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The Effectiveness of an Aquatic Therapy Program in Improving Health Related Quality of Life for Children and Adolescents with Cerebral Palsy

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Overall Clinical Bottom Line: The evidence presented in these three articles suggests the need for further research on this topic. Research analyzed shows that significant improvements can be made with an aquatic therapy program on vital capacity in conjunction with land-based physical therapy, although other improvements were not found to be significant or cannot be applied to a larger population. In regards to educating patients and their families about aquatic therapy, the available evidence did not conclusively prove aquatic therapy will significantly improve quality of life and, therefore, it may not be worth the additional cost.

Clinical Scenario: At one of our clinical affiliations, many parents of children with cerebral palsy were questioning whether or not they should enroll their children in the optional summer aquatics program offered at the clinic. Parents would have to pay an extra $20 per week out of pocket for this program since insurance would not cover it. The parents wanted to know how children with cerebral palsy benefit from aquatic therapy.

Clinical Question:

Population: Children and adolescents with cerebral palsy (all ability levels)
Intervention: A one-on-one aquatic therapy program 2 times a week for 8 weeks at a local warm water pool in addition to traditional physical therapy.
Comparison: Children receiving only traditional outpatient physical therapy for 8 weeks.
Outcome: Health related quality of life as defined by the Ped QL (physical, emotional, social, and school function).

Search Terms: adolescent, functional independence, self-esteem, swimming, aquatic therapy, pediatrics, cerebral palsy.

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Article #1

Dorval, G., Tetreault, S., Caron, C. (1996). Impact of aquatic programmes on adolescents with cerebral palsy. *Occupational Therapy International* 3, 4, 241-61.

Clinical Bottom Line: This study does not directly answer our clinical question. Reported results would indicate that a conventional aquatic therapy program would improve self-esteem and functional independence more than the experimental program (although we were not able to calculate whether the treatments made significant improvements). The lack of a control group makes it impossible to determine whether or not the differences between groups were really due to the treatment protocols. Overall, this study was not designed in a way that allows us to use the results to convince parents about the importance of aquatic physical therapy, but it does suggest that a conventional program is probably more time and cost effective for patients with cerebral palsy.

Study Question:

Population: 20 adolescents age 10-17 with diagnosed cerebral palsy
Intervention: An experimental aquatic therapy program
Comparison: A conventional aquatic therapy program
Outcome: Rosenberg's Self-Esteem Scale and Functional Independence Measure for children (WeeFIM)

Blinding: The principle investigator was an occupational therapist. She was not blind to the group assignments. The two other occupational therapists that administered the WeeFIM to the participants and parents were blinded from group assignment and test scores. The study did not discuss whether the participants knew which group they were put into.

Controls: There was no true control group. The study compared two different aquatic therapy programs.

Randomization: There was no randomization of participants into treatment group. Groups were assigned by the research designer according to transportation availability, although effort was made to make sure groups were similar at baseline according to characteristics including age, sex, type of palsy, and number of related conditions.

Study: In this study, two different experimental treatments were compared to each other, without any comparison to a control group. Ten participants were assigned into each treatment group (conventional and experimental aquatic therapy) according to transportation availability and when the participant could get to the pool for treatment. Inclusion criteria: age 10-17 years old, diagnosed with cerebral palsy, able to follow verbal cues, and residence in Quebec City. Both the conventional and experimental groups met once a week for 55 minutes. The study lasted ten weeks. The conventional aquatic therapy program involved a short warm-up, 15 minutes of practicing swim skills and playing aquatic games, free time, and then a short relaxation period. The goal of this group was to have fun and not to achieve therapeutic outcomes. There was no music while in the pool and although there were volunteers in the water for safety, they were instructed not to provide verbal encouragement. The experimental aquatic therapy program was more structured and was divided into five phases. First were preparation and entry to pool, then a warm-up, individual exercises, group activities, and relaxation. This program was planned and specific objectives were addressed each week. Music was played during each session and volunteers were encouraged to provide feedback regarding increasing self-esteem and self-confidence.

