

## IMPROVEMENT OF FINE MOTOR SKILLS IN CEREBRAL PARETIC PATIENTS<sup>7</sup>

### Authors:

Réka Tóth  
University of Debrecen

E-mail address of the first author:  
tothreka038@gmail.com

### Lectors:

Zsuzsanna Vekerdy-Nagy  
University of Debrecen

Annamária Balóné Jóna  
University of Debrecen

Veronika Schéder  
University of Debrecen

Katalin Mező  
University of Debrecen

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### Abstract

The aim of this review is to give an overview about the ADL functions in children and young adults with cerebral palsy and our planned studies. For measuring the ADL functions, the Functional Independence Measure (FIM) and the Functional Independence Measure for Children (WeeFIM) will be used. The hand functions will be analysed by the Quality of Upper Extremity Skills Test (QUEST). The fine motor skills of the hand will be revealed by using the selected subtests of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). Based on the outcomes of the measures, a complex therapeutic protocol will be implemented including the elements of the ergo and manual therapy, proprioceptive neuromuscular facilitation (PNF), and piano therapy. It is anticipated that the complex therapy adapted to individual needs will result in significant improvement in the ADL functions in disabled children and young adults.

**Keywords:** children, cerebral paresis, hand, ADL, FIM, BOT2, ICF, physiotherapy

**Disciplines:** physiotherapy, neurology, rehabilitation

### Absztrakt

Az összefoglaló közlemény célja, hogy áttekintést adjon idegrendszeri sérüléssel, speciálisan cerebrális paresissel élő gyermekek és fiatal felnőttek ADL funkcióiról. Az ADL funkciók mérésére a Functional Independence Measure-t (FIM) ill. annak gyerekekre adaptált változatát (WeeFIM), a kézfunkciók vizsgálatára a Quality of Upper Extremity Skills Test

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<sup>7</sup> The editorial board does not take any responsibility for the English of the papers. Indeed, we made some slight changes but wanted to keep the style of the authors.

(QUEST) használatát tervezzük. A kéz finommotoros funkcióit a Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) releváns alkategóriájának használatával kívánjuk vizsgálni. A továbbiakban figyelembe vesszük az ADL funkciókkal kapcsolatos eredményeket és a páciensek preferenciáit. A mérési eredmények alapján egy komplex terápiás protokollt fogunk kidolgozni, ami ergoterápiás és manuál terápiás elemeket, propioceptív neuromusculáris facilitációt (PNF), és zongora terápiás elemeket foglal magába. Feltételezzük, hogy a személyes szükségletekhez igazított komplex mozgásterápia szignifikáns javulást fog eredményezni az ADL funkciók és az életminőség területén a mozgássérült gyerekeknél és fiatal felnőtteknél.

**Kulcsszavak:** gyerekek, cerebral paresis, kéz, ADL, FIM, BOT2, ICF, fizikoterápia

**Diszciplína:** fizikoterápia, neurológia, rehabilitáció

## **INTRODUCTION**

The impaired activities of daily living (ADL) functions (eating, bathing, dressing, toileting, transferring and continence) significantly alter the quality of life in every age group. In the medical and physiotherapy practice, it is always a major challenge to determine the best treatment for those diseases that affect the quality of life. In neurological diseases, the gross and fine motor skills are frequently affected causing difficulties in the activities of daily living.

### **ADL functions and motor skills**

The normally developing children are able to perform washing/bathing and dressing themselves independently by the age of 5-6. By the age of four, the children are able to eat with a fork and spoon without assistance. With regards to toileting, the age of 3 is taken as a milestone for being toilet trained. Transferring is completely developed by the age of 4 (Choo, 2014). The ADL functions require the well-developed fine motor skills that are not independent of gross motor functions.

Motor skills are essential for moving the body and parts of the body based on the activity of skeletal muscles as effectors. These motor skills are divided into gross and fine motor skills although they cannot be fully separated from each other. In life, individuals learn the gross motor skills first, and these skills become automatic as the years progress.

