ORIGINAL PAPERS

Adv Clin Exp Med 2013, **22**, 2, 261–272
ISSN 1899–5276

Emilia Mikołajewska

The Value of the NDT-Bobath Method in Post-Stroke Gait Training

Wartość metody NDT-Bobath w poudarowym usprawnianiu chodu

Rehabilitation Clinic, Military Clinical Hospital No. 10 and Polyclinic, Bydgoszcz, Poland

Abstract

Background. Stroke is perceived a major cause of disability**,** including gait disorders. Looking for more effective methods of gait reeducation in post-stroke survivors is one of the most important issues in contemporary neurorehabilitation.
Objectives. Following a stroke, patients suffer from gait disorders. The aim of this paper is to present the outcomes of a study of post-stroke gait reeducation using the NeuroDevelopmental Treatment-Bobath (NDT-Bobath) method.
Material and Methods. The research was conducted among 60 adult patients who had undergone ischemic stroke. These patients were treated using the NDT-Bobath method. These patients' gait reeducation was assessed using spatio-temporal gait parameters (gait velocity, cadence and stride length). Measurements of these parameters were conducted by the same therapist twice: on admission, and after the tenth session of gait reeducation.
Results. Among the 60 patients involved in the study, the results were as follows: in terms of gait velocity, recovery was observed in 39 cases (65%), in terms of cadence, recovery was observed in 39 cases (65%), in terms of stride length, recovery was observed in 50 cases (83.33%).
Conclusions. Benefits were observed after short-term therapy, reflected by measurable statistically significant changes in the patients' gait parameters (**Adv Clin Exp Med 2013, 22, 2, 261–272**).

Key words: rehabilitation, ischemic stroke, NDT-Bobath, gait parameters, gait training, gait analysis.

Streszczenie

Wprowadzenie. Istnieje potrzeba poszukiwania i badania nowych, bardziej skutecznych form rehabilitacji poudarowej.
Cel pracy. U pacjentów po udarze dochodzi do zaburzeń funkcji chodu. Celem pracy była ocena wyników rehabilitacji prowadzonej metodą NDT-Bobath dla dorosłych z zakresu reedukacji chodu ocenianego za pomocą czasowo-przestrzennych parametrów chodu.
Materiał i metody. Badana grupa składała się z 60 pacjentów po udarze niedokrwiennym mózgu podanych rehabilitacji metodą NDT-Bobath dla dorosłych. Parametry chodu (szybkość chodu, tempo i długość dwukroku) były mierzone u każdego pacjenta przez tego samego terapeutę dwukrotnie: przy przyjęciu (przed terapią) oraz po ostatniej sesji terapii.
Wyniki. Wśród pacjentów objętych badanie uzyskano następujące wyniki: w szybkości chodu zaobserwowano poprawę w 39 przypadkach (65%), w tempie chodu zaobserwowano poprawę w 39 przypadkach (65%), w długości dwukroku zaobserwowano poprawę w 50 przypadkach (83,33%).
Wnioski. W krótkim czasie zostały zaobserwowane istotne statystycznie pozytywne zmiany stanu zdrowia pacjentów, odzwierciedlone przez zmiany parametrów chodu w wyniku prowadzonej terapii (**Adv Clin Exp Med 2013, 22, 2, 261–272**).

Słowa kluczowe: rehabilitacja, udar niedokrwienny, NDT-Bobath, parametry chodu, usprawnianie chodu, analiza chodu.

Stroke is perceived a major cause of disability, including gait disorders. It is currently estimated that 15 million people suffer from stroke each year worldwide [1, 2]. Annual mortality due to stroke is estimated at 5 million worldwide [3]. The annual incidence of stroke in Poland is 70,000 per year [1].

The incidence rate of stroke in Poland is reported to be 125/100,000 among females, and 177/100,000 in males [1–6]. Approximately 60% of stroke survivors suffer from motor deficits. Moreover, 50% of post-stroke patients need the assistance of other people in their daily activities. Most of them have limited ablity to work and/or to participate in social life [6, 7]. Thus, the effects of a stroke can be perceived as multidimensional, impacting the medical, social and economic areas of the patient's life. Research in the area of the rehabilitation of patients following ischemic stroke is therefore of great importance, since ischemic stroke constitutes 80–85% of all strokes [2–6]. Therapeutic success in this area will no doubt have a positive impact on the effectivity of post-stroke rehabilitation in general.

