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Short-term, Early Intensive Power Mobility Training: Case Report of an Infant at Risk for Cerebral Palsy

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Abstract

Purpose—This case report describes the feasibility of quantifying short-term, intensive power mobility training for an infant soon after with cerebral palsy.

Key Points—An 11-month-old infant with significant mobility impairments and her parents were filmed during 14 consecutive daily sessions. The infant moved the power chair with hand-over-hand assistance, and open exploration of the joystick and toys. Mobility measures, coded from video, were compared across training. Frequency and combination of looking at and interacting with the joystick, percent time of moving independently, and average percent success in moving when prompted, all increased across the training.

Clinical Implications—Quantifying short-term, intensive power mobility training for infants is feasible, and may have yielded positive short-term effects for this infant. The ‘who’, ‘when’, and ‘how’ of early power mobility training, as well as the critical need for paradigm shifts of power mobility training, are discussed.

Introduction

Clinical and research interest in power mobility for young children with significant mobility impairments¹⁻⁷ continues to build upon earlier work.⁸⁻¹¹ This interest is based in part on the acknowledgement that independent mobility significantly affects many areas of typical development, such as motor, social, emotional, language, cognitive, and perceptual development,¹²⁻¹⁵ yet current clinical standards of practice are such that power mobility is rarely used for children younger than 3 years of age.¹⁶ Starting power mobility training as part of a comprehensive early intervention program may have the potential to avoid or lessen the secondary effects of immobility on the child and family including impairments in cognition, language, and socialization. This case report, which quantified the training for an 11-month old infant soon after diagnosed with cerebral palsy (CP), joins other recent reports on power mobility training for young children.^{2,3} This infant’s family wanted to address mobility goals and address developmental impairments with a comprehensive program involving early power mobility in combination with pre-gait training.

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Despite strong empirical support for the effect of mobility on typical development, and the obvious effects of immobility on children and their families, only 2 case reports and 1 group study have focused on power mobility training for infants under 1 year of age. First, an 11-month-old infant with phocomelia, a congenital disorder characterized by underdevelopment of limbs and other body features, was provided opportunities to drive a custom-made device indoors and outdoors at home with the help and instruction of his parents.⁸ No quantitative measures were reported, however the authors concluded that the infant “showed complete control over all operations of the cart” with more than 6 months of continual use of the cart within a 10 month period.⁸ No specific training characteristics were documented, such as frequency or duration of training sessions, or training protocol, except that the parents progressively familiarized the infant with the device. Second, our laboratory provided a 7-month-old with significant immobility due to spina bifida with a standardized training protocol consisting of 1-hour sessions at a child care center 3 to 4 times per week over 5 months.² The infant achieved greater than 90 percent success in test trials of moving straight to a standardized location, termed ‘directional driving’. Moreover, his cognition and language scores on the Bayley Scales of Infant Development (Bayley) increased at a rate greater than his chronological age. Finally, our laboratory recently completed a controlled trial of 4-6 month old infants who were typically developing and who received 30 minutes of training 3 times per week for 6 months. Compared to a non-trained control group, the trained group both learned to drive during directional driving trials, and scored higher on the Bayley cognitive, language and motor subscales post training.⁵ Taken together, these findings confirm previous reports that early power mobility training may have potential developmental effects, however, many basic questions about training young children to use power mobility still exist.

This case report specifically addresses 3 gaps in our knowledge. First, we could locate no reports describing specific training with infants with CP, one of the most common diagnoses of children who receive physical therapy intervention. CP is of particular interest given that 25-30 percent of all cases may not ambulate independently.^{17,18} Moreover, power mobility may provide for greater independence compared to manual wheelchairs for children under 3 years of age.¹⁹ Second, no reports document the immediate effects of daily intensive training sessions. Most reports, including our own, have used training with low frequencies and short durations relative to the total available time per day. For example, 2 to 3 times per week for 30 minutes with effects measured after several months of training.^{2,5} Third, behaviors, even those of young infants, do not emerge de novo but rather emerge from the dynamic interaction of multiple factors.²⁰ Thus, theoretically, efficient training of power mobility should not only have infants mimic directional motions (i.e. maneuver the power chair by moving the joystick) in a controlled environment, but should also provide opportunities for infants to build on existing behaviors during increasingly complex physical and social interactions involving the power chair and key adults such as family, therapists, early childhood educators, and/or childcare providers. Consequently, in this case report, we quantified a set of behaviors that we believe may be linked to purposeful mobility, such as looking at and interacting with the joystick, as well as the amount and type of adult assistance, and success in prompted mobility. We predicted that comparing these variables between earlier and later training sessions would provide new information about the process of learning to maneuver a power chair.