Gross motor skills help individuals to move and it involves using the large muscles of the body. These skills are vital for everyone. For example, the core muscles stabilize the trunk and this way it is possible to walk, run or to throw a ball.

Fine motor skills mean using the smaller muscles of the hands. It is required in everyday life in order to perform different kinds of tasks or to manipulate objects. Fine motor skills involve the task outcomes and the speed of the different kinds of task performances. It means the precise movement with the hands, which are required for writing using a pen and other similar everyday objects.

For a newborn baby to control body movements is difficult. The infants are unaware of the fact that they have hands. During life, they must learn hand-eye coordination, bilateral integration, hand dominance, hand division and how to manipulate objects. The proprioception as a sensory process is very important in the motor functions.

Hand-eye coordination means that if an individual switches off one of his organs that helps him to orient or to balance (for example, if one closes his eyes), then it does not cause any problems with coordination.

Bilateral integration involves the two sides of the body, the movements of the upper and lower extremities, and reflex integration. The third one denotes that there are certain reflexes that work in a synergism. All of these three functions are based on the vestibular system.

Hand dominance signifies that all of the children use one of their hands more often. For example, a ball is always thrown with the same hand as is cutlery held with the same hand. Furthermore when writing, the pen or pencil is held in the preferred hand. Hence, the dominant hand is slightly more skilled than the other hand.

Hand division is somewhat similar to hand dominance. It refers to how the children divide the tasks between their two hands. If they only use one of their hands, then the other one can remain weaker and not so skilled.

Proprioception is also a very important function. There are numerous proprioceptors in our body which are mainly found in the joints, ligaments, and between the muscles' and the tendons' connection. On our hands, there are proprioceptors on the muscles called the lumbrical muscles. These muscles have many functions. They help to stabilize our fingers, they allow our fingers to do flexion and they play a role in the abduction and adduction movement. These proprioceptors help us to coordinate our movements and prevent falls on bumpy or moving surfaces.

If the children's development is physiological, then in the fourth month they can grasp their own hands. In the sixth month, they play with their big toe and in the seventh month, the radial grasp appears. In the eighth month, they start to use the inferior scissor grasp. In the ninth month, they can grasp objects with their thumb and index finger. By the end of the first year, they can use the pincer grasp, too. These timing points are not always the same, so if there is a slight difference in the development of the child, it is not a very big problem.

During the toddler stage, we can see that the children use one of their hands more frequently so the dexterity of the hands starts to emerge at this point in time. The preschool period is also a big challenge for children. This is because during this time, they have to learn how to tie their shoelaces, how to put on or take off their clothes, how to use cutlery and eat by themselves. There are good toys that can improve the children's fine motor skills such as building from blocks/cubes or playing with puzzles.

### **Cerebral palsy**

Among the neurological disorders, one of the most common in childhood is cerebral palsy. Cerebral palsy (CP) is the most frequent neurological disorder in childhood with an occurrence of 2.11 per 1000 live births (Oskoui et al, 2013). The CP is defined by Bax and his coworkers (2005, p.2.) as "a group of disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, cognition, communication, perception, and/or behaviour, and/or by a seizure disorder."

Cerebral palsy affects almost the whole human organism. Children who suffer from this disease have abnormal muscle tone. Furthermore, their development is slower than a healthy child's. We can see asymmetry at how they use the two sides of the body. They have both fine and gross motor dysfunctions and they start to speak later than an average child. Besides, they also have difficulties with visual-hand control and their movements are not coordinated.

Himmelman et al (2006) studied the motor functions and accompanying neurological disorders in children with cerebral palsy. 411 children diagnosed with CP aged from 4 to 8 years were involved in the study. They concluded that the motor functions and the type of CP together determine the total impairment load.

### **Activity preferences and assessment of ADL functions in patients with cerebral palsy**

Lemmons et al (2014) studied the activity preferences in hand-related ADL functions in different age groups. The movement components necessary for performance were also defined. It was found that the most preferred aims in the age group of 2.5-5 are related to dressing, and in the age group of 6-11 dressing and eating. However, in the age group of 12-19 in addition to the previous aims mentioned, the preferred goal is typing on a keyboard and playing computer games.