The ability to perform basic activities of daily life (ADLs) and locomotion in post-stroke survivors may be compromised. One of the possible effects of stroke is gait impairment, significantly influencing stroke survivors' mobility and the ADLs. Thus, looking for more effective methods of gait reeducation for post-stroke patients is one of the most important issues in contemporary neurorehabilitation.

The NeuroDevelopmental Treatment-Bobath (NDT-Bobath) method is currently perceived as one of the leading methods in the rehabilitation of adult stroke surviviors [8–14]. A distinctive feature of the method is that the NDT-Bobath method does not constitute a set of exercises. It is a whole concept, including a multidimensional analysis of functional deficits and cause-effect relationships. A key role in the method is played by the neural plasticity of the central nervous system (CNS): its ability to be changed (in both structure and functions) in response to stimuli such as various activities, changes in the environment, etc. In hemiplegic patients, the therapy aims at integrating the affected and unaffected sides of the body, including increased stimulation and motivation of the patients to use the affected side. The following key skills are considered essential for therapists using the NDT-Bobath method: a problem-solving approach, the ability to analyze human movement (both normal and abnormal), the ability to evaluate and analyze the cause of the limitation(s) and the goals of the therapy, the ability to set short-term and long-term plans for the therapeutic intervention.

A deep knowledge of biomechanics, neuroanatomy, and neurophysiology must underlie all of these.

Unfortunately, widespread use of the NDT-Bobath method has not been accompanied by an increase in the number of research studies on the outcomes of post-stroke rehabilitation using this method [15–19], including gait reeducation [20–22]. The existing research is insufficient. A review of fifteen clinical trials performed by Paci [15] and a case study by Lennon [20] still raise controversy. Some general guidelines for further investigations have been formulated, such as the necessity to develop new diagnostic tools better fitted to the goals of the Bobath approach (motor performance, etc.). An additional criterion for further studies should be the therapists' thorough knowledge of the state-of-the-art NDT-Bobath method for adults. Moreover, the therapists' knowledge and experience should be supported by internationally recognized certification [15, 17].

The aim of this paper is to present the outcomes of a study of post-stroke gait reeducation using the NDT-Bobath method. The hypothesis is that NDT-Bobath method is effictive in gait reeducation in adult patients following ischemic stroke.

Material and Methods

The research was conducted among 60 patients. All of them had been admitted to rehabilitation after suffering an ischemic stroke. Patients were eligible for inclusion if they were aged 18 years or more and had suffered a cerebrovasculat accident (CVA) from 6 weeks to 3 years earlier, as confirmed by medical records.

The study was approved by the Bioethical Committee of the University of Medical Sciences in Poznań, Poland. It was conducted in accordance with the rules of Good Clinical Practice and the Helsinki Declaration. Informed consent was obtained from each patient before they were enrolled in the study.

A clinical summary of the patients is presented in Table 1.

During the study patients who had undergone ischemic strokes were treated using NDT-Bobath method. The therapist's knowledge of the NDT-Bobath method was confirmed by international certificates:

1) the International Bobath Instructors Training Association (IBITA) recognized Basic Course in "Assessment and Treatment of Adults with Hemiplegia – The Bobath Concept",

2) the IBITA recognized Advanced Course "Assessment and Treatment of Adults with Neurological Conditions – The Bobath Concept", and

3) the European Bobath Tutors Association (EBTA) "NDT-Bobath Basic Course in the Assessment and Treatment of Children".

The therapist also had several years of experience in neurorehabilitation ward. This ensured

Table 1. Clinical summary of the patients

Tabela 1. Charakterystyka pacjentów objętych badaniem

	Patients (Pacjenci) (n = 60)
Side of paresis: (Strona niedowładu) Left (L) Right (P)	 30 (50%) 30 (50%)
Sex: (Płeć) Females (K) Males (M)	 30 (50%) 30 (50%)
Age [years]: (Wiek [w latach]) Min Max SD (Odchylenie standardowe) Mean (Wartość średnia) Median (Mediana)	 42 86 10.3 65.7 68
Age brackets [years]: (Przedziały wiekowe [w latach]) 38–47 48–57 58–67 68–77 78–87	 2 (3.33%) 13 (21.67%) 13 (21.67%) 27 (45%) 5 (8.33%)
Time lapse since cerebrovascular accident (CVA): (Czas po incydencie udarowym) 6 weeks – 6 months (od 6 tygodni do 6 miesięcy) > 6 months – 1 year (pow. 6 miesięcy do roku) > 1 year – 2 years (pow. roku do dwóch lat) > 2 years – 3 years (pow. 2 lat do trzech lat)	 20 (33.33%) 13 (21.67%) 14 (23.33%) 13 (21.67%)

a sound basis and therapeutic consistency using the NDT-Bobath method described in the aforementioned article by Paci [15, 17].

