

SHORT THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PHD)

**Developmental possibilities of gait, cognitive and upper limb  
functions during rehabilitation of subacute and  
chronic stroke patients**

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Supervisor: Dr. Zoltán Jenei Ph.D.



UNIVERSITY OF DEBRECEN  
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## **Developmental possibilities of gait, cognitive and upper limb functions during rehabilitation of subacute and chronic stroke patients**

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The Examination takes place at Lecture Hall of Bldg. Medical Rehabilitation and Physical Medicine, Faculty of Medicine, University of Debrecen.

28th August 2020 11 a.m.

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The Ph.D. Defense takes place at the Lecture Hall of Bldg. A, Department of Internal Medicine, Faculty of Medicine, University of Debrecen.

28th August 2020 13 p.m.

## Literature review

In our country stroke is the second leading cause of death, it gives 10% of the total mortality. 40-50 thousand people get a stroke yearly and in every ten minutes a person is taken to a hospital because of stroke. In Hungary, the predominant percentage of stroke cases, 85-90%, has ischaemic origin. In order to decrease mortality in the future and at the same time to provide the proper quality of life, the improvement and effectiveness of the rehabilitation services followed by the acute care are key. The complex rehabilitation started as early as possible, the recovery of functions and independence result in the improvement of the quality of life and the decrease of the health care costs.

The most common impairments because of stroke are gait disturbances, the functional problems of the upper limb, speech, cognitive and social skills. Because of the complex functional impairments, stroke makes the everyday activities more difficult.

After stroke, getting into an institution dealing with rehabilitation and taking advantage of the possibilities of brain plasticity (including spontaneous and therapy related changes), we can put faith in the improvement of the independence.

Adaptive and maladaptive plastic reorganizational processes take place in the same time after brain damage and so as in case of stroke. The goal of the therapies is to tip out the equilibrium towards the adaptive processes. Animal and clinical studies underpin the fact that movement results increase the level of neurotrophins (brain-derived growth factor, insulin-like growth factor, nerve growth factor). All this makes it possible what has been proven in adult clinical studies: synaptogenesis and dendritic growth are of outstanding importance in brain plasticity.

Therapies have two different effects on brain plasticity. Neurofacilitation techniques are in the first group, where in order to increase reorganization and improvement of body functions, stimuli from the periphery is given. Conventional physiotherapy (CP) based on Bobath Concept and proprioceptive neuromuscular facilitation of the therapies used in our country appertain to this category. Furthermore, the role of aerobic training (AT) in the facilitation of plastic changes is vividly investigated. One direction of research studies is the effect of AT on cognitive functions. According to the published data, AT improves executive functions, working memory and processing speed. Until now, results are controversial in connection

with the intensity of AT. In addition, there are few good quality publications in connection with AT effects on cognitive functions. During low intensity training there is a BDNF level increase in hippocampus, plus the level of synaptophysin-I, the number of dendritic branches and the neurons in the affected side dentate gyrus are increased.

The other approach is that through learning processes we can affect the central nervous system directly. Sensorimotor integration and Hungaricum Pető method = conductive education (CE) belong to this group, of those available in Hungary. As the result of the pedagogic development, the method has influence not only on movement functions, but on learning skills and social functions. The conductor can deliver individual and group sessions for stroke patients. The disadvantage of the previous publications regarding the conductive education for adult stroke patients is that the quality of the publications is very different, researchers made semi-objective measurements and they are not suitable for determining the level of evidence.

Robot-assisted therapy also belongs to the therapies proven to develop brain plasticity, often accompanied by the virtual reality of simple computer games, making it possible for the problem-oriented tasks to be performed with high repetition. The effectiveness of repetitive training during occupational therapy sessions is confirmed by evidences. Furthermore, adaptive reorganization can also be facilitated by functional electrical stimulation, the anode end of direct current stimulation and high-frequency repetitive transcranial magnetic stimulation.

The customized service consistent with the rehabilitation plan is provided by the team, the basic members of which are the patient himself/herself and his/her relative, a PRM (physical rehabilitation and medicine) specialist, a physiotherapist, a (neuro)psychologist, an occupational therapist, a nurse, a speech therapist, an orthotic specialist and a social worker.

The method of Goal Attainment Scale (GAS) helps the preparation of the rehabilitation plan and the patient-centred service. GAS is an ordinal scale where we can define five or six levels. The patient chooses a problematic function which is important for him/her and its severity is assessed at the time of admission. We place this at baseline level. After this, the patient formulates what he/she would like to reach in connection with this function, which is placed on the level of the target to be achieved on the scale. Numbers symbolize the levels which ease statistical calculations. The distribution of the levels is different in case of the five- (-2-2) or six- (-3-2) level versions. So far, the traditional five-level version has been used for stroke patients. As in this group of patients a small degree of functional improvement may

be successful and may require the expression of a potentially worsening function, it can only be expressed by six-level GAS. The feasibility of six-point GAS in stroke patients has not been tested before. The six-point scale has been used before in pediatric rehabilitation and orthopedic areas.