Outcome Measures: Although the study had many outcome measures, changes in self-esteem and functional independence best match the outcome measures of our clinical PICO. These outcomes were measured prior to receiving treatment, after the ten week study period, and at a nine month follow up. Changes in self-esteem were measured using the Rosenberg Self-Esteem Scale. This self-administered instrument was reported to have internal consistency of .79, meaning there is high reliability regarding multiple questions used to measure the same characteristic. The authors state that test-retest reliability for the Rosenberg Self-Esteem Scale was found to be .82. The MCID is not stated in the article. Functional independence was measured using the Functional Independence Measure for Children (WeeFIM). This tool

focuses on 18 different tasks including self-care activities of daily living, continence, mobility, communication, and social skills. The authors reported internal consistency for this study was found to be .91. Test-retest reliability was reported to be .99 and inter-rater reliability was .95. Criterion validity has been found to be between .88 and .95 in other studies. Again, MCID was not reported for this outcome measure.

Study Losses: All twenty participants completed the ten week aquatic therapy program. At the nine month follow-up, only twelve of the twenty participants agreed to be re-evaluated (six in each group).

Summary of Internal Validity: Overall internal validity of this study is somewhat weak. The participants were not randomized into treatment groups and the principle investigator was not blinded to group assignments, which could have a profound effect on the data collected. Outcome measures were appropriate and no participants withdrew from the study during the program (eight did not return for the nine month follow up). The groups were similar at baseline, but they were specifically designed to be that way by the principle investigator. She hand-picked participants for each group making them similar, but the lack of randomization and blinding were negative consequences to this choice.

Evidence:

SELF-ESTEEM	Conventional Group (average group score)	Experimental Group (average group score)
Pre-Intervention	30.40	31.30
Post-Intervention	32.70	33.60
Nine Month Follow-up	34.00	32.00

FUNCTIONAL INDEPENDENCE	Conventional Group (average group score)	Experimental Group (average group score)
Pre-Intervention	87.20	88.50
Post-Intervention	92.40	92.00
Nine Month Follow-up	94.00	89.17

Discussion: Due to a lack of standard deviation information provided, analysis of statistical tests for score data is not possible. So, our conclusions must be based upon reported data alone. Therefore, when looking at self-esteem scores there was a 2.3 point average increase for both groups during the ten weeks of the study (although we do not know if this is significant since MCID is not known). At the nine month follow up self-esteem scores decreased for the experimental group and continued to increase for the conventional aquatic therapy group (each group lost four participants, n=6). This information indicates the difference between the conventional and experimental therapy programs regarding improving self-esteem scores is minimal.

Functional independence scores improved by 5.2 points for the conventional group and 3.5 points for the experimental group over the ten week study period. This would lead us to believe that functional independence benefits were greater in the conventional type aquatic group, but we are not sure if a 5.2 point increase meets the MCID. Again, at the nine month follow up the conventional group continued to display improvements while the experimental group lost some

ground. This would lead us to believe that the conventional aquatic therapy program was more effective at improving functional independence.

Applicability of Study Results:

Similarity to Our Patients: The participants in this study are a little older than the patients treated at our clinic. The authors of the study do not discuss the functional levels of the participants regarding ambulation and self-care prior to the study, so it is difficult to conclude if the sample in this study was similar to clinical patients. Twelve out of twenty study participants were in a special school and most of our clinical patients attend public school, but overall the study population is likely similar to a typical clinical population.

Benefits v. Costs: There would be some costs associated with implementing this program in our clinic. We would need to find a warm water pool to use, and we would have to charge money to cover pool entry fees. We would likely choose to use the conventional program versus the experimental if only considering cost because it would take less time to plan and there would be less labor costs.

Feasibility of Treatment: Implementing these aquatic therapy programs is feasible in our current clinical situation. A challenge to implementing this program would be finding volunteers to work with each participant. The conventional program could be replicated due to lack of structure, but it may be hard to replicate the experimental program because the exact exercises and order of events is unknown.

Summary of External Validity: The participants in this study are a suitable match for the children in our practice considering an aquatic therapy program. The small sample size makes it difficult to say that a larger group of patients would experience the same results. Internal validity was weak and the lack of a control group makes it impossible to know if the improvements made were truly caused by the specific type of aquatic therapy program alone.

Article #2

Hutzler, Y., Chacham, A., Bergman, U., Szeinberg, A. (1998). Effects of a movement and swimming program on vital capacity and water orientation skills of children with cerebral palsy. *Developmental Medicine & Child Neurology* 40, 3, 176-181.