The participants received ten 30-minute physical therapy sessions based on the NDT-Bobath concept over a two-week period. Therapy lasting two weeks (five days a week) provides research outcomes that are easy to compare with other studies. Measurements of spatio-temporal gait parameters (gait velocity, cadence and stride length) were conducted by the same therapist twice: on admission, and after the tenth session of gait reeducation. The author's own method of gait analysis, described in [23], is based on:

– gait recording (using a digital video camera),
– visual gait evaluation,
– measurement of spatio-temporal gait parameters: gait velocity, cadence and stride length,
– calculating values using the Clinical Gait Analyzer free software developed by Chris Kirtley, MD (USA), and their interpretation.

All the data were analyzed with Statistica version 9 software. The results were calculated as mean, median, minimum value (Min), maximum value (Max) and standard deviation (SD). Wilcoxon's test was used to compare scores. The level of significance was set at 0.05.

Results

The study focused on searching for statistically significant changes reflecting recovery in gait velocity, cadence and stride length, which are often impaired in stroke survivors. The results are shown in Tables 2 through 6.

In the study, among the 60 patients involved, the results were as follows:

In terms of gait velocity, recovery was observed in 39 cases (65%), relapse was observed in 9 cases (15%), and a lack of (measurable) change was observed in 12 cases (20%).

In terms of cadence, recovery was observed in 39 cases (65%), relapse was observed in 16 cases (26.67%), and a lack of (measurable) change was observed in 5 cases (8.33%).

In terms of stride length, recovery was observed in 50 cases (83.33%), relapse was observed in 4 cases (6.67%), and a lack of (measurable) change was observed in 6 cases (10%).

The following terms need to be clarified:

"Recovery" means that after the therapy there was a significant difference (favorable change) as compared to the results at the beginning of the therapy.

"Relapse" means that after the therapy there was a significant difference (unfavorable change) as compared to the results at the beginning of the therapy.

"No change" means that after the therapy there was no significant difference (measurable change) as compared to the results at the beginning of the therapy.

The statistical analysis of the results for gait velocity depending on side of paresis provided the following evidence of the efficacy of the therapy (Table 4a):

In the group of patients with right-sided paresis, statistically significant recovery ($p < 0.001$) was observed. The mean increased from 0.5 m/s in the first measurement to 0.7 m/s in the second measurement; the median increased from 0.5 m/s to 0.6 m/s.

In the group of patients with left-sided paresis, statistically significant recovery ($p = 0.007$) was observed. The mean increased from 0.515 m/s in

Table 2. Statistical analysis of the study results for the whole group of patients

Tabela 2. Wyniki analizy statystycznej w badaniu dla całej grupy pacjentów

	n	Mean (Wartość średnia)	Median (Mediana)	Min	Max	SD (Odchylenie standardowe)
First examination (Badanie pierwsze)						
Gait velocity [m/s] (Szybkość chodu) [m/s]	54	0.496	0.500	0.100	0.900	0.215
Cadence [steps/min] (Tempo) [kroków/min]	54	78.1	83.5	28.0	103.0	19.0
Stride length [m] (Długość dwukroku) [m]	54	1.481	1.540	0.500	2.220	0.438
Second examination (Badanie drugie)						
Gait velocity [m/s] (Szybkość chodu) [m/s]	58	0.659	0.650	0.100	1.600	0.397
Cadence [steps/min] (Tempo) [kroków/min]	58	84.8	90.5	14.0	151.0	31.5
Stride length [m] (Długość dwukroku) [m]	58	1.730	1.820	0.610	2.860	0.591

P values of differences between data before and after rehabilitation (Wilcoxon's test): gait velocity: $p < 0.001$, cadence: $p = 0.004$, stride length: $p = 0.004$.
Wartości p różnic między danymi przed i po rehabilitacji (test Wilcoxona): prędkość chodu: $p < 0{,}001$; tempo: $p = 0{,}004$, długość dwukroku: $p = 0{,}004$.