James, Ziviani and Boyd (2013) reviewed 8 measures to reveal the impairments in ADL functions in children and adolescents. The Functional Independence Measure for Children (WeeFIM) is one of the recommended items.

The WeeFIM is suitable for measuring the ADL functions in the age range of 6 months to 21 years (Wong et al, 2002). In older patients, the Functional Independence Measure (FIM) is generally used in clinical practice.

These tests contain parameters about self-care, sphincter control, transfer, locomotion, communication and special cognition. If the patients can perform the task and they are independent 7 points are added, while 6 points are given if they need some kind of device to assist them in the different kinds of tasks. If the patients need supervision, then we give them 5 points. 4 points are given for the patients requiring minimal assistance and 3 points for patients who can do the tasks with moderate assistance. For maximum assistance 2 points are given, whereas 1 point is given for total assistance. In the WeeFIM the minimal total point is 18, whereas the maximum is 126.

Both the FIM and the WeeFIM measure the same main parameters although in the FIM there are more little components below the main ones.

### **Assessment of hand functions**

The Quality of Upper Extremity Skills Test (QUEST) is used mainly for those children who suffer from cerebral palsy. It can be used to measure dissociated movements at all the joints of the upper extremity, the quality of different kind of grasp, weight bearing at different positions, and protective extension (DeMatteo et al, 1992).

### **Assessment of fine motor skills**

The revised version of Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) (Bruininks and Bruininks, 2005) is frequently used by clinicians, physiotherapists and other professionals to measure the motor performance of the children with neurological disorders (Deitz, Katin and Kopp, 2007). The test contains 8 subtests including fine motor precision, fine motor integration, manual dexterity, bilateral coordination which are in the focus of our interest. It can be administered to individuals from 4 to 21 years of age.

#### *The International Classification of Functioning, Disability and Health (ICF)*

The International Classification of Functioning, Disability and Health (ICF) was provided by the World Health Organisation (WHO) in 2001 as a system which offers a good frame for diagnostic procedures, therapy and monitoring. The ICF gives a good possibility to describe the categories of individual functionality and disability. The version adapted to the children is also available: International Classification of Functioning, Disability and Health, Child and Youth Version, (ICF-CY). The ICF measures the functionality and disability in a multi-dimensional model: impairment of the body function, activity and participation are studied. Relevant subtests can be selected and combined for determination of the individual state. The use of ICF categories can complete the description of the body functions and can reveal finer details. Use the ICF/ICF-CY requires well-trained professionals.

**Tools for improvement of fine motor skills**

The most frequently used methods are as follows: ergo (occupational) therapy, manual therapy, constraint induced movement therapy (CIMT), mirror therapy, proprioceptive neuromuscular facilitation (PNF), and piano therapy.

Ergo (or occupational) therapy is a method that helps patients to improve their everyday functions. With ergo therapeutic method, we can practice different kind of grasps and it helps us how to release subjects and how to make our movement more purposeful. More accurately, it involves using objects including plugs, cutlery and door handles (Paskaleva et al, 2010). This therapy is said to be effective with children with fine motor delays (Case-Smith, 2000). According to this method, we should use the child's sensory motor performance components in order to improve the functional performances. The therapists engage in playful tasks with the children thereby improving the youngsters' fine motor skills.

Manual therapy helps us to make our muscles more pliable and helps our movements. Manual therapy can incorporate stretching as well, which is also quite effective at making our muscles more flexible and helps us to warm up before the therapy. With stretching, muscle injuries can also be avoided.

Giuliani and his co-workers (2006) examined the efficiency of constraint induced movement therapy (CIMT) in stroke patients. They found a great improvement in arm motor functions in patients where they used the CIMT compared to the control group. According to the CIMT, the therapists tie the dexterous hand and this way the patient needs to use the clumsier hand. The method can be used in cerebral palsy also.

