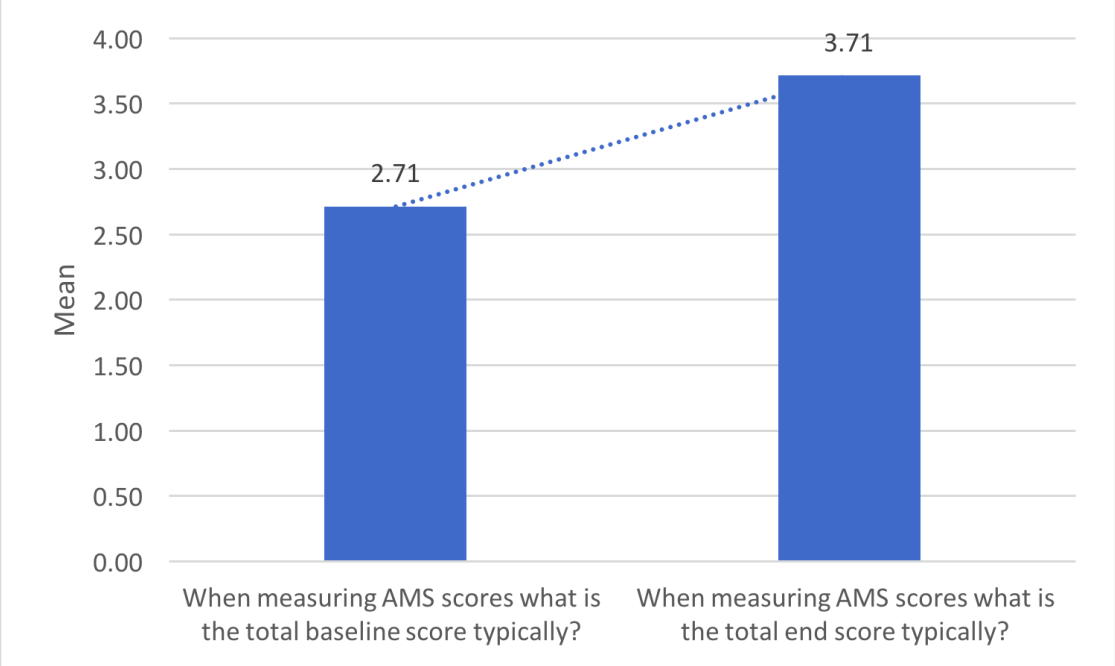

Figure 6. There was a significant increase in means between baseline and post AMS scores (excluding participants who endorsed “Neither” from the question: "Do you use NMES for a nerve transfer, tendon transfer, both, or neither?")

Appendix: Survey Consent

Hello,

We are occupational therapy graduate students from Stanbridge University interested in studying treatment modalities used with patients with obstetric brachial plexus palsy (OBPP) injuries. We have developed a survey that should take 3-5 minutes to complete.

Before beginning this survey, please read the following consent statement: I agree to participate in the research study. I understand the purpose and nature of this study and I am participating voluntarily.

https://docs.google.com/forms/d/1P29aKqpfsyMdHjWCWjnDQtF9EAH03kP4nBRt7sDmGqU/edit

https://www.surveymonkey.com/r/5GJLRXF

All responses will be used for learning purposes and no personal information will be collected. We would appreciate it if you could take some time to fill out this survey. We will be collecting data until June 15th, 2020.

Thank you for your time!

McKenzie Collins, Eleni Dimopoulos, Emily Jones, & Sivan Louria