Clinical Bottom Line:

From the results of this study, it was shown that aquatic physical therapy, in conjunction with land-based physical therapy, produced a significant increase in the vital capacities of children with cerebral palsy. Increases in vital capacity can help respiratory function, which could lead to an improvement in functional activity tolerance quality of life. However, this only answers a small part of our clinical question. The specific interventions were not presented. So depending on how much parents are willing to spend and travel, aquatic therapy may or may not be worth supplementing a child's treatment program for the vital capacity benefits.

Study Question:

Population – 46 kindergarteners aged five to seven years old with cerebral palsy

Intervention - Aquatic therapy with Bobath therapy

Comparison - Bobath therapy only

Outcome - Vital capacity, measured by calibrated 9-liter turbine spirometer, and water orientation skills, measured by an adapted version of the Water Orientation Checklist

Blinding:
Blinding was not mentioned within this article, so it is assumed that no blinding took place.

Randomization:
The 46 participants were assigned to an intervention group and a control group with 23 participants each. Randomization did not occur, but the two groups were found to be similar at baseline. Assignment was not concealed because one group received water-based treatment, and the other received land-based treatment.

Study:
In this nonrandomized study, participants, ages from five to seven years old, with some form of cerebral palsy were recruited. Forty-six were selected from four different kindergarten schools for those with neuromotor impairments. The participants selected for the experimental group were chosen from two of the schools, while the control subjects were taken from the other two. Twenty-three participants were placed into each of the two groups.

The treatment selected for the experimental group was a six month program including individual aquatic exercise twice a week and a once a week gym session. Individual aquatic exercise focused on water orientation, and gym exercises focused on locomotion and ball-handling skills. They also received Bobath therapy twice a week. All treatment sessions were 30 minutes long. The control group received four sessions of Bobath therapy a week for six months.

Outcome Measures:
Changes in vital capacity and water orientation skills addressed in this study were measured at baseline and post-treatment. The change in vital capacity, which was recorded by a calibrated 9-liter turbine spirometer administered by the same technician, is the outcome measure related to the clinical question. Improvement in vital capacity relates directly to better respiratory function. From baseline to post-treatment, the mean vital capacity of the experimental group increased 65.1 percent (380.4 cc to 628.3 cc), while the control group improved 23.3 percent (443.5 cc to 546.7 cc). Significant differences were found using ANOVA. No significant difference was found at the baseline measures, but the study reports that there were significant changes from baseline to post-treatment in vital capacity ($p=0.009$) in both groups, and that there was a significant difference between the treatment group's improvement vs. the control group's improvement ($p=0.009$). No reliability was given for the spirometry test. The authors did not discuss minimal clinically important difference.

Study Losses:
None of the 46 participants were lost from the six month study.

Summary of Internal Validity:
There was no randomization to the study. Two schools made up each testing group when all the participants should have just been randomized to each group. Despite this, baseline subject data was reported to be similar with no significant differences in vital capacity ($p=0.32$). Participants,

treatment personnel, and assessors were not blinded for this study. In this study, it is impossible to blind the subjects and those treating them, but the assessor could have been. Results of respiratory function should have not have been limited to just the changes in vital capacity. Other respiratory function tests should have been carried out. The biggest threats to the internal validity are the lack of randomization and blinding. Those threats may not have compromised the study since the baseline measures of the participants were similar and the test used for vital capacity is objective.

Evidence:
Those in the experimental group showed a mean improvement of 247.8 cc from baseline (380.4 cc) to post-treatment (628.3 cc), while the control group showed a mean improvement of 103.3 cc (443.5 – 546.7).

Vital Capacity	Treatment (SD)	Control (SD)
Initial	380.4 (241.6)	443.5 (179.2)
Post-treatment	628.3 (281.2)	546.7 (182.5)
Change in VC	247.8 (217.7)	103.3 (127.1)
Difference	144.5 (33 - 256 CI)	
Effect Size	0.81 (0.21 to 1.41)	

Discussion:
The data shows that between these two groups, there is a significant difference in their mean scores. An effect size of 0.81 qualifies as a large effect meaning there is a strong relationship. The 95% confidence intervals stay in a positive range, but they cover a wide area, meaning the differences could have been a small change or even bigger.

