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Benefits of a Group Exercise Program on a Student With Congenital Hydrocephalus and Multiple Co-Diagnoses

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Abstract:

Congenital Hydrocephalus (CH) is a condition at birth where excess cerebral spinal fluid accumulates in the ventricles of the brain due to inadequate drainage, resulting in an increase in intracranial pressure and damage to the surrounding nervous tissue. Although hydrocephalus is successfully treated at birth, a resulting diagnosis of a memory-related learning disorder is common. However, having multiple independent subsequent diagnoses is unique. This report mainly describes a 13 year-old boy who was diagnosed and treated for congenital hydrocephalus at birth and then was subsequently diagnosed with multiple co-morbidities, such as partial agenesis of the Corpus Callosum, Cerebral Palsy with ataxic gait (CP), mild spasticity of the quadriceps group, Developmental Encephalopathy, and Attention Deficit Hyperactivity Disorder (ADHD). In addition to Occupational and Physical Therapy, this student also participated in a weekly group exercise program, which not only attended to individual movement goals, but also added a social component to treatment. Activities were structured to incorporate the individual needs of each student, but to also foster a group atmosphere and a need to work together to successfully complete the activity. Some activities included baseball, kickball, and Zumba dancing. After the conclusion of the 12-week program,

the social gains and adaptations were clearly evident, however more time would have been required to identify specific physical benefits.

Introduction:

Congenital Hydrocephalus (CH) is a condition in which cerebral spinal fluid (CSF) accumulates in the ventricles of the brain causing harmful pressure on the nervous tissue[1]. It is caused by either an overproduction of CSF or due to a blockage in the ventricle or subarachnoid space[1]. The compression of the brain from the accumulating fluid can result in various medical complications, including permanent brain damage and cognitive deficits. Treatment for this condition requires the surgical insertion of ventricular shunts in order to drain excess fluid into other body cavities where it can be absorbed by the circulatory system[1]. This case report describes a 13 year-old boy who was diagnosed with congenital hydrocephalus, which was treated by inserting a ventriculoperitoneal shunt to drain excess CSF. However, he presents with multiple co-diagnoses, some of which include Cerebral Palsy (CP) and Attention Deficit Hyperactivity Disorder (ADHD). The culmination of these conditions results in treatment being very complex and intricate. This report details the interactions and complications of his comorbidities and his response to group exercise.

Literature Review:

Hydrocephalus is one of the most common birth defects affecting about one in every 1000 newborns and fifty percent of all hydrocephalus cases are congenital[2,3]. In infants with congenital hydrocephaly, the cranial bones have not yet fused, thus the increasing intracranial pressure causes a rapid increase in head circumference[1]. According to Persson et al. the prevalence of children born with hydrocephalus is on the decline, majorly due to the gradual decrease in the prevalence of extreme premature births[4]. However, those born with

hydrocephalus have shown an increase in the need to undergo multiple revisionary surgeries after the initial treatment due to obstructions, disconnection, or infections[4]. Once ventriculoperitoneal shunts became an available treatment option for congenital hydrocephalus the mortality rate decreased from about fifty percent to five percent, where it remains currently[4]. It was found that ventriculostomy, an alternate treatment option where a hole is created in the ventricle to allow for adequate CSF drainage, resulted in a decreased need for subsequent surgical interventions[4,5]. However, it was accompanied by an increased mortality rate explaining why this method has been used significantly less than ventricular shunts [4]. Eighty percent of children born with hydrocephalus were found to have some type of significant neuroimpairment, such as epilepsy, cognitive deficits, visual impairments, short-term memory deficits, or cerebral palsy and the number of revisional surgeries needed has been found to have a positive correlation with the number of associated neuroimpairments[1,4,6]. Therefore eliminating the need for subsequent surgeries is imperative going forward.

Research shows that lifelong conditions often result from complications due to shunts inserted to treat infantile hydrocephalus, including comorbidities that adversely affect social functioning and mobility [6]. The complications resulting from the shunts that were implanted during infancy can lead to general movement dysfunction and can cause a decreased ability to appropriately interact with peers and understand social cues [6]. It was also noted that the increased mortality rate of ventriculostomy was significantly decreased if performed after the age of two[6]. Therefore choosing this alternative surgical solution may be beneficial in the long term by avoiding the complications that accompany ventricular shunts. However, if the patient is not of an appropriate age the benefits still may not outweigh the risks.