Table 3. Study results for the whole group of patients

Tabela 3. Wyniki badania dla całej grupy pacjentów

	Gait speed [m/s] (Szybkość chodu) [m/s]		Cadence [steps/min] (Tempo) [kroków/min]		Stride length [m] (Długość dwukroku) [m]	
	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	60	100	60	100	60	100
Recovery (Poprawa)	39	65	39	65	50	83.33
Relapse (Pogorszenie)	9	15	16	26.67	4	6.67
No change (Brak zmian)	12	20	5	8.33	6	10

Table 4. Results for gait velocity depending on: a) side of paresis, b) sex, c) age, d) time elapsed since the CVA

Tabela 4. Wyniki badania dotyczące szybkości chodu w zależności od: a) strony porażenia, b) płci, c) wieku, d) czasu od incydentu udarowego

a)

	Right (P)		Left (L)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	21	70	17	56.67
Relapse (Pogorszenie)	2	6.67	8	26.67
No change (Brak zmian)	7	23.33	3	10

b)

	Female (K)		Male (M)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	15	50	24	80
Relapse (Pogorszenie)	7	23.33	2	6.67
No change (Brak zmian)	8	26.67	4	13.33

c)

	38–47 years (38–47 lat)		48–57 years (48–57 lat)		58–67 years (58–67 lat)		68–77 years (68–77 lat)		78–87 years (78–87 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	2	100	13	100	13	100	27	100	5	100
Recovery (Poprawa)	2	100	7	53.85	7	53.85	22	81.48	1	20
Relapse (Pogorszenie)	0	0	4	30.77	2	15.39	2	7.41	1	20
No change (Brak zmian)	0	0	2	15.39	4	30.77	3	11.11	3	60

d)

	6 weeks – 6 months (od 6 tyg. do 6 miesięcy)		> 6 months – 1 year (powyżej 6 miesięcy do 1 roku)		> 1 year – 2 years (powyżej 1 roku do 2 lat)		2 years – 3 years (powyżej 2 lat do 3 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	17	100	12	100	17	100	14	100
Recovery (Poprawa)	11	64.71	7	58.33	12	70.59	9	64.29
Relapse (Pogorszenie)	3	17.65	1	8.33	2	11.77	3	21.43
No change (Brak zmian)	3	17.65	4	33.33	3	17.65	2	14.29

the first measurement to 0.628 m/s in the second; the median increased from 0.5 m/s to 0.7 m/s.

The statistical analysis of the results for gait velocity in the study depending on sex provided the following evidence of the efficacy of the therapy (Table 4b):

In the group of females statistically significant recovery ($p = 0.023$) recovery was observed. The mean increased from 0.448 m/s in the first measurement to 0.539 m/s in the second; the median did not change (0.500).

In the group of males statistically significant recovery ($p < 0.001$) was observed. The mean increased from 0.544 m/s in the first measurement to 0.77 m/s in the second; the median increased from 0.5 m/s to 0.75 m/s.

For the purposes of statistical analysis by age, the whole group was divided into two subgroups using the median (68 years). The statistical analysis of the results for gait velocity depending on age provided the following evidence (Table 4c):

In the group of patients younger than 68 years, statistically significant recovery ($p = 0.001$) was observed. The mean increased from 0.516 m/s in the first measurement to 0.7 m/s in the second. The median increased from 0.5 m/s to 0.65 m/s.

In the group of patients aged 68 years or more, statistically significant recovery ($p = 0.001$) was observed. The mean increased from 0.470 m/s in the first measurement to 0.608 m/s in the other; the median increased from 0.5 m/s to 0.65 m/s.

The statistical analysis of the results for gait velocity depending on how much time had elapsed since the patient's CVA provided the following evidence (Table 4d):

In the group of patients whose CVA had occurred 6 weeks to 6 months earlier, statistically significant recovery ($p = 0.025$) was observed. The mean increased from 0.507 m/s in the first measurement to 0.594 m/s in the second; the median increased from 0.507 m/s to 0.594 m/s.

In the group of patients whose CVA had occurred 6 months to 1 year earlier, statistically significant recovery ($p = 0.028$) was observed. The mean increased from 0.427 m/s in the first measurement to 0.658 m/s in the second; the median increased from 0.5 m/s to 0.65 m/s.

In the group of patients whose CVA had occurred 1 year to 2 years earlier, statistically significant recovery ($p = 0.003$) was observed. The mean increased from 0.547 m/s in the first measurement to 0.771 m/s in the second; the median increased from 0.600 m/s to 0.700 m/s;

In the group whose CVA had occurred 2 years to 3 years earlier, statistically significant recovery ($p = 0.049$) was observed. The mean increased from 0.475 m/s in the first measurement to 0.592 m/s in the other; the median did not change (0.500 m/s) (Table 4d).