Applicability of Study Results:

Similarity to Our Patients

The participants in this study fit within the criteria we are looking for. Ages five to seven does not include the whole age range of patients seen in the pediatric clinic, but it does fall inside of it. All of the participants had some form of cerebral palsy (not all the same) representative of a typical clinic population.

Benefits v. Costs

The final data supports the experimental treatment, but there are other things to consider. Those in the experimental group were spending another 30 minutes a week in therapy than those in the control group. More time and money must be considered if there is a long commute to the pool involved and if parents have to pay for every visit.

Feasibility of Treatment

This is a feasible treatment if there are therapists already treating patients in the aquatic setting. It is not a good alternative if there is no pool in the area and patients have to make a longer commute to receive the therapy. There is also the additional cost issue that would come with supplementing this therapy if it is not covered by insurance.

Summary of External Validity

The subject sample used in this study is similar to a portion of what we see in the clinic except for the fact that the study took place in Israel. Also, there is a broader range of ages seen in our clinic outside of five to seven years old. Since the groups were made up of a decent sample size with different types of cerebral palsy, the results could be extrapolated to a larger population. The lack of randomization and blinding of the assessor does hurt the validity of this study.

Article #3

Fragala-Pinkham, M. A., Dumas, H. M., Barlow, C. A., Pasternak, A. (2009). An aquatic physical therapy program at a pediatric rehabilitation hospital: A case series. *Pediatric Physical Therapy* 21, 1, 68-78.

Clinical Bottom Line:

From the results of this study, it was shown that there were clinically detectable improvements made by the participants in an aquatic therapy in conjunction with land-based physical therapy. Due to the small sample size, it is impossible to generalize this information to our PICO population, however, it could be a pilot for a larger study.

Study Question:

Population - Four participants (two with cerebral palsy, one with juvenile idiopathic arthritis, one with Prader-Willi syndrome) ages two to 19 years old.
Intervention - Personalized aquatic therapy interventions for each participant added to land-based physical therapy
Comparison - Baseline measures with personalized standard land-based physical therapy before the addition of aquatic therapy
Outcome - Canadian Occupational Performance Measure (COPM), Gross Motor Function Measure-66 (GMFM-66), Pediatric Evaluation of Disability Inventory (PEDI) mobility functional skills (FS) and caregiver assistance (CA), 3-min walk and Energy Expenditure Index (EEI), Observational Gait Scale (OGS), Functional Reach Test (FRT), timed single limb stance, Floor to Stand (FTS), manual muscle testing (MMT), isometric muscle strength: hand-held dynamometer (HHD), passive range of motion (PROM), Face Legs Activity Cry and Consolability (FLACC), Numerical Pain Scale, Juvenile Arthritis Quality of Life Questionnaire (JAQQ).

Blinding:

Blinding was not mentioned within the article, so it is assumed that no blinding took place.

Randomization:

Subjects were not randomized into groups because this was a multiple case study where each participant received his or her own personalized intervention program.

Study:

In this study, there were participants with cerebral palsy (2), juvenile idiopathic arthritis (1), and Prader-Willi syndrome. Each participant had his or her own treatment program that differed in program length, interventions, and measures. The two cases of interest were the participants with cerebral palsy.

The first was a seven year old male with spastic diplegic cerebral palsy who was referred to physical therapy because of heel cord tightness and progressing number of falls. This child was seen twice a week for six weeks. Each session was 60 minutes long with eight of them being in the water and four on land. Pool activities included: kickboard kicking with ankle cuffs, chest deep toe and heel raises, balance challenges against jet resistance, gait training, running with water at hip height, swimming, stretching hip and ankles. Land activities included: treadmill, single leg stance games, obstacles, karate, relays, soccer kicking with ankle cuffs, stretching hips and ankles. The participant progressed by increasing the water depth, ankle cuff weight, speed, and jet resistance.

The second participant was a ten year old male with right hemiplegic cerebral palsy referred to physical therapy after a foot surgery. This child was seen twice a week for 10 weeks, and then once a week for five and a half months after a femoral neck fracture suffered at home. Sessions were 60 minutes long with three quarters of them being pool treatments. Pool activities included: hip knee and ankle strength training, standing and sitting balance, gait training, cardiorespiratory endurance, and swimming. Land activities included: electrical stimulation of right foot muscles, lower extremity progressive resistive exercises, trunk strengthening, gait training, and a home exercise program of stretching and PREs.