Description of Case

This case report describes the performance of an 11-month-old infant soon after diagnosed with CP, during a 14-day power mobility training period. The infant had received physical therapy and occupational therapy since she was 3 months and 10 months old, respectively. She was appropriate for early power mobility training based on several factors. At 11

months, she was not yet crawling and demonstrated significant delays in achieving independent mobility of any type due to weakness and poor motor control. This infant purposefully moved her upper extremities to reach for objects and had no known sensory or cognitive impairments that would prevent her from maneuvering a power chair, making her a good candidate for early power mobility training. This case report began in response to her parents' and physical therapist's goal for her to become independently mobile. Her parents contacted our lab having heard about our early power mobility projects to maximize exploration for very young children. Prior to participation, her parents provided informed consent as approved by the University of Delaware Internal Review Board.

The infant was born at 29 weeks gestational age. At 8 months of age (non-adjusted) her developmental age based on the Bayley cognition subscore was 4 months and 20 days (4:20), receptive language was 5:20, expressive language was 5:00, fine motor was 4:20, and gross motor was 3:10. Three months later at the start of this case report, she was 11 months old and unable to roll, crawl or sit independently or prop sit for greater than 5 seconds. She could push her prone scooter for distances of 5 to 6 feet using both legs and her left arm. She had full passive range of motion in the upper and lower extremities, however displayed stiffness to passive motion in bilateral hamstrings, gastrocnemii, adductor muscles, and throughout her upper extremities. Overall her arms and legs had very limited active motion. She could flex and extend her knees bilaterally in a kicking motion with minimal hip flexion. In general, she moved her left arm and hand more frequently than her right. Similarly, she used her left hand more than her right hand for daily activities and reached for objects with a sweeping motion. Her hands remained fist at rest.

Intervention

Overview

The training period of 14 consecutive weekday sessions was based on family availability prior to an extended period of travel. As in our previous research, sessions combined training and testing. Although we allotted 1 hour for the sessions, they typically lasted 35 to 45 minutes depending on the infant's attention span and mood. One experimenter and 1 or both parents participated in the training. Training took place in a large gym and/or large outdoor playgrounds at the University of Delaware Early Learning Center, a childcare and research facility. For 5 days, other early childhood educators and infants and/or toddlers were in the gym for part of the session.

Materials

We used a standard, pediatric power chair (Permobil Koala; Lebanon, TN) for each session. We used the chair's standard seat belt and added an additional trunk strap and fabric seat cover to provide extra stability and comfort.

We placed a miniature tennis ball over top of the joystick for better grasping and to draw the infant's attention. We positioned the joystick on the right side of the power chair to encourage the infant to increase her use of her right hand and arm, as she primarily used her left upper extremity more in play throughout the day and her parents and physical therapist were interested in trying to promote more use of her right upper extremity. We videotaped portions of each session with a digital camera (Samsung NV24HD, Samsung Techwin; Ridgefield Park, NJ).