The implementation of a group exercise program as a form of adapted physical education may be a beneficial addition to a treatment program. The social aspect of this form of

therapy can not only increase strength and mobility, but also improve upon the quality of life. Unfortunately, limited research on the effects of exercise on congenital hydrocephalus patients can be found in the literature due to the fact that the complication occurs and is treated in early infancy. However, since the majority of hydrocephalus patients present with comorbidities, such as the one described in this case study, exercise can prove to be extremely beneficial and an integral part of treatment. As aforementioned, one common resulting diagnosis after hydrocephalus is cerebral palsy (CP), which is also the diagnosis of the patient described in this study. Unlike hydrocephalus, there are many references in the literature pertaining to exercise and CP, specifically in a group setting. One study conducted by Blundell et al. used a four-week group circuit-training program that met twice weekly[7]. The program focused mainly on lower extremity work, featuring exercises such as treadmill walking, step-ups, sit-to-stands, and leg presses[7]. Eight children with spastic diplegia CP ranging in age from four to eight participated in the group exercise program[7]. Results showed improvements in isometric and functional strength, longer walking strides, and increases cadence[7]. In addition, eight weeks after the cessation of training, all improvements had been maintained[7]. A similar study conducted by Verschuren et al. found that not only were there improvements in physical fitness, but also in participation level and quality of life after implementing an eight-month group training program for children with CP, ranging in age from seven to eighteen[8]. This shows that the group atmosphere is an important component of treatment because it allows for additional health-related benefits outside of fitness and mobility. While similar results can be achieved utilizing either a group or individual setting, group training provides a social component that has shown to lead to an increase in participation and a greater quality of life [8].

Presentation of Case:

The patient is a 13 year-old male who has attended St. Vincent's School for Special Needs (Trumbull, CT) since September of 2007. He was diagnosed with CH at 35 weeks gestation and was treated by implanting a ventriculoperitoneal shunt two days after birth on February 10, 2000. The shunt was successful in draining the excess fluid, however he was later diagnosed with a memory related learning disorder that is common in hydrocephalus patients. He has also since been diagnosed with multiple co-morbidities independent if the original diagnosis of hydrocephalus. He presents with partial agenesis of the Corpus Callosum, CP, mild spasticity of the quadriceps group, Developmental Encephalopathy, and ADHD.

As a result of CP and spastic quadriceps he has difficulties with ambulation, balance, body awareness, and motor control. Both lower limbs exhibit increased muscle tone thus leading to a soft tissue contracture and excessive extension. The left limb also has difficulty with abduction and external rotation. Due to his lack of balance, he typically ambulates using a walker, even though he is able to walk short distances. The student also demonstrates limited trunk rotation, thus utilizing hip hiking as a compensatory mechanism. Weakness and decreased muscle tone are evident in the upper body, specifically in the rhomboids and trapezius, causing scapular winging. He is also severely right hand dominant and usually avoids using his left arm entirely. As for the intellectual component of his disability, he has difficulties staying on task, following directions, and recalling recently learned activities.

The student receives Physical Therapy (PT) and Occupational Therapy (OT) two to three times a week during school hours. His goals for his PT treatment are to strengthen the lower extremities, specifically the hip flexors and abductors, in order to improve gait, and to strengthen the upper extremity, specifically the left side, to improve coordination between both limbs. The student wears a Standing Walking and Sitting Hip (SWASH) brace daily, which aids in decreasing hip adduction and in-toeing of the left leg. He also wears an Ankle Foot Orthosis

(AFO) on both limbs to manage equinas by lengthening the triceps surae complex. The goals of his OT treatment are to improve his ability to stay on task, increase independence in accomplishing activities of daily living, improve fine motor skills, and to improve visual and perceptual skills.

The implementation of a regular group exercise program can be very beneficial for this population. The group activities are selected based on the individual and collective needs of the students. Therefore his goals for PT and OT are still being met, but in a group setting instead of an individualized one-on-one manner. Although this may seem counterintuitive being that personalized individual attention is being exchanged for group treatment, the benefits outweigh this minor sacrifice. While both individual and group therapy sessions can attend to the students' needs and goals, the group setting adds a social component that is absent with one-on-one treatment. Not only are the students' learning new tasks and concepts and exercising through the group activities, but they are also learning how to work together as a team. The social interactions brought on by the group atmosphere are an integral component to this exercise program. Social skills, such as sharing, paying attention to the actions of others, and reacting based on the actions of a peer, are being enhanced while the students reap the benefits of exercise and continue to work on their individual goals as well. Thus the expected outcome of incorporating a group exercise program into the treatment of this student is that the benefits will exceed that of traditional therapies alone. For this client, the group exercise program took place once a week, in substitution of one OT session. Therefore all other weekly treatment sessions remained the same, thus individual attention remained the majority of the students' treatment.

