Neurodevelopmental therapy is not more effective in improving gross motor function of children with spastic cerebral palsy when compared to alternative therapy or no therapy.

Prepared by: Dani Cowan
Date: December 9, 2010
Review date: December 9, 2012

CLINICAL SCENARIO:

Client Population
This critically appraised topic includes children with spastic cerebral palsy ages 2 to 18 years old.

Treatment Context
In the studies reviewed, neurodevelopmental treatment took place in an outpatient setting, a rehabilitation center, and in programs in the participants local communities or schools.

Problem/Condition
Cerebral palsy is classified as a neuromuscular disorder with the main symptoms being motor, postural, neurological, and muscle tone impairments. This disorder is caused two different ways. Congenital cerebral palsy is caused by injury or illness at or before birth; this is the most common form. Acquired cerebral palsy is caused by an injury that occurs in early childhood. Cerebral palsy is categorized based on where the lesion is located in the brain as well as by which limbs are affected. A lesion to the motor cortex of the brain causes spastic cerebral palsy with high tone being the primary physical symptom. A lesion in the basal ganglia produces diakinesia, dystonia, or atetosis, all of which are characterized by fluctuations in muscle tone. Cerebral palsy is also classified based on which limbs are affected by the lesions in the brain. When the upper and lower limbs on one side of the body are affected it is referred to as hemiplegic cerebral palsy. When all of the limbs are affected, that is classified as tetraplegia or quadriplegia. Finally, if all four limbs are involved, but the upper extremities are only mildly affected it is referred to as diplegia (Case-Smith & O'Brien, 2010).

Neurodevelopmental therapy is designed to address deficient motor performance skills that are affected by the impairments of cerebral palsy. In this critically appraised topic, the studies reviewed specifically looked at the ability of NDT to improve gross motor function, which is a common deficit in cerebral palsy. Children rely on gross motor skills in order to participate within their environment by crawling, walking, or using the stairs (functional mobility ADL). These skills are also used as children are exploring their world and the leisure activities available to them. Play is a major occupation of children, especially in the younger age ranges, and gross motor skills such as reaching allow them to play at the best of their abilities.

Intervention
Neurodevelopmental therapy is an approach used to target the neuromuscular and central nervous systems based on neurologic principals and normal development and movement. This treatment strategy focuses on the abilities of the individual to carry out efficient postural responses and movement patterns while, with the therapists help, avoiding abnormal patterns of movement. NDT principles include encouraging the use of both sides of the body at all times, not just the affected or unaffected sides. It is important to note that NDT is not solely a muscle re-education technique; it is a 24-hour management program and should ideally be incorporated into the daily lives of the individual. NDT is designed to address motor problems, such as flaccidity or spasticity. It is also used to help clients learn to bear weight on the affected side in a way that will help to lessen or increase tone. The
goals of this therapy method are to relearn normal movements, use both sides of the body, decrease use of adaptive equipment, and to help the client move more freely with more manageable muscle tone (Kramer & Hinojosa, 2010).

How Does NDT Work?
With cerebral palsy, children experience atypical movement patterns. This is often related to muscle tone, among other aspects of the motor system. Children with CP have a characteristic impairment in their ability to maintain normal postures due to a lack of co-activation of the muscles needed for stability as well as the development of abnormal compensatory strategies. Compensatory strategies, or patterns, occur in specific muscle groups to help the child maintain an upright position. They also affect movement against gravity.

With NDT, the therapist uses hands-on manipulation and the client is positioned in such a way that aligns the joints and prepares the muscles by giving them appropriate proprioceptive input, which then prepares the body for functional activity. One way this is done is through traction of the muscles, which stretches and elongates them to help decrease stiffness and promote alignment. Compression at the joints facilitates stability as well as decreases tone. For decreased tone, a therapist can perform a quick stretch at the muscle, which elicits the stretch reflex at the level of the muscle spindles, causing a contraction at the muscle. The weight bearing principles of NDT create co-contraction of the muscles, which promotes stability and alignment at the joint being utilized. However, this aspect is not recommended for long periods of time because co-contraction also decreases the degrees of freedom available within that joint. Prolonged over use of this strategy can result in decreased energy which will impede functional performance. Therefore, understanding NDT and its uses is essential. The theory is that if the body is prepared through aligning the joints, normalizing tone in the muscles, and facilitating stability then optimal performance can occur and atypical activity can be avoided by establishing more normal movement patterns (Kramer & Hinojosa, 2010).