Procedure

During each session, we positioned the infant in the power chair, secured all positioning straps, and maneuvered the power chair to the gym or playground (see Figure 1a). This

marked the beginning of each session. Training included periods of ‘Open Exploration’ when the infant moved or was moved in the power chair throughout the gym or playground to interact with toys and/or people, and ‘Prompted Mobility’, which consisted of calling the infant to move towards us and counting the number of times that she initiated power chair movement in response to our prompt. Detailed descriptions of Open Exploration and Prompted Mobility are as follows:

Open Exploration—Training included using toys and verbal prompts with hand gestures as well as ‘hand-over-hand’ assistance to move the joystick and encourage the infant to maneuver the power chair (see Figure 1b). To maximize the infant’s contacts with the joystick, we supplemented the infant’s spontaneous contacts with the joystick with two types of ‘hand-over-hand’ demonstration: “Caregiver Mobility” and “Assisted Mobility.” In Caregiver Mobility, a caregiver placed the infant’s hand on the joystick and drove the chair with his/her hand on top of the infant’s hand. The primary purposes of Caregiver Mobility were to allow the infant to experience that 1) the chair could move, and 2) the chair’s movement was linked to movement of her hand and the joystick. A secondary purpose of Caregiver Mobility was to increase the infant’s attention and arousal when she appeared disinterested or tired. Often times, we drove the power chair at a higher speed and ran with her through the gym, and stopped and started abruptly as the infant smiled and laughed at the abrupt movements of her body in the chair. Assisted Mobility involved the caregiver placing the infant’s hand on the joystick and then immediately letting go to see if the infant would move independently. The purpose of assisted mobility was to reinforce the connection between the child’s movement of the joystick and movement of the chair. If she could not be verbally encouraged to place her hand on the joystick independently and move, then we initiated Assisted Mobility. If with further verbal and non-verbal instruction, the infant would not independently move, then we initiated Caregiver Mobility. Generally, the majority of each session consisted of Open Exploration.

Prompted Mobility—We also performed 5 trials of ‘Prompted Mobility’ during each session, which provided training experiences and allowed us to quantify the infant’s ability to move independently when prompted. The infant was encouraged to maneuver the power chair to a caregiver who stood several feet outside of the infant’s arm length directly in front of her. If she did not move in any direction after 1 minute, the caregiver drew her attention to the joystick both verbally and by pointing to it, and then began the next trial. If she moved, then we allowed her to move as long as she wanted. Thus, total time spent with trials of Prompted Mobility varied across sessions and depended upon how long the infant continued to move about after being called. Each new trial started by first removing the infant’s hand from the joystick and then prompting her to move towards the caregiver. This protocol was similar but not identical to “Directional Driving” of Lynch et al.² In this case report, a successful trial was when the infant independently moved the chair in any direction for any distance following our prompt, as compared to moving to and stopping at a specific location in front, to the left, or to the right of the start position, as reported by Lynch et al.² Although less rigorous than Lynch et al, requiring this infant to independently reach for and push or pull the joystick following a command was sufficiently difficult to reflect the emergence of basic skills required to maneuver the power chair. Note that we did not allow Caregiver Mobility or Assisted Mobility during our Prompted Mobility trials. In addition to the daily mobility training, the infant’s parents also provided her with 15 minutes per day of additional experiences reaching and grasping for objects to increase the infant’s interest in and experience with objects such as the joystick.^{21, 22} Although we encouraged this, we did not track or monitor this aspect of her training.

Recording Outcomes—The first author videotaped the infant in the power chair for portions of each session whenever she was not physically moving the infant in the power chair, providing Caregiver or Assisted Mobility training. As such, Prompted Mobility trials were always included in the videotaped portion of each session. Thus, the amount of total video footage collected varied across the 14 days of training and ranged from 5.5 to 13.5 minutes, with an average of 7.5 minutes. Days 5, 6, 7, and 14 had the highest number of minutes recorded (average = 10.5 minutes). A potential limitation of this method includes the varying length of video footage per session, which may have caused us to 1) miss important evidence of the infant moving herself in the power chair, 2) unintentionally bias the video content towards minutes when the infant was only moving independently, or 3) both. To correct for the varying amount of video footage each day, each measure coded was normalized to the amount of footage per session. Of the 14 days of training, we eliminated only day 10 from data analysis due to a technical malfunction.

Measures

Our choice of outcome measures was based on our previous studies^{2, 3} and the previously described interest in tracking behaviors involved in the initial emergence of driving, such as looking at, touching and pushing the joystick.