Discussion:

This case is extremely unique because there are a very limited number of reports in the literature on the implementation of an exercise program for the long-term treatment of CH, especially in a group setting. In addition, the complexity of the patient's history of having multiple co-morbidities adds to the rarity of this case because not only is the treatment protocol targeted at the consequences of CH, but also to correct movement dysfunctions caused by the subsequent diagnosis, such as CP and mild quadriceps spasticity. The group exercise program in which this student participated was designed to incorporate the needs and goals of all of the participants as well as an interactive component. The activities chosen were selected based upon not only the movement patterns required to successfully complete the tasks, but also to encourage the students to work together or act in response to one another. Over the course of the 12-week program the students participated in four different activities: baseball, kickball, Zumba dancing, and an obstacle course[9]. The most successful activities were kickball and Zumba. While participating in these activities, the student described in this study remained in his gait trainer and wore his AFOs.

Kickball was an extremely successful activity because it required not only neuromuscular coordination and strength, but also concentration, rapid reaction time, and teamwork. The game was taught in a slow progression beginning with the simple motor pattern of kicking the ball. First the students practiced solely the motion without having the ball rolled to them. This movement is an important portion of the physical component of the program because it requires rapid and fluid motion, which is difficult for the students due to either lower extremity weakness or spasticity. Then they took turns practicing kicking the ball, which added an extra challenge because timing became important. They now had to appropriately time their kick so they would make contact with the ball, requiring coordination and balance. This was more difficult for some students than it was for others. Next, base running was incorporated which

established the team component of the activity. Now the students had to pay attention to what their peers were doing, not just their own actions. They needed to be alert in order to respond once the ball was kicked and to know where they should run. They needed to be aware of the person ahead of them as well so that they did not outrun them. The final component of the activity that was taught was tagging runners out. This added an extra cognitive component because not only did they need to be aware of what the kicker and the runners in front of them were doing, but also what the fielders were doing. This activity was one of the most successful due to the step-by-step progression that built upon the preceding step. The students greatly enjoyed the game, although the cognitive strain from intense concentration became evident toward the end of the session. The student described in this study absolutely enjoyed learning how to play kickball and learned each step fairly quickly. However, he had the most trouble with reacting to his peers and staying on task. He was able to kick the ball and run to the base independently, but when it was time to react after another peer kicked the ball, he struggled. Most of the time he would not react unless told to run, even if he directly watched the batter kick the ball. This activity was beneficial for him because it focused on unilateral motion and motor planning.

Zumba was another very successful activity because it required both upper and lower extremity movement. A dance was choreographed which emphasized independent arm and leg movements, such as punching and marching. Since the majority of the students have a pronounced weakness on one side, the choreography focused on single arm and single leg movements in repetition. First the students were taught all of the movements performed in the dance one by one without the music, which included frontal and lateral punching, overhead arm swings, marching in place, and side stepping. Then the dance sequence was taught in counts of eight, first without and then with the music. Once the students became proficient in the first set

of steps, the next set was demonstrated and practiced, then added to the preceding sequence. As the dance was taught, specific unilateral weaknesses for each student became evident because they would easily perform the movement on one side, but would have great difficulty with the other. Even though each student performed the dance independently of the other students, paying attention to the demonstrator was important in order to accurately mimic movements. Spatial awareness became important with this activity as well because since the group was performing the dance together, each student needed to maintain their own space and not invade the area of others. Thus knowing where they were in relationship to their peers and how much space they needed to complete each movement was crucial for not only completion of the activity, but for safety as well. The student described in this study enjoyed the activity the most out of the entire group and had positive physical benefits as well. He loved moving to the music and was very successfully in mimicking the movements of the demonstrator. After watching the steps being done a few times, he was able to copy them and independently perform the dance. The unilateral movements utilized in the majority of the steps were beneficial for this student to aid in stabilization of the lower extremity and increase strength in the upper extremity, specifically on the left side. However, he struggled with remaining in his own space and changing from one set of steps to the next. Since the other students performed much smaller movements that he did, it was difficult for him to adapt his movements so that he would not interfere with his peers. In addition, even though he knew all of the steps and could perform them correctly, he was often a few behind. For example, after eight counts of marching the dance would progress to eight counts of punching to the front and side. However, he would continue to march until about the third or fourth punch, where he would then continue with the rest of the group. This occurred as a result of decreased reaction time and slower cognitive processing. This activity could be significantly improved if each

movement was held for a count of sixteen instead of eight. By elongating the time of each move, it would allow more time for the students to adapt and progress onto the next movement. Performing each movement for a longer period of time would better accommodate for the slower cognitive processing of the group as a whole.