Based on a motor development theory, it is believed that through handling the therapist can integrate and assimilate the atypical, competing patterns of movement that children with cerebral palsy have developed and turn them into a more balanced interaction to allow for movement and postural control. When one aspect of motor control or postural stability is affected, it affects the entire body and its ability to efficiently move. For example, if the child has poor head control this is typically due to inefficient co-activation of the cervical muscles (flexors and extensors). This in turn causes the center of gravity to shift anteriorly resulting in the thoracic and lumbar spine to create compensatory strategies in order to maintain an upright position. The sensory aspect comes into play because often with cerebral palsy children have hyperactive responses to tactile, visual, and/or auditory stimulation. This over reactivity to sensory input affects the muscles by causing fluctuations of muscle tone that impacts postural control and impairing everyday function (Case-Smith & O'Brien, 2010).

Another role of NDT is to help the child build equal strength in muscles in order to achieve balanced muscle tone. With cerebral palsy, messages are interrupted from the brain to the muscles causing unequal development of muscles. Because cerebral palsy can result in both flaccidity and/or spasticity, NDT is a tool that can also be used for strengthening.

As discussed, therapeutic handling is the primary intervention technique of NDT. The handling used by therapists is intended to help organize input to the body in order to produce more efficient movement. The client is able to achieve more correct alignment of the body and more equal muscle tension relationships. Overall, NDT is designed to prepare the client's body, facilitate more active movement, and inhibit unwanted movements of those affected by cerebral palsy (Kramer & Hinojosa, 2010).

OT Framework
This critically appraised topic looks at the use of NDT for gross motor function. This falls under the body functions section of Client Factors within the Occupational Therapy Practice Framework:
Domain & Process. More specifically, gross motor function is in the “Neuromusculoskeletal and movement-related function” category. NDT works to improve gross motor function through working with the structures related to movement, within the body structures section of Client Factors. Gross motor skills also fall under the motor and praxis skills category of the Framework’s Performance Skills section. Finally, NDT affects the habits and routines of the child as well as the family due to the fact that it is considered to be a full time intervention strategy. Also, NDT theory states that through interventions, typical movement patterns can be learned and can alter existing motor patterns of children with cerebral palsy (Kramer, & Hinojosa, 2010). Habits and routines fall under the Performance Patterns portion of the Framework, more specifically of the person (American Occupational Therapy Association, 2008).

OT Theory

NDT used to facilitate gross motor function of children with cerebral palsy fits well within the sensorimotor frame of reference due to the fact that sensorimotor techniques are the fundamental aspects of NDT. NDT is also based on the concepts of the biomechanical frame of reference. NDT integrates concepts such as planes of movement, range of motion, alignment of the body, base of support, muscle strength, postural control, and weight shifts and mobility (Kramer & Hinojosa, 2010).

NDT also uses concepts from motor control and systems theories. Practice for automatic and voluntary components of movement is emphasized, especially allowing the child to be an active participant in the therapy in order to build the motor maps necessary to learn the movements and postural control. Under the systems theories, it is imperative that one takes into account the interaction between the client, the task, and their environment in order to best facilitate movement and control. It is also emphasized that therapists cannot take away something that is working for the child (removing a compensatory movement, for example, through management of abnormal tone) without replacing it with something to allow function (for example, teaching the child how to function with normalized tone) (Kramer & Hinojosa, 2010).

FOCUSED CLINICAL QUESTION:
Is neurodevelopmental therapy more effective in improving gross motor function of children with cerebral palsy when compared to alternative therapy or no therapy?

- **Patient/Client Group:** Children with Cerebral Palsy ages 2-18 years
- **Intervention (or Assessment):** Neurodevelopmental Treatment
- **Comparison Intervention:** Alternative Therapy or No Therapy
- **Outcome(s):** Improvement in Gross Motor Function
LIMITATION OF THIS CAT: This critically appraised paper (or topic) has been reviewed by occupational therapy graduate students and the course instructor.