Independent Joystick Contacts—number of independent physical interactions with the joystick per session divided by the total minutes of footage per session. Independent joystick contacts required touching the joystick with or without joystick displacement that may or may not have resulted in power chair movement.

Visual Attention to Joystick—number of times the infant looked at the joystick per session divided by the total minutes of footage per session.

Independent Mobility Time—number of minutes of independent mobility per session divided by the total minutes of footage per session. See *Assisted* and *Caregiver Mobility* below for categories in which the infant moved but did not independently place her hand on the joystick.

Assisted Mobility Time—number of minutes the infant moved after the caregiver placed her hand on the joystick per session divided by the total minutes of footage per session.

Caregiver Mobility Time—number of minutes the caregiver moved by pushing the infant's hand on the joystick resulting in power chair movement per session divided by the total minutes of footage per session.

Success in Prompted Mobility—number of times out of five trials that infant independently moved the power chair in response to verbal prompting by caregiver per session.

For all outcomes except Success in Prompted Mobility, we created separate cumulative sums of measures from the first half of the training period (days 1-7; 46 minutes; 6 days), and from the second half of the training period (days 8-13; 51 minutes; 7 days). These cumulative sums were divided by the cumulative sum of the video footage (minutes) for the first and second half of training.

Coding Reliability

Two raters coded approximately 20 percent of the total video footage (3 of the 13 days of video) for each measure. The coded values for each measure across the 3 days were

summed. The summed total per measure for each coder was then compared for inter-rater reliability using the equation: $\text{Agreed}/(\text{Agreed} + \text{Disagreed}) \times 100$. 'Agreed' was the smaller of the 2 compared values, and 'disagreed' was the difference between the 2 values. Raters achieved at least 90 percent inter-rater reliability for all measures coded, and we used 1 coder for all measures for the remaining days.

Description of Outcomes

Figure 2 shows outcome measures suggesting that from the first half to the second half of training, the infant a) looked more often at the joystick (white columns), b) independently interacted more with the joystick (gray columns), and c) independently moved the power chair (black columns). Figure 3 shows measures suggesting that the infant more often combined independent joystick contacts with a) looking at the joystick, b) moving independently, and c) both looking and moving independently during the second half as compared to the first half of training. Figure 3 also shows outcomes suggesting that she decreased the amount of independent joystick contacts that were *not* associated with looking, moving, or both, from 50 to 25 percent.

Figure 4 shows values that suggest that from the first half to the second half of training, the infant 1) did not change the percent of time spent in Caregiver Mobility, 2) slightly decreased the time spent in Assisted Mobility (from approximately 6 to 4 percent), and 3) increased the time spent in Independent Mobility (from approximately 3 to 12 percent). Interestingly, between the first and second half of the training, the summation of Caregiver and Assisted Mobility (Fig. 4 white and grey columns) times together decreased while Independent Mobility (Fig. 4 black column) increased from less than 1/3 to about 2/3 of the total mobility time (Fig. 4 all columns together). Figure 5 shows the day-to-day variability of the time spent in each type of mobility. On days 1 and 5, Caregiver Mobility occurred almost exclusively with no Independent Mobility, whereas all but 1 session during days 8 through 10 had a majority of time spent in Independent Mobility. Finally, of the 5 Prompted Mobility trials each session, the infant increased from an average of 20 percent success in the first half to an average of 60 percent success in the second half of training.

Discussion

These findings suggest that daily power mobility training is possible and may have yielded positive short-term effects for this young infant at high risk for CP, such as experiencing the cause and effect relationship between the joystick and power chair movement, increases in self-initiated movement of her right arm and hand, as well as other developmental changes associated with sitting in a power chair, though not quantified, such as practice with upright sitting tolerance and postural training, reaching and grasping, and more. Group studies are required to validate these preliminary findings; however, the outcomes and our experiences gained from this case report suggest the following 3 potentially important factors in early power mobility training.