## Research questions

For the purpose of the improvement of upper-, lower limb, cognitive functions and ultimately the independence of stroke patients, there are several therapeutic strategies, but according to Cochrane reviews, their evidence levels are doubtful, mainly because of the quality problems of the articles included. During our studies we have chosen research areas where there are unanswered questions.

Our goal was to examine the effect of the different therapies (for which the active participation of the patient is needed) aiming to improve brain plasticity (CE and AT) through the improvement of lower limb (gait) and cognitive functions in subacute and chronic stroke patients.

In another study we tested the feasibility of a scale that seems to be effective, customized and which has motivating power through goal setting (six-point GAS), while among other therapies aiming to improve plasticity, a task-oriented repetitive training session for the upper limb was provided for the patients.

Our research in subacute and chronic stroke patients has the following specific goals.

1. The evaluation of the effectiveness of the aerobic training added to conventional physiotherapy on cognitive functions in stroke patients.
2. The evaluation of the feasibility of the six-point Goal Attainment Scale in the rehabilitation of stroke patients with special regard to upper limb functional goals.

3. The evaluation of the effectiveness of the conductive pedagogic method added to conventional physiotherapy with regard to gait function improvement.

## Methods

We did our research in the Debrecen University Clinical Center Medical Rehabilitation and Physical Medicine Clinic by involving subacute (3-6 months after stroke) and chronic (6 months poststroke) stroke patients. After testing the congruity of the inclusion and exclusion criteria, basic data were collected, the patient examination was done „lege artis medicinae”, the rehabilitation plan was set, and the instrumental assessments were done. At the end of the therapeutic sessions, re-assessments were done. Statistical calculations were carried out with nonparametric tests (inside group analysis: Wilcoxon signed rank test; between group analysis: Wilcoxon rank sum test).

## The evaluation of the effectiveness of the aerobic training added to conventional physiotherapy on cognitive functions after stroke in the subacute and chronic phase

A randomized pilot study was done through a draw and as a result study and control groups were created.

During assessment and reassessment, the patient endurance was measured by ergospirometry.

Out of the outcome measures we chose tests often used in previous studies to assess cognitive functions, those were: three tests of the Wechsler Adult Intelligence Scale fourth edition: coding and symbol search subtests for processing speed test and digit span subtest for working memory measurement. Besides, the cognitive part of Functional Independence Measure Scale (FIM) (an outcome scale for the assessment of global functions) was also applied. During AT, blood pressure and heart rate were measured.

Therapies for study group: CP (consisted of 30 minutes of resistance training, exercises for improving the active range of motion, gait pattern and balance function), occupational therapy (30 minutes of task-oriented repetitive training, with 70-100 times of repetition, 3-4 tasks/occasion), stationary bicycle (30 minutes). Control group took part in the first two therapies only, but the CP was 60 minutes long, so the length of the therapies was the same for both groups.

## The evaluation of the feasibility of the six-point Goal Attainment Scale in the rehabilitation of stroke patients with special regard to upper limb functional goals

The feasibility study of the six-point GAS was done by involving the same patient group as before, but during the analysis we treated them as one group. During goal setting, upper limb goals were chosen, furthermore upper limb and hand functions were assessed with two standard scales: Action Reach Arm Test (ARAT) and Fugl-Meyer upper extremity test (FM-UE). Goals chosen by the patients and the content of the two tests were afterwards linked to the domains of the International Classification of Functioning, Disability and Health (ICF). The therapies were detailed above. To judge feasibility, we analyzed the test results and



the following aspects: demand, acceptability, implementation, practicality, adaptation, integration, expansion, and efficacy.

The evaluation of the effectiveness of the conductive pedagogic method added to conventional physiotherapy with regard to gait function improvement in stroke patients

We carried out a randomized, controlled clinical study. A study group (CP+CE) and a control group (CP) were formed. In order to compare the two groups, pairs were formed according to the same poststroke stadium, Brunnstrom stadium and Functional Ambulation Categories. Patients in the study group took part in CP sessions (3x20 minutes). The participants of the other group, where beside CP, CE techniques were also provided, took part in a longer therapy (45-minute individual and 30-minute group sessions).

During assessment and reassessment, the objective gait parameters were monitored by a special treadmill with sensors. Among semi-objective outcome measures three-minute walk test, Timed up and go test, FIM, at some predefined muscle strength and tone were measured, for balance testing Fugl-Meyer balance subtest was used, the range of motion was measured at lower limb joints and some domains characterize stroke patient functions of ICF were chosen.