SEARCH STRATEGY:
### Table 1: Search Strategy

<table>
<thead>
<tr>
<th>Databases Searched</th>
<th>Search Terms</th>
<th>Limits Used</th>
<th>Inclusion and Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CINAHL Plus with Full Text</strong></td>
<td>NDT + CP&lt;br&gt; OT + cerebral palsy&lt;br&gt; NDT + cerebral palsy + handwriting&lt;br&gt; Neurodevelopmental treatment + cerebral palsy + occupational therapy&lt;br&gt; Neurodevelopmental treatment intensity + cerebral palsy + occupational therapy&lt;br&gt; Occupational therapy + cerebral Palsy&lt;br&gt; Bobath Approach</td>
<td>AND</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
<tr>
<td><strong>COCHRANE</strong></td>
<td>Neurodevelopmental treatment + occupational therapy</td>
<td>AND</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
<tr>
<td><strong>OTSeeker</strong></td>
<td>Neurodevelopmental treatment&lt;br&gt; Cerebral Palsy&lt;br&gt; Bobath approach</td>
<td>None</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
<tr>
<td><strong>OT Search</strong></td>
<td>Neurodevelopmental treatment&lt;br&gt; Cerebral palsy</td>
<td>None</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
<tr>
<td><strong>Medline</strong></td>
<td>NDT&lt;br&gt; Neurodevelopmental treatment&lt;br&gt; Bobath Approach&lt;br&gt; Cerebral Palsy</td>
<td>None</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
<tr>
<td><strong>PEDro</strong></td>
<td>Cerebral Palsy &lt;br&gt; <em>Advanced Search:</em>&lt;br&gt; <em>(Therapy:)</em> neurodevelopmental therapy, neurofacilitation +&lt;br&gt; <em>(Subdiscipline:)</em> Paediatrics +</td>
<td>None</td>
<td>Inclusion/Exclusion Criteria&lt;br&gt; Full text&lt;br&gt; English&lt;br&gt; Diagnosis: cerebral palsy&lt;br&gt; Population: children (&lt;18 years)&lt;br&gt; Intervention: NDT or Bobath Approach only&lt;br&gt; Must be more recent than 1980</td>
</tr>
</tbody>
</table>
*Also searched the reference sections of articles retrieved from databases.

**RESULTS OF SEARCH**

**Table 2: Summary of Study Designs of Articles Retrieved**

<table>
<thead>
<tr>
<th>Level</th>
<th>Study Design/Methodology of Articles Retrieved</th>
<th>Number Located</th>
<th>Source</th>
<th>Citation (Name, Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
<td>Randomized Control Trials</td>
<td>1111</td>
<td>Developmental Medicine &amp; Child Neurology; Iranian Journal of Child Neurology;</td>
<td>Law, 1991; Bar-Haim, 2006; Tsorlakis, 2004; Shamsoddini, 2010;</td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
<td>Non-randomized control group (two groups)</td>
<td>11</td>
<td>Hong Kong Journal of Occupational Therapy; Developmental Medicine &amp; Child Neurology; Physical Therapy</td>
<td>Davland, 2009; Ketelaar, 2001</td>
</tr>
<tr>
<td><strong>Level 3</strong></td>
<td>Non-randomized control group (one group); crossover design</td>
<td>11</td>
<td>Physical Therapy; Developmental Medicine &amp; Child Neurology</td>
<td>Fetter, 1996; Law, 1997;</td>
</tr>
<tr>
<td><strong>Level 4</strong></td>
<td>Single-subject/ Repeated Measures Designs</td>
<td>1111</td>
<td>Developmental Medicine &amp; Child Neurology; Physical &amp; Occupational Therapy in Pediatrics</td>
<td>Knox, 2002; DeGangi, 1994; Sheppard, 2007;</td>
</tr>
<tr>
<td>Level</td>
<td>Qualitative, Case Study</td>
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</tbody>
</table>