Outcome Measures:
Outcomes were taken before aquatic intervention began, and after the six week intervention for the seven year old. The participant made improvements in all of his measures (COPM, GMFM-66, OGS, 3-min fast walk, standing functional reach, peak isometric strength, passive ROM). The authors reported all of the minimal detectable change (MDC) and minimal important difference (MID) numbers for the measurements done if they were available. Improvements in the COPM (performance and satisfaction) and GMFM-66 exceeded both the MDC and MID, and improvements in the 3-min fast walk (EEI and distance), standing functional reach, peak isometric strength of left and right knee extensors and left ankle plantarflexors, and passive ROM in left and right popliteal angle and left ankle dorsiflexors.

For the ten year old, outcomes were taken at the initial assessment, week 5 (this was after the hip fracture), week 20 (when participant had improved to full weight bearing), and then at eight months when the intervention was finished. This participant made improvements in all measures at the end of eight months (COPM, PEDI, floor to stand, 3-min fast walk, MMT of right LE, right LE passive ROM). Measures demonstrating improvements greater than the MDC and MID were in the COPM (performance and satisfaction) and the PEDI. Improvements in the floor to stand, 3-min fast walk (EEI and distance), and right ankle dorsiflexion and eversion passive ROM exceeded their MDC. MMT of the right knee extensors also improved greater than its MID.

Authors also reported each tests' reliability and ICC if available.

Study Losses:

None of the four participants were lost from the study. One of the participants with cerebral palsy sustained a right femoral neck fracture, but still completed the treatment after given time to heal.

Summary of Internal Validity:
In this case study, there was no randomization, no blinding, no control, and no similarity of subjects at baseline. No participant had the same exact intervention plan, and only two of the four subjects had the condition we desired. Since there was no blinding, there easily could have been bias by the assessors.

Evidence:
The outcomes of this study could correlate with a participant's physical well being, making it relevant to our PICO.

7 Year Old		
	Initial	6 Weeks
COPM		
Performance	1.3	7.7*
Satisfaction	3	8*
GMFM-66	69.22	76.75*
OGS	L 6/22 R 8/22	L 10/22 R 13/22
3-min fast walk		
EEI (beats/min)	1.02	0.85*
Distance (m)	274.3	327.36*
Standing functional reach (cm)	23	29.5*
Peak isometric strength (kg)		
Knee extensors	L 14.8 R 14.0	L 16.6* R 16.2*
Ankle DFs	L 2.2 R 2.2	L 3.3 R 3.6
Ankle PFs	L 13.5 R 14.3	L 17.3* R16.2
Passive ROM		
Popliteal angle	L 54 R 48	L 40* R 35*
Ankle DF	L -5 R 5	L 6* R 10

10 Year Old		
	Initial	8 Months
COPM		
Performance	1	6.25*
Satisfaction	1	7.75*
PEDI	38.2	94.2*
Floor to stand	Assisted	10.1*
3-min fast walk		
EEI (beats/min)	1.77	0.66*
Distance (m)	128	458*

MMT right		
Hip ABD	3-	4-
Hip EXT	3-	4-
Knee EXT	4-	4*
Ankle DF	0	1
Ankle PF	0	1
Ankle INV	0	1
Ankle EV	0	0
Passive ROM		
Right ankle DF	5	20*
Right ankle EV	5	10*

* Value changed greater than MDC or MID

Discussion:
The data presented shows improvements in all measurements. Since this was a case study and only two of the participants were of interest, effect size and confidence intervals could not be computed. Many individual results of this study are of magnitudes that are clinically important, but this was a very sample size.

Applicability of Study Results:

Similarity to Our Patients - Two children in this case study did fit within our clinical PICO (children with cerebral palsy), but only represent a very small subset of our desired population. Both are male and don't cover our desired age range.

Benefits v. Costs - Both participants presented in this multiple case study spent most of their therapy sessions in the water (2/3 to ¾ of treatments). Financial and time costs may be quite high for the participants' parents. However, the authors bring up a good point that attendance for the program was high for all their case studies; the number of therapy sessions reportedly missed go down when aquatic therapy is part of children's program.