Mirror therapy is a special type of therapy. During this therapy, patients do tasks in front of a mirror. It is very useful for the patients because they are able to see what they are doing, and it is a type of visual feedback for the brain. The mirror is used as visual stimuli for the brain through moving a body part and watching it at the same time. Consequently, it is easier to learn movements using this therapy. Donghoon and his colleagues (2016) proved this method's efficiency with patients who had a stroke. They combined this method with motor tasks on the upper extremity.

Proprioceptive neuromuscular facilitation (PNF) is a special physiotherapeutic method, which has an effect on the different kind of loco motor system, especially in cerebral palsy (Levitt, 1966). This method works possible with the help of the different proprioceptors. These proprioceptors can be found in the joints, ligaments as well as between the muscles and tendons. PNF improves coordination, increases muscle strength, provides better stamina, makes the muscles more pliable, increases the range of movement, normalizes the rhythm and speed of the movement and the muscle tone itself. The patients should do different kinds of movement patterns cornerwise and have to overtake the resistance applied by the physiotherapist. This method is very useful because it can be used with numerous clinical aspects with excellent results.

Piano therapy is a new and special kind of therapeutic method. According to a study, the piano lesson's effectiveness was examined with a professional piano teacher with children who have cerebral palsy. The aim was to improve their fine motor skills. This therapy lasted for 18 months with every session being 35-40 minutes in duration. The movement and accuracy of the fingers as well as the speed of pressing the piano keys was examined. The music was a motivating factor for all the children as they could remain very enthusiastic during the therapy (Lampe et al, 2015).

**Study design for our studies**

The aim of our study is to reveal the ADL functions in the patients with cerebral palsy, to obtain information about the goal of rehabilitation preferred by the patients at a wide range of ages and to improve the fine motor skills in order to improve the hand-related ADL functions.

It is a long term plan covering some semesters with more than one physiotherapy students. In every year 2-3 students write thesis work in this field which are not connected to each other. Our idea is to give a frame for these studies, so the students can work individually but along a common conception. In this case the results may be evaluated together and hopefully offer sufficient amount of data for evidence based conclusion.

The studies will be carried out in the Immanuel Home in Debrecen, where 82 patients ranging in age from 6-30 spend their daily hours. The Immanuel Home is an educational and social institution for disabled children and young adults. Approximately half of the participants suffer from cerebral palsy. In addition, there are children with genetic diseases, multiple handicapped children and children with diseases caused by infection or trauma. They are cared for by a team that includes an ergo therapist, a physiotherapist and a music conductor. The aim of the general physiotherapy is to maintain or develop the motor skills.

To measure the ADL functions, we will use the Functional Independence Measure (FIM) in older children and the WeeFIM in the younger patients. The FIM and WeeFIM tests will be completed by a question prepared by us: which task is the most crucial for the patients/parents to be improved?

These measurements will show us which functions need to be improved the most. According to the results, those children will be selected for further measurements and therapeutic interventions that have poor quality of these functions (the number of participants are estimated 20-30). For further measurements, we will use the test called QUEST (Quality of Upper Extremity Skills Test) and the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) to get more detailed information on the hand-related functions.

On the basis of the outcomes, a target group (at least 10 participants) will be established for the therapeutic intervention oriented to the improvement of hand-related ADL functions. Inclusion criteria will comprise impaired fine motor skills, informed consent from the patient (parents), proper communication skills, and regular attendance at the exercises.

The intervention will include the elements of the ergo therapy, manual therapy, proprioceptive neuromuscular facilitation (PNF), and piano therapy. The professional guide will be available for these methods.

The measurement of the ADL functions, the quality of the upper extremity skills and the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2) will be performed once again at the end of the therapeutic programme.

Our short term plan for the next academic year is to perform the measurements according to the ADL function in the whole population attending the Immanuel Home, and to select the group for further investigation related to the hand function and fine motor skills. The therapeutic interventions will be performed after the screening of the needs and possibilities.