### STUDIES INCLUDED

**Table 3: Summary of Included Studies (add more columns if necessary)**

<table>
<thead>
<tr>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention Investigated</strong></td>
<td>Adeli Suit - Daily treatment sessions: 2 hours a day, 5 days a week for 4 weeks - Total of 20 sessions</td>
<td>NDT - 1.5 hours a day, 2 days a week for 3 months</td>
</tr>
<tr>
<td><strong>Comparison Intervention</strong></td>
<td>Neurodevelopmental Therapy - Daily treatment sessions: 2 hours a day, 5 days a week for 4 weeks - Total of 20 sessions</td>
<td>Sensory Integration Therapy - 1.5 hours a day, 2 days a week for 3 months</td>
</tr>
<tr>
<td><strong>Dependent Variables &amp; Outcome Measures</strong></td>
<td>DV1: Motor Function OM1: Gross Motor Function Measure (GMFM-66) DV2: Mechanical Efficiency during Stair Climbing OM2: metabolic energy cost (heart rate while stair climbing)</td>
<td>DV: Gross Motor Function OM: Gross Motor Function Measure (GMFM-88)</td>
</tr>
</tbody>
</table>

Prepared by Danielle Cowan, OTS (December 9, 2010). Available at www.UWLAX.EDU/OT
<p>| Contextual factors (includes maternal behaviors, environment, parent satisfaction) |</p>
<table>
<thead>
<tr>
<th>Population age range</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population age range</td>
<td>Findings</td>
</tr>
<tr>
<td>5 years 11 months – 12 years 11 months (n=24)</td>
<td>Found a significant improvement in scores on the GMFM-66 after 1 month of treatment in both groups as well as after 10 months of treatment. (NDT group after 10 months: $p&lt;0.006$) (Adeli Suit after 1 month: $p&lt;0.037$) No significant difference in motor function or mechanical efficiency using the Adeli Suit compared to NDT. This means that NDT is not superior to Adeli Suit treatment in improving motor function.</td>
</tr>
<tr>
<td>2 – 6 years (n=22)</td>
<td>Significant improvements in GMFM-88 scores were seen in lying and rolling, sitting, crawling and kneeling, and standing when an independent sample t-test was performed comparing the mean scores of both SIT and NDT. However, no significant improvement was seen when comparing mean scores of NDT and SIT in walking, running, and jumping. Paired t-tests were also performed for each group. In the SIT group, a significant change was found between pre and post test scores on the GMFM-88 in lying, rolling, sitting, crawling, kneeling, and standing. No significant change was noted in walking, running, and jumping however. In the NDT group, a significant change was noted in all areas (lying and rolling, sitting, crawling, kneeling, standing, walking, running, and jumping) when comparing pre and post test means. Based on the above information, the authors concluded that both NDT and SIT improve gross motor function as measured by the GMFM-88. Therefore, it cannot be concluded that NDT is more beneficial than</td>
</tr>
<tr>
<td>5 months-15 years</td>
<td>Findings did not imply that NDT was more advantageous than the alternative therapy or no therapy to which it was compared. 14 of the 21 studies were at level I or level II so it was also implied that the results could be seen as “definitively or tentatively valid.” However, the review also found small sample sizes in many of the studies, and heterogeneity of the populations, which are all threats to validity. The techniques used to administer NDT also varied across time and across therapists. Over all, the results showed that the children in therapy got better, no matter what treatment they received, showing that NDT is not better in improving function of children with cerebral palsy compared to alternative or no therapy.</td>
</tr>
</tbody>
</table>
SYNTHESIS: IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

Is Neurodevelopmental therapy more effective in improving gross motor function of children with cerebral palsy when compared to alternative therapy or no therapy?

Overall Conclusions:

All three articles found consistent findings regarding the use of NDT, however there were some differences between the articles reviewed. The two randomized control trials differed most markedly in the intensity of NDT that was used. Study 1 (Table 3) used a much more intensive protocol for NDT than Study 2, with therapy provided daily rather than twice a week. The systematic review also looked at studies with differing intensities. A second aspect in the protocol for therapy was what aspects of NDT were used in each therapy session. This detail was not included in any of the three articles reviewed and may have differed. Because the three articles still concluded the same things, the differences in intensities and protocols allow this critically appraised topic to conclude that the intensity and the type of NDT does not seem to make a difference in outcomes. However, this conclusion is based on the articles reviewed and may not be generalizable to all studies.