First, visual attention to and physical contact with the joystick may be important initial behaviors to document as an infant learns to move a power chair. Such behaviors may be prerequisites for deciding when and for whom to start training or may emerge only as a result of intensive power mobility-specific training. The issue of when training should begin and for who is of interest with only a few group studies reported (see McCarty & Morress²³ and Livingstone²⁴ for recent reviews). Two general philosophies on determining when and how to begin training for young children exist. Some suggest assessment of specific cognitive, psychosocial and motor readiness factors prior to entry into clinician directed training,^{7, 25, 26} and others suggest assessment of general factors such as tolerance for sitting and ability to activate the joystick or other interface prior to entry into family and child-

directed training.²⁷⁻²⁹ At this point, we focus more heavily on the latter with infants and include the assessment of cognitive, psychosocial and motor factors to determine how they change during training. Future quantitative studies stand to have an effect on the decision-making process of initiating early power mobility training, given that few statements on assessment and training with young children have strong empirical or theoretical support. Our hope is to establish a body of research supporting the feasibility and providing protocols to clinicians and families for facilitating successful intensive power mobility training as early as possible.

Second, the infant's rapid increase in Prompted Mobility success joins our previous work and that of others to suggest that certain populations of infants including those with spina bifida and CP may rapidly learn the basic relationship between movement of their hand, the joystick, and the power chair to purposefully move the chair. Moreover, this initial cause and effect connection may be learned quicker than previously observed.^{2, 5, 8} See below for important constraints on generalizing these results.

Third, the infant's family participated actively in each session, reported high satisfaction with the training protocol, and commented that their infant's postural stability, grasping and reaching were increasing at home. Such positive family involvement was an important factor in other studies of power mobility.³⁰⁻³² For this case report, family members were consistently motivated and willing to learn, offered novel training suggestions (such as providing the fabric seat cover, bringing in the infant's favorite toys, bringing in the infant's older sister to help promote movement with play), and reported observations outside of the training context (as mentioned above). The research team's experience with and positive perception of infant power mobility training may have contributed to the families' enthusiasm with early power mobility training.^{33, 34}

This case report provides preliminary data suggesting that quantifying daily, intensive training is feasible, and such training is potentially effective for basic skills required for maneuvering a power chair. Previous work by our lab and others suggests that this short-term training will not, however, be sufficient to provide young children with independent functional mobility. First, this short training did not result in consistent, independent functional driving, but rather the initial emergence of moving a power device with a joystick. We propose that functional and safe community driving will not efficiently emerge from short-term training within a controlled, experimental environment, but rather only with continued daily practice within the community, enriched by the assistance of clinicians, early educators, families, and/or peers. Ideally, the physical therapist will provide short-term, daily training and education with a trial power chair until it is deemed safe for the family to take the power chair home. That is, various requirements must be met before sending the chair home, including but not limited to having the family demonstrate understanding of the operation, usage, and risks of the power chair, having a home conducive to the use of a power chair, and having the family consent to follow any rules or guidelines set up by the therapist for maximum safety. The family would then provide daily opportunities for the infant to explore using the power chair as part of a comprehensive program with the physical therapist assessing impairment, activity and participation. It is important to note that the power chair and training serves not only as a vehicle but also as a therapeutic tool for motor, cognitive and socialization goals. As outlined briefly below, the focus could be on impairments as well as increasing the infant's independent participation in the home and community.

In the ICF model for clinical decision-making in physical therapy,³⁵ power mobility training is an "Activity" that addresses multiple "Body Functions and Structures" such as impairments in postural control, reaching and grasping, self-initiated movements, head

control, independent mobility, and so forth. Power mobility also addresses “Participation” such as independent exploration of the infant’s environment, independence with activities of daily living, safe community mobility, and increased opportunities for socialization (See Figure 6). In this way, power mobility training can be an important adjunct to traditional interventions designed to help meet the family’s goals for the child (for example, for the child to move on her own, for the child to have better sitting control). When viewed as a *dynamic* intervention tool, power mobility can be used to as progressive therapeutic exercise such as providing less postural support to challenge sitting balance and strengthening or altering the joystick location or size to challenge grasp control and strength. These are non-intuitive uses of power mobility, thus the goals and rationale for these uses need to be carefully explained to family and other professionals.