The results of our study are expected to be used routinely in the Immanuel Home, and hopefully, in a wider field in the care of disabled individuals.

## REFERENCES

- Bax, M., Goldstein, M., Rosenbaum, P., Leviton, A., Paneth, N., Dan, B., Jacobsson, B., & Damasio, D. (2005). Proposed definition and classification of cerebral palsy, April 2005. *Developmental Medicine and Child Neurology*, 47, 571-576.
- Bruininks, R. H., & Bruininks, B. D. (2005). *BOT-2, Bruininks-Oseretsky Test of Motor Proficiency Second Edition*. Minneapolis, Minnesota: Pearson Assessments
- Case-Smith, J. (2000). Effects of Occupational Therapy Services on Fine Motor and Functional Performance in Preschool Children. *American Journal of Occupational Therapy*, 54, 372-380.

- Choo, S. (2014). Assessment of activities of daily living in infants and children with developmental disabilities. *The Singapore Family Physician*, 40, 50-54
- Deitz, J.C., Kartin, D., & Kopp, K. (2007). Review of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2). *Physical & Occupational Therapy in Paediatrics*, 27, 87-102.
- DeMatteo, C., Law, M., Russell, D., Pollock, N., Rosenbaum, P., & Walter, S. (1992). QUEST: Quality of Upper Extremity Skills Test. Hamilton, ON: McMaster University, CanChild Centre for Childhood Disability Research.
- Donghoon, K., Kyoungbo, L., Kyunghoon, K., Sukmin, L., & Youlim, K. (2016). Effects of mirror therapy combined with motor tasks on upper extremity function and activities daily living of stroke patients. *Journal of Physical Therapy Science*, 28, 483-487.
- Himmelmann, K., Beckung, E., Hagberg, G., & Uvebrant, P. (2006). Gross and fine motor function and accompanying impairments in cerebral palsy. *Developmental Medicine and Child Neurology*, 48, 417-423.
- James, S., Ziviani, J., & Boyd, R. (2014). A systematic review of activities of daily living measures for children and adolescents with cerebral palsy. *Developmental Medicine and Child Neurology*, 56, 233-244.
- Lampe, R., Thienel, A., Mitternacht, J., Blumenstein, T., Turova, V., & Alves-Pinto, A. (2015). Piano training in youths with hand motor impairments after damage to the developing brain. *Neuropsychiatric Disease and Treatment*, 11, 1929-1938.
- Lemmens, R.J., Janssen-Potten, Y.J., Timmermans, A.A., Defesche, A., Smeets, R.J., & Seelen, H.A. (2014). Arm hand skilled performance in cerebral palsy: activity preferences and their movement components. *BioMed Central Neurology*, 19, 14:52.
- Levitt S. (1966). Proprioceptive neuromuscular facilitation techniques in cerebral palsy. *Physiotherapy*, 52, 46-51.
- Oskoui, M., Coutinho, F., Dykeman, J., Jetté, N., & Pringsheim, T.A. (2013). An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. *Developmental Medicine and Child Neurology*, 55, 509-19.
- Bax M, Goldstein M, Rosenbaum P, Leviton A, Paneth N, Dan B, Jacobsson B, Damasio D.
- Paskaleva, R., Mihaylova, R., Mollova, K., & Petrova, M. (2010). Features of kinesitherapy and ergotherapy for children with cerebral damage. *Trakia Journal of Sciences*, 8, 346-348.
- Wolf, S.L., Winstein, C.J., Miller, J.P., Taub, E., Uswatte, G., Morris, D., Giuliani, C., Light, K.E., Nichols-Larsen, D., & EXCITE Investigators. (2006). Effect of Constraint-Induced Movement Therapy on Upper Extremity Function 3 to 9 Months After Stroke. *Journal of the American Medical Association*, 296, 2095-2104.
- Wong, V., Wong, S., Chan, K., Wong, V. (2002). Functional Independence Measure (WeeFIM) for Chinese children: Hong Kong Cohort. *Pediatrics*, 109, E36.