Another difference between the three studies was seen in the population. Each article reviewed a different range of age groups, with some overlap. Overall the ages range from 5 months to 15 years, which is a broad range. This allows the conclusion to be made that the age of the participants did not make a difference in determining significant improvement from NDT. Also, the demographics of the participants were different, as Study 1 used individuals from Israel and Study 2 used individuals from Iran. The systematic review evaluated articles from various countries, including the United States. These differences result in this critically appraised paper to come to the same conclusion regardless of where the therapy is taking place.

Finally, the articles all compared NDT to an alternative type of therapy, or to no therapy, yet none of the articles compared to the same therapy. There was a vast amount of therapies, however, that were used in comparison especially in the systematic review. This difference gives this paper the ability to conclude with confidence that NDT is not more effective than a variety of alternative treatments, or no treatment.

Despite the fact that the three articles differed in sample sizes, treatment intensities, population characteristics, and comparison therapies, this critically appraised topic found consistent results across all three studies reviewed that NDT is not more effective in improving gross motor function of children with cerebral palsy when compared to alternative therapy or no therapy.

Boundaries:

The studies represent a broad array of contexts, with one study being done on participants from Iran, one study on participants from Israel, and one was written here in the United States. This is important because it increased the ability for these results to be generalized across cultures.

None of the studies looked at the effect of NDT if it was performed outside of the clinical setting. Therefore, it is not known for sure if these results would be similar had treatment been administered elsewhere. Also, the outcome measures analyzed in this critically appraised topic are specific to gross motor function. NDT is a therapy that can be applied for a large number of outcomes other than gross motor. Therefore, one cannot generalize these results to NDT being used for any other outcome.
Another boundary that is consistently analysed in research on NDT is the variability in treatment strategies and techniques. None of the studies seemed to look at exactly how NDT was performed or how the training was given to the therapists administering the therapy. This could have a sizeable effect on the results of the treatment. It would be important to look at which aspects of NDT were helping or which specifically were not getting improvements and compare the aspects across studies, something the reviewed articles did not include. Therefore, one has to be cautious before generalizing these results to all aspects and techniques of NDT.

As previously discussed, neither of the articles were specific in their treatment protocols. This does not only include treatment strategies and techniques but also includes the amount of minutes that the participants received the therapy, which could be a threat to the validity of the study. None of the three articles reviewed in this paper made it clear as to whether or not protocols were standardized.

While the sample sizes were consistent between the two randomized control trials, they were relatively small. However, neither of the randomized control trials performed a power analysis to determine adequate sample size. This should be kept in mind as one is considering the results. A larger sample size may be more effective in generalizing results.

**Implications for Practice, Education, and Future Research:**

The results of this critically appraised topic suggest that neurodevelopmental therapy is not more effective in improving the gross motor function of children aged 2 to 18 years who are diagnosed with cerebral palsy when compared to alternative therapy or no therapy. This implies that clinicians currently using NDT techniques for this population must be cautious and should possibly re-evaluate why the techniques are being used over alternative therapies that might be equally or more cost effective. The literature does not support the use of NDT over alternative therapies that can be used to reach the same outcomes. One might argue that the literature reviewed in this paper as well as the related articles are not highly rated. However, the vast amount of literature that is available all come to the same conclusions. These conclusions are not implying that NDT is not effective in improving gross motor function rather they are concluding that NDT is not superior to the alternatives. With NDT being a specialty area of occupational therapy requiring additional training and certification, clinicians must evaluate the benefits of using it in their practice. The extra steps and costs required of becoming an NDT therapist is not justified by the outcomes of the therapy and this is supported by the literature. It would be very important in future research to gather information on exactly what the techniques being used are and what aspects of NDT are being applied, as there is a very limited amount of literature on this. There may be aspects of NDT that are used for outcomes other than gross motor functioning that show significant improvements in children with cerebral palsy, but that needs to be investigated further.