Feasibility of Treatment - Interventions done for both participants were given so that this study could be replicated in some way, but they were individualized and not made to fit everyone. Feasibility of this intervention is dependent upon pool accessibility, either directly or in partnership with another facility.

Summary of External Validity - The participants evaluated in this case study appear similar to what we would see in the clinic, but only a tiny portion of the total population of children diagnosed with cerebral palsy. It would then be very difficult to extrapolate these results from this small sample size to a larger population. Since there was no way of controlling blinding, bias could have been an issue.

Synthesis/Discussion: Weaknesses in these three articles are numerous. The Pedro rating scale was used to objectively compare the quality of each article. As it can be seen, none of the articles scored above a five out of ten, with the Fragala-Pinkham et al. article of multiple case studies just scoring a two out of ten. All three articles failed in five similar criteria findings. These had to do with random allocation, concealment of allocation, and blinding of subjects, therapists and assessors, which is difficult to control in this setting since participants and

intervention providers are going to be in the pool together or not. The Fragala-Pinkham et al. article also failed to provide similarity between subjects at baseline, statistical comparisons between subjects, and measures of variability.

Article	Pedro Rating
#1 Dorval et al.: conventional v. experimental	5/10
#2 Hutzler et al.: vital capacity	5/10
#3 Fragala-Pinkham et al.: two case studies	2/10

This analysis indicates the need for further higher quality research on aquatic therapy as an intervention in children with cerebral palsy. Cerebral palsy is a heterogeneous condition, as it has different types (spastice, athetoid, mixed), distribution (hemi, bilateral, upper extremity, lower extremity, and severity. This further complicates the process of performing research as it is difficult to find a study population similar to the diverse population of children that we are clinically treating. As there is little research on aquatic therapy, it was very difficult to find three highly rated articles on this subject.

A common weakness among the Dorval et al. and Hutzler et al. studies was a lack of reported treatment parameters. Dorval et al. lacked information about the experimental group protocol, as the authors do not report what was done for individual exercises, group activities, or relaxation. Although this group did not improve as much as the conventional aquatic therapy group, the authors did not leave us with enough information to replicate their study. Hutzler et al. found significant improvements in vital capacity, but replicating this clinically would be impossible as water orientation skills used for intervention were not reported. Fragala-Pinkham et al. listed the intervention used for their case studies, but those interventions were individualized and are not appropriate for children with different types of cerebral palsy.

Due to the lack of research done in this still expanding area of pediatrics, there is little standardization regarding which outcome measures are best to evaluate progression of aquatic therapeutic intervention in children diagnosed with cerebral palsy. Each study used specific and different outcome measures (self-esteem, vital capacity, MMT, ROM, etc.). This made it difficult to find a common clinical outcome to comparatively evaluate all three articles. So we chose health related quality of life to link these outcome measures as it is a broad measure influenced by many different measurable factors.

Minimally clinical important differences (MCID) for self-esteem, functional independence, and vital capacity were not available for us to use as an evaluative tool when formulating our discussion. We hypothesize the lack of MCIDs is due to the difficulty of finding a sufficient number of participants with similar baseline characteristics within the same geographical area, who are willing to participate in clinical research and have consenting parents. Until MCIDs are available for more pediatric outcome measures, physical therapists will be limited when trying to use evidence, in combination with clinical experience and patient preference, during physical therapy treatment.

Evaluating the data presented by these articles based from the perspective of health related quality of life was quite challenging. We would suggest looking at the effectivness of aquatic

therapy in both short and long term outcomes. It is well known that swimming and aquatic activities are a lifetime fitness option for individuals with cerebral palsy, leading us to believe it would be valuable to study the effect of aquatic therapy on improving ability to swim independently during childhood and into adulthood. Not only can aquatic therapy cause short term changes (self-esteem, vital capacity), but it may serve as a opportunity to introduce children with cerebral palsy to a cardiovascular exercise option that can be used throughout the lifetime.

References

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Hutzler, Y., Chacham, A., Bergman, U., Szeinberg, A. (1998). Effects of a movement and swimming program on vital capacity and water orientation skills of children with cerebral palsy. Developmental Medicine & Child Neurology 40, 3, 176-181.

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