Second, our previous work has shown that power mobility does not automatically translate into using mobility for socialization for an older child.^{3, 36} One potential solution would be to initiate basic power mobility training during infancy such that, by toddlerhood, socialization and mobility co-emerge in children using power mobility simultaneously and alongside their typically developing peers. This requires advances in technology and training beyond that used in this case report. For example, smaller devices than our standard pediatric power chair are required that safely explore smaller spaces such as homes, and toddler and preschool classrooms.³ Additionally, new training paradigms could be implemented in the future, such as the novel, therapeutic use of peer groups such that newly mobile toddlers, both those walking and those driving, learn to be ‘socially mobile’ together.

Lastly, locomotion is an appropriate primary goal for many young children with mobility impairments, even those who will eventually use power mobility.³⁷ We propose that the operative question is: How can we best expand the child’s independent exploration during the majority of the day when he/she is not actively pursuing locomotion goals? Many pediatric clinicians and clinical researchers are interested in advancing a paradigm shift in which locomotion training and power mobility go together to provide maximum mobility as early as possible.^{2, 11, 38, 39}

Conclusions

We need future studies to confirm the findings from this case report showing that early, intensive training may be effective for teaching basic power mobility skills in infancy. After confirming the effects on a larger scale, we can begin to focus on the use of mobility for socialization in toddlerhood. We believe that ‘mobility for socialization’ is a critical component in early power mobility given 3 interrelated issues: 1) immobility is associated with increased risk of social isolation and delay,⁴⁰ 2) socialization typically emerges over a relatively short window between infancy and preschool, thus requiring therapists, educators and families to work together such that the 1 to 2 year old child with consistent ability to move independently in a power chair becomes the 3 to 4 year old child using those skills for socialization, and 3) we cannot assume that a child who achieves basic power mobility will automatically use mobility to interact with others to the extent that the child desires.^{3, 36} This confirms that the physical therapist’s role extends beyond basic mobility and wheelchair prescription into the issues and training for community mobility. We believe that studies focused on examining the co-emergence of power mobility and socialization during infancy and toddlerhood would advance early power mobility training and technology, illuminating the potential needs for training to prepare them for functional home and community mobility.

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Figure 1.

A) The infant moving the standard pediatric power chair in the training facility. B) The infant's father performing 'hand-over-hand' mobility assistance to encourage the infant to drive.

Figure 2.

A comparison of the infant's Visual Attention to the Joystick (white), Independent Joystick Contacts (grey), and Independent Mobility Time (black) during the first half of the training sessions (days 1-7) to the second half of the training sessions (days 8-13). Visual attention and Independent Joystick Contacts are measured as occurrences per minute (left y axis), whereas Independent Mobility Time is measured as a percentage of total video footage (right y axis).

Figure 3.

The association of the infant's Independent Joystick Contacts with 1) Visual Attention to the Joystick (light grey), 2) Independent Mobility (dark grey), 3) both Visual Attention to the Joystick and Independent Mobility, and 4) neither Visual Attention to the Joystick nor Independent Mobility (white). These associations are compared from during the first half of training sessions (days 1-7) to during the second half of training sessions (days 8-13), and are measured as occurrences per minute.

Figure 4.

A comparison of the type of mobility that the infant performed during the first half of the training sessions (days 1-7) to during the second half of training sessions (days 8-13). Types of mobility include Caregiver (white), Assisted (grey), and Independent (black).

Figure 5.

A ratio of the types of mobility that the infant performed each day. Types of mobility include Caregiver (white), Assisted (grey), and Independent (black).

Figure 6. Model of how Power Mobility Training may fit into the International Classification of Functioning, Disability, and Health (ICF) for clinical decision-making in physical therapy. Modified from International Classification of Functioning, Disability, and Health (ICF). ICF full version.³⁵