In the educational settings and in schools, it is important to critique the significance of including sections on NDT. Because literature does not support its superiority over alternative therapies, is this topic something that should be included in the courses over others? With the limited amount of time that professors have to include the vast array of topics regarding occupational therapy, there may be interventions that are more supported by research that can fill this time. Clinicians who wish to continue to administer NDT are also strongly advised to monitor and record their outcomes when using NDT in order to determine it's effectiveness with each individual client.
REFERENCES

Reviewed Articles


Available in Hard Copy

Related Articles and Literature (not individually appraised)


**Sources Cited**


APPENDIX (Article Critique)

Title:


Purpose of the Study:
The overall purpose of this study was to compare the efficacy of Adeli suit treatment (AST) with that of neurodevelopmental treatment (NDT) when used with children who have cerebral palsy to improve gross motor function and mechanical efficiency.

• There were two hypotheses tested in this study:
  1. There will be more significant improvements in motor function and mechanical efficiency after one month of AST than after one month of NDT.
  2. There will be more significant improvements in motor function and mechanical efficiency after 10 months of AST than after NDT.

Study Design:
• Level of Study
  o Level 1
• Type of Design
  o Randomized Control Trial
• Study Characteristics
  o 2 groups:
    § Experimental group: AST
    § Comparison group: NDT
• Group assignment was done using blocked randomization techniques. Participants were divided into six different blocks of four. Each block was made up of two children from the AST group two from NDT. The treatment-based pairs were also matched by age and GMFCS level.
• Measurements of gross motor function and mechanical efficiency were taken at baseline, after 1 month of therapy, and 10 months after therapy began. Keep in mind, the final measurement was taken 9 months after completion of the AST or NDT program and all participants had then returned to previous therapies.

Setting
• Both treatments were provided in a rehabilitation setting in Israel.
Participants

- Recruitment
  - Ads were placed in Israel’s national and local newspapers.
  - Parents interested then received a letter that explained the purpose of the study as well as the requirements.
- Total number at beginning of study:
  - The parents of 40 children applied to be in the study.
  - Of the 40, 16 children did not meet the requirements (due to contraindications for treatment or meeting exclusion criteria). Therefore, a convenience sample of 24 children were present at the beginning of the study.
- Number of Drop-outs:
  - All participants (24) completed the study, however, three children were allowed an extra week to make up missed sessions due to health problems.
- Inclusion Criteria
  - Cerebral Palsy diagnosis
  - 6 to 12 years old
  - Level II, III, or IV according to the GMFCS
  - Participants could not have undergone orthopaedic surgery or any spasticity-reduction interventions within the last 6 months.
  - Participants also could not be candidates for other interventions within the last year, including surgery.
  - Parents had to agree that the child could be placed in wither treatment group by a random process
- Exclusion Criteria (chosen based on contraindications for AST)
  - Hip dislocation or scoliosis
  - High degree of spasticity
  - Poorly controlled epilepsy
  - Hydrocephalus
  - Progressive encephalopathy and myopathy
- Before participation was allowed, a paediatric neurologist screened all children’s medical histories. Orthopaedic status was also determined for each child by a paediatric orthopaedic surgeon. A paediatric physiotherapist established GMFCS levels at the children’s initial visit.
- There was not any blinding of participants as it was very obvious what treatment was being received.
- Demographics:
  - 17 males, 7 females
    - NDT group
      - 9 males, 3 females
      - Mean age: 8 years 1 month
    - AST group
      - 8 males, 4 females
      - Mean age: 8 years 3 months
  - Mean age overall: 8 years 2 months
    - Range: 5 years 11 months to 12 years 11 months
- No significant difference was found between the groups in anthropometric measures (physical measurements of the body including height, weight, leg length, type of cerebral palsy, and GMFCS level) with \( p \geq 0.05 \).

Intervention Investigated
• Both treatments were provided in the same rehabilitation setting; specifics of this setting were not given.

• Participants in both groups received treatment 2 hours a day, 5 days a week, for 4 weeks making that a total of 20 sessions of whichever treatment they were to receive. All other physiotherapy treatments were stopped during the study, but participants were allowed to continue educational and recreational activities.