The statistical analysis of the results for cadence depending on the side of paresis provided the following evidence (Table 5a):

In the group of patients with right-sided paresis, statistically significant recovery ($p = 0.003$) was observed. The mean increased from 76.4 steps/min in the first measurement to 86.0 steps/min in the second; the median increased from 84.0 steps/min to 93.0 steps/min.

The statistical analysis of the results for cadence depending on sex yielded the following evidence (Table 5b):

In the group of males, statistically significant recovery ($p = 0.003$) was observed. The mean increased from 79.1 steps/min in the first measurement to 89.5 steps/min in the second; the

Table 5. Distribution of cadence results depending on: a) side of paresis, b) sex, c) age, d) time elapsed since the CVA

Tabela 5. Wyniki badania dotyczącee tempa chodu w zależności od: a) strony porażenia, b) płci, c) wieku, d) czasu od incydentu udarowego

a)

	Right (P)		Left (L)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	22	73.33	17	56.67
Relapse (Pogorszenie)	6	20	11	36.67
No change (Brak zmian)	2	6.67	2	6.67

b)

	Female (K)		Male (M)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	17	56.67	24	80
Relapse (Pogorszenie)	8	26.67	2	6.67
No change (Brak zmian)	5	16.67	4	13.33

c)

	38–47 years (38–47 lat)		48–57 years (48–57 lat)		58–67 years (58–67 lat)		68–77 years (68–77 lat)		78–87 years (78–87 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	2	100	13	100	13	100	27	100	5	100
Recovery (Poprawa)	2	100	7	53.85	8	61.54	20	74.08	2	40
Relapse (Pogorszenie)	0	0	6	46.15	3	23.08	5	18.52	2	40
No change (Brak zmian)	0	0	0	0	2	15.39	2	7.41	1	20

d)

	6 weeks – 6 months (od 6 tyg. do 6 miesięcy)		> 6 months – 1 year (powyżej 6 miesięcy do 1 roku)		> 1 year – 2 years (powyżej 1 roku do 2 lat)		2 years – 3 years (powyżej 2 lat do 3 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	17	100	12	100	17	100	14	100
Recovery (Poprawa)	10	58.82	8	66.67	13	76.47	8	57.14
Relapse (Pogorszenie)	4	23.53	3	25	4	23.52	4	28.57
No change (Brak zmian)	3	17.65	1	8.33	0	0	2	14.29

median increased from 83.0 steps/min to 94.5 steps/min.

The statistical analysis of the results for cadence depending on age yielded the following evidence (Table 5c):

In the group of patients aged 68 years and older, statistically significant recovery ($p = 0.008$) recovery was observed. The mean increased from 74.6 steps/min in the first measurement to 80.5 steps/min. in the second; the median increased from 81.0 steps/min to 87.5 steps/min.

The statistical analysis of the results for cadence depending on the time elapsed since the patient's CVA yielded the following evidence (Table 5d):

In the group of patients who had undergone CVA 1 year to 2 years earlier, statistically significant recovery ($p = 0.049$) was observed. The mean increased from 85.2 steps/min in the first measurement to 96.9 steps/min in the second; the median increased from 84.0 steps/min to 104.0 steps/min.

The statistical analysis of the results in the area of stride length depending on the side of paresis provided the following evidence (Table 6a):

Among patients with right-sided paresis, statistically significant recovery ($p < 0.001$) recovery was observed. The mean increased from 1.428 m in the first measurement to 1.726 m in the second; the median increased from 1.38 m to 1.54 m.

Among patients with left-sided paresis, statistically significant recovery ($p < 0.001$) was noted. The mean increased from 1.538 m in the first measurement to 1.735 m in the second; the median increased from 1.54 m to 1.82 m.

The statistical analysis of the stride-length results depending on sex provided the following evidence (Table 6b):

In the group of females, statistically significant recovery ($p < 0.001$) was observed. The mean increased from 1.315 m in the first measurement to 1.511 m in the second; the median increased from 1.33 m to 1.54 m;

Among the males, statistically significant recovery ($p < 0.001$) was noted. The mean increased from 1.647 m in the first measurement to 1.935 m in the second; the median increased from 1.67 m to 1.91 m.