The third type of activity that was conducted during the group exercise program was the completion of an obstacle course. The course consisted of four independent activities completed in succession to one another, with one student at each station at a time. The students moved clockwise to each station until they each completed all four. The first station consisted of two mats placed together with a graded elevation to create one ramp to walk up and another ramp to slide down. This activity focused on lower extremity strength, coordination, and stability, all of which were required to successfully walk of the ramp. The next station consisted of the claw game, which emphasized unilateral arm motion on the weaker side as well as dynamic stability. The goal of the game was to pick up ten small beanbags using a pair of tongs, or a "claw", and place them in a bucket. The tongs were placed in the hand of the weaker side and the beanbags were placed to the right of the student while the bucket was to the left, thus promoting cross-body movement. While completing the activity, the student lied supine on a semicircle geoform mat with the apex of the mat touching the ground. This created an unstable surface, thus increasing the degree of difficulty and requiring dynamic stability of the core musculature in order to successfully complete the exercise. Once all ten beanbags were placed in the bucket, the student moved on to the third activity, shooting a beach ball through a small basketball hoop. The student was required to step over a hula-hoop placed on the ground and remain in the circle while they completed the activity. They were given five attempts to successfully shoot the ball through the hoop, but a two-handed throw was required. This engaged the weaker arm, which would have otherwise been avoided in a single-arm throw.

After a successful basket or five attempts, the student moved on to the fourth and final portion of the course. At this station, a second semicircle geoform mat was placed on the ground with the apex at the top forming a tunnel. The students were prompted to crawl either under or over the tunnel, thus working on both physical and cognitive skills. Crawling under the tunnel requires total body coordination and stability, while climbing over requires more motor planning for successful execution. Although each task was done independently with the help of a facilitator, their was an added group component because the students needed to follow each other in succession. If the student ahead of them had not yet completed the activity, they were not able to move on. This dynamic may seem simple, but for the group of students it required patience and control, especially for the students at a slightly higher skill level. Since the student described in this study was able to complete most of the activities faster than his peer ahead of him, he felt compelled to help them finished the activity so they could both move on. However, after prompted, he was able to demonstrate patience and control to let the other student compete the task on their own. One negative aspect of the implementation of this activity was that there were only two facilitators for four students. Ideally, there should have been a one-to-one ratio of facilitators to students so that each student would have assistance at every obstacle. Although the obstacle course incorporated various physical skills as well as a group atmosphere, it was not implemented to its fullest capacity. More activities should have been incorporated in order to keep the students engaged for a longer period of time. In addition, the activity could have been conducted as a relay race where each student completed the course and then tagged the next person signaling for them to begin the their turn. Conducting the activity in this manner would enhance the overall group atmosphere and encourage teamwork. However, a larger space would need to be available in order to provide additional activities for the students not going through the course to be working on, such as practice obstacles. This

type of obstacle course game has the potential to be an extremely beneficial activity, which not only promotes a group dynamic, but also works on a variety of personalized skills. However, it needs to be implemented in a different way to maximize these benefits.

The final activity of the exercise program was baseball. This was taught as an additive progression as well, beginning with learning how to swing. A two-handed swing was emphasized in order to incorporate the weaker side in the movement. Next, the students began practicing hitting the ball and timing their swing with the release of the ball. This step required a large amount of practice before moving onto base running. In the next phase, the students were instructed to run to first base after making contact with the ball. In order to gain familiarity with base running, each student took a turn batting and running around all of the bases back to home plate. Once the students became comfortable with both batting and base running, a short game was played where students needed to react once their peers hit the ball. Tagging out was also incorporated in later stages of the game, which required the students to be aware of where the fielder was as well as where they should be running to next. The game incorporated more of the group atmosphere than did the separate skills because they needed to be aware of when the batter hit the ball and had to be careful not to outrun the person in front of them. Baseball targeted physical skills such as bilateral motion and coordination as well as the cognitive skills of motor planning and concentration. The student described in this study enjoyed the game, especially hitting the ball. At first he was hesitant to use a two-arm swing, but after a few practice trials he no longer had any trouble. As in kickball, he struggled in identifying where he needed to run to next and would not run unless prompted, even when he knew the ball had been hit. However, he did understand the concept of getting tagged out and enjoyed racing he fielder to the bag. Baseball enhanced the group atmosphere because the students cheered each other on and they enjoyed watching each other succeed.

Conclusion:

This case study is unique because there is limited research on the benefits of group exercise on CH patients with multiple co-morbidities. After the conclusion of the 12 week program, the social benefits are clearly evident. The students enjoyed playing together and often cheered for their peers while they waited for their turn. Group exercise is beneficial because it includes a social component with an emphasis on teamwork, sharing, and paying attention to the actions of peers, as seen in the activities incorporated into this program. These characteristics are absent in traditional individual therapy. Being that the program still targeted both general and individualized physical skills, there should not be any negative consequences of a once weekly substitution of a group program for traditional therapy. However, more time is necessary to observe specific physical adaptations as a result of the group exercise intervention.

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