• Once again, blinding of interventionists was not a part of this study, as it is obvious which treatment is being performed.

• There was blinding of the physiotherapist who did outcome measures. The therapist was unaware of the treatment session that the participant being scored came from. They also were not given scores or videos from the assessments that took place before the study.

  o AST
    o Treatment involved the suit combined with an intensive protocol.
    o Suits were sized based on anthropometric measurements
    o Protocol included:
      ▪ Massage before fitting suit
      ▪ Passive stretching of all extremities
      ▪ Putting on the suit with body properly aligned, extremities in restricting positions
      ▪ Rigorous exercises to be performed while in the suit
    o Sessions also included:
      ▪ Walking activities, including walking on various terrains
      ▪ Sit-to-stand movements
      ▪ Standing activities (playing with a ball)
      ▪ Jumping on a trampoline
      ▪ Climbing stairs and ladders
    o Treatment was provided by Russian physical therapists (Russia was where suits were obtained and fitted from) that were considered experts in AST. Specific details of why the therapists were considered experts or if any training was performed were not included in the article.

  o NDT
    o Although this was not the primary intervention investigated in the study, this intervention is pertinent to this CAT.
    o Since there is often not a strict protocol that therapists follow during NDT, the authors chose to take a different route. They determined what the treatments goals were to be, including improved stability while sitting and the ability to walk or ride tricycles. A structured program was then created for each child based on this. The program included:
      ▪ Passive stretching of lower extremities
      ▪ Spasticity reduction techniques
      ▪ Facilitation of more normal movement patterns during functional activity
        • Functional activity included walking, sit-to-stand movement, and sitting on a bench
    o Treatment was provided by physical therapists trained in NDT (both basic and advance courses) with a minimum of seven years of experience. Details on training and experience were not given.

**Dependent Variables and Outcome Measures**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Outcome measure</th>
<th>Data type</th>
<th>Scoring</th>
<th>ICF level</th>
<th>Framework Term</th>
</tr>
</thead>
</table>

Prepared by Danielle Cowan, OTS (December 9, 2010). Available at www.UWLAX.EDU/OT
Gross motor function in five dimensions: Lying and rolling, crawling and kneeling, sitting, standing, and walk-run-jump activities

<table>
<thead>
<tr>
<th>Gross Motor Function Measure-66 (GMFM-66)</th>
<th>Ordinal</th>
<th>Higher score indicates higher motor function</th>
<th>Impairment level variable</th>
<th>Client Factors: Body Functions: Neuromusculoskeletal and movement-related functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Motor Ability Estimator (computer scoring system)</td>
<td></td>
<td>Lowest possible score on each item: 0 (does not initiate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highest possible score on each item: 3 (completes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NT: Not tested</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ambulatory function/mobility efficiency

<table>
<thead>
<tr>
<th>Mechanical efficiency index</th>
<th>Interval</th>
<th>Higher score indicates increased efficiency</th>
<th>Impairment level variable</th>
<th>Client Factors: Body Structures: Structures related to movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Client Factors: Body Functions: Cardiovascular, haematological, immunological, and respiratory system function: Cardiovascular system function</td>
</tr>
</tbody>
</table>

Main Findings

Hypothesis 1:
- There will be more significant improvements in motor function and mechanical efficiency after one month of AST than after one month of NDT.
Hypothesis 2:
- There will be more significant improvements in motor function and mechanical efficiency after 10 months of AST than after NDT.

<table>
<thead>
<tr>
<th>Effect Size of Motor Function:</th>
<th>Baseline</th>
<th>1 Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.24 (Medium)</td>
<td>Mean(SEM)</td>
<td>Range</td>
</tr>
<tr>
<td><strong>NDT</strong></td>
<td><strong>Motor Function (GMFM-66 Scores)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>52.2 (3.0)</td>
<td>36.4-72.6</td>
</tr>
<tr>
<td></td>
<td>*SD: 10.39</td>
<td>*SD: 10.39</td>
</tr>
<tr>
<td></td>
<td>Mechanical Efficiency Index</td>
<td>11.1 (5.0)</td>
</tr>
<tr>
<td></td>
<td>*SD: 17.32</td>
<td>*SD: 18.36</td>
</tr>
<tr>
<td><strong>AST</strong></td>
<td><strong>Motor Function (GMFM-66 Scores)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>54.0 (4.0)</td>
<td>36.4-85.2</td>
</tr>
<tr>
<td></td>
<td>*SD: 17.32</td>
<td>*SD: 14.20</td>
</tr>
<tr>
<td></td>
<td>Mechanical Efficiency Index</td>
<td>12.7 (3.5)</td>
</tr>
<tr>
<td></td>
<td>*SD: 12.12</td>
<td>*SD: 14.20</td>
</tr>
</tbody>
</table>