## **New scientific results of the thesis**

The evaluation of the effectiveness of the aerobic training added to conventional physiotherapy on cognitive functions after stroke, in the subacute and chronic phase

The scientific results of the effect of AT on cognitive functions are controversial, in addition these trials applied moderate and high intensity training (clinical trials with stroke patients), albeit chronic stroke patients are not able to do training at this intensity according to our experience.

35 of the included 37 participants finished the study: 19 in study group, 16 in control group. There were nonsignificant differences in patient characteristics in the two groups. The novel result of our study is that the positive effect of AT was present in all of the three cognitive tests (independently of the cardiovascular inefficiency) in the study group. Improvement

in coding and symbol search was significant ( $p=0,003$  and  $p=0,041$ , respectively). While in control group only symbol search was significant ( $p=0,006$ ).

### The evaluation of the feasibility of the six-point Goal Attainment Scale in the rehabilitation of stroke patients with special regard to upper limb functional goals

The uniqueness of the study is that feasibility of six-point GAS was not yet measured in stroke patients. Originally 35 were included, analysis was done with 34 patients. Most of the participants ( $n=22$ ) were in chronic poststroke phase. One of the strengths of the study is that the content of the six-point GAS was compared with the ARAT and FM-UE tests (all the three outcome measures changed significantly,  $p<0.001$ ). Regarding six-point GAS, patients were able to reach better results in their goals than the baseline level in 74,59 % of the goals. Linking the content of the three outcome measures to the ICF domains proved that GAS is more sensitive and has the potential to express individualized goals better compared with the standard tests. The fact that some patients took part in AT as well, was not influenced the upper limb results. The beneficial qualities of the six-point GAS was also proven by the predefined feasibility aspects.

The evaluation of the effectiveness of the conductive pedagogic method added to conventional physiotherapy with regard to gait function improvement in stroke patients

Our study is unique because the effectiveness of CE has not been tested before with objective outcome measures among stroke survivors. With this study we contributed to broaden of the evidences of CE. Previously, the effectiveness of CE was tested with semi-objective tests. Furthermore, there is no article from the Hungarian author regarding this theme.

17 of the included 20 participants finished the study: 8 in the CP group, 9 in the CE+CP group. There was no significant difference in the patient characteristics data. Though according to our treadmill measurements there were nonsignificant changes in the objective gait parameters neither inside, nor between groups, the results obtained reflect the stroke specific changes of gait disturbances. As for the semi-objective outcome measures, there were significant changes only in CE group: in FIM motor subtest, muscle strength in hip extensors, knee flexors, ankle plantar and dorsiflectors, maintaining a body position and long-distance gait pattern functions of the ICF.

## Discussion

The stroke rehabilitation become more and more important worldwide because of the increasing number of the survivors. These patients have different functional problems. The development of these functions is the main task of the rehabilitation specialists in order to provide the social participation, reintegration and good quality of life for the patient. During our clinical studies we examined the changes in the cognitive functions as a result of aerobic training, the feasibility of the six-point Goal Attainment Scale and its advantages in the connection with upper limb functions and the effect of conductive pedagogic method applied beside conventional physiotherapy on gait functions in subacute and chronic stroke patients.

The first and the last study was randomised, controlled, where there was no significant difference between the two groups.

However, in the first study, in the group where low intensity aerobic training was done, significant difference was found in the Wechsler Adult Intelligence Scale's processing Speed/Coding subtest.

The six-point Goal Attainment Scale seemed to be feasible in connection with the upper limb goals of stroke patients according to the criteria.

The conductive pedagogic method added to conventional physiotherapy proved to be effective on gait functions in point of more outcome measures.

## Certified publication list



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Candidate: Adél Debreceni-Nagy  
Neptun ID: LICYS7  
Doctoral School: Doctoral School of Clinical Medicine

### List of publications related to the dissertation

- 1. Debreceni-Nagy, A.**, Horváth, J., Nagy, S., Bajusz-Leny, Á., Jenei, Z.: Feasibility of six-point goal attainment Scale among subacute and chronic stroke patients.  
*Int. J. Rehabil. Res. [Epub ahead of print]*, 1-6, 2019.  
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*Int. J. Rehabil. Res.* 42 (3), 275-279, 2019.  
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- 3. Debreceni-Nagy, A.**, Angeli, C., Högye, Z., Bajusz-Leny, Á., Réti, G., Nagy, A. C., Jenei, Z.: Effectiveness of the conductive educational approach added to conventional physiotherapy in the improvement of gait parameters of poststroke patients.  
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### List of other publications

4. **Debreceni-Nagy, A.:** Célalgoritás a gyermekrehabilitációban.  
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7. **Debreceni-Nagy, A.**, Vekerdy, Z.: Célskála alkalmazása a rehabilitációs medicinában.  
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9. Vekerdy, Z., **Debreceni-Nagy, A.:** Teammunka a rehabilitációs medicinában: a célképzés és a képzés jelentősége.  
*Rehabilitáció.* 26 (2), 120-124, 2013.

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