*Value not calculated in study, was done independently by student.

- GMFM-66 mixed-effects p:
  - Time= 0.006
  - Group= 0.73
  - Interaction= 0.38
• Mechanical efficiency index mixed-effects $p$:
  o Time = 0.013
  o Group = 0.86
  o Interaction = 0.28

**Original Authors’ Conclusions**

**Hypothesis 1:**
- There will be more significant improvements in motor function and mechanical efficiency after one month of AST than after one month of NDT.
  - This hypothesis was rejected.

**Hypothesis 2:**
- There will be more significant improvements in motor function and mechanical efficiency after 10 months of AST than after NDT.
  - This hypothesis was rejected.

**Overall conclusions:**
- The authors stated that overall, all participants improved significantly based on GMFM-66 scores and mechanical efficiency indexes after 1 month of either intensive treatment (significant time-effect). From this, they concluded that their results support the theory that children with CP can more quickly acquire motor abilities with intensive therapy (either NDT or AST).
- The authors also stated that regardless of these results, none of the participants actually experienced any change in their GMFCS status after the study was completed.
- Regarding mechanical efficiency, the authors saw a trend towards improvement (or a reduction in the metabolic cost) after AST when compared with NDT.
- When comparing results, the authors concluded that the significant improvements seen in GMFM-66 scores in the AST group are related to improvements in mechanical efficiency.
- Final conclusions that the authors made included that AST can improve mechanical efficiency without improving in gross motor skills.

**Validity**
- PEDro Score: 7
  o This article had good validity with a PEDro score of a 7 out of a possible 10. Aspects that make it strong include the following:
    - Participants were randomly assigned to the two groups and both groups were similar at baseline regarding demographic and anthropometric factors.
    - The physiotherapist who performed the outcome measures was blinded to which treatments the participants received as well as what their status was prior to treatment.
    - Outcome measures were obtained from all of the participants in the study, and there were no dropouts, all participants completed the entirety of the study and received the treatment or control condition as allocated in the methods sections.
    - The authors did state between-group statistics of the results, for all outcomes. Also, results were presented in mean, standard error, and range of scores.
  o Allocation was not concealed (item 2).
  o There was no blinding of participants or of the therapists administering the therapy (items 4 and 5).

**Interpretation of Results**
The results showed that between AST and NDT, not one treatment approach is more effective than the other. However, an outcome of interest was that both treatments did elicit improvement in gross motor function. This needs to be taken in perspective because none of the participants actually improved in GMFCS status indicating that only small gains were made. Intensive therapy was shown to be more effective than the regular amounts of therapy that the children were receiving prior to the study. Overall, one cannot deem that NDT is more effective than NDT, as both therapies were similarly effective.

**Summary/Conclusions (Take Away Message)**

Overall, this study did find that both NDT and AST significantly improved gross motor control of children with cerebral palsy over time. However, the study also found that there was no significant difference when doing a between groups comparison. This means that one type of treatment was not superior to the other.

One must be careful when generalizing this information to their clients. A power analysis was not performed and the sample size used was relatively small. Also, the participants and therapists were all from Israel, which could have an impact on how NDT was performed. NDT training may be different in Israel than it is here in America. In general, NDT is a technique that varies widely and the study did not specify the techniques and strategies they specifically used on the children. Therefore, the results cannot be generalized to all NDT being used as the strategies may vary. It would be important in future studies to be more clear about how the training was performed and how NDT was administered. It may also be more helpful to deconstruct the therapy and look for what specifics of NDT helped and what specifics did not help.