The statistical analysis of the stride-length results depending on age providedthe following evidence (Table 6c):

Among patients younger than 68 years, statistically significant recovery ($p < 0.001$) was observed in stride length. The mean increased from 1.473 m in the first measurement to 1.764 m in the second; the median increased from 1.540 m to 1.764 m.

In the group of patients aged 68 years and older, statistically significant recovery ($p = 0.001$) was noted. The mean increased from 1.491 m in the first measurement to 1.689 m in the second; the median increased from 1.43 m to 1.67 m.

The statistical analysis of stride length depending on the time elapsed since the patient's CVA yielded the following evidence (Table 6d):

In the group of patients whose CVA had taken place 6 weeks to 6 months prior to the therapy, statistically significant recovery ($p = 0.003$) was observed in stride length. The mean increased from 1.501 m in the first measurement to 1.623 m in the second; the median increased from 1.605 m to 1.745 m.

In the group of patients whose CVA had taken place 6 months to 1 year earlier, statistically significant recovery ($p = 0{,}012$) was observed in stride length. The mean increased from 1.407 m in the first measurement to 1.705 m in the second; the median increased from 1.43 m to 1.605 m.

In the group of patients who had undergone their CVA 1 year to 2 years earlier, statistically significant recovery ($p = 0.001$) was observed in

Table 6. Distribution of results for stride length depending on: a) side of paresis, b) sex, c) age, d) time elapsed since the CVA

Tabela 6. Wyniki badania dotyczące długości dwukroku w zależności od: a) strony porażenia, b) płci, c) wieku, d) czasu od incydentu udarowego

a)

	Right (P)		Left (L)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	25	83.33	26	86.67
Relapse (Pogorszenie)	1	3.33	2	6.67
No change (Brak zmian)	4	13.33	2	6.67

b)

	Female (K)		Male (M)	
	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	30	100	30	100
Recovery (Poprawa)	23	76.67	27	90
Relapse (Pogorszenie)	2	6.67	2	6.67
No change (Brak zmian)	5	16.67	1	3.33

c)

	38–47 years (38–47 lat)		48–57 years (48–57 lat)		58–67 years (58–67 lat)		68–77 years (68–77 lat)		78–87 years (78–87 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	2	100	13	100	13	100	27	100	5	100
Recovery (Poprawa)	2	100	11	84.62	10	76.92	25	92.59	2	40
Relapse (Pogorszenie)	0	0	0	0	2	15.39	1	3.70	1	20
No change (Brak zmian)	0	0	2	15.39	1	7.69	1	3.70	2	40

d)

	6 weeks – 6 months (od 6 tyg. do 6 miesięcy)		> 6 months – 1 year (powyżej 6 miesięcy do 1 roku)		> 1 year – 2 years (powyżej 1 roku do 2 lat)		2 years – 3 years (powyżej 2 lat do 3 lat)	
	number of patients	%	number of patients	%	number of patients	%	number of patients	%
Number of patients (Liczba pacjentów)	17	100	12	100	17	100	14	100
Recovery (Poprawa)	14	82.35	9	75	16	94.12	11	78.57
Relapse (Pogorszenie)	2	11.77	0	0	0	0	2	14.29
No change (Brak zmian)	1	5.88	3	25	1	5.88	1	7.14

stride length. The mean increased from 1.506 m in the first measurement to 1.856 m in the other; the median increased respectively from 1.54 m to 1.82 m.

Discussion

Human physiological gait is a very complex and fluid set of movements, requiring synchronous activity of several body systems: muscular, sensory, visual, vestibular, auditory, cerebellar and basal ganglia. Impairments observed in post-stroke patients – loss of muscle strength, motor control, tone, balance, sensation, perception, etc. – may significantly influence their walking abilities. The ways these deficits combine is influenced by many causes, such as the place and extent of damage and the individual (neuro)physiological abilities. The resulting gait deficits can have a severe effect on the patient's quality of life. Therefore, the amount and type of post-stroke gait training is one of the most important issues within post-stroke rehabilitation, leading scientists and clinicians to search for the most effective approach. The NDT-Bobath method is perceived as one of the most promising, but the amount of evidence is not currently sufficient. The consequences may be very significant, even in the area of the patients' subjective quality of life: Using a method commonly perceived as more effective may increase the patients' motivation and family support.

The results of the current study show that the NDT-Bobath method may be considered an effective approach to gait reeducation in adult ischemic-stroke surviviors. The changes observed changes in the patients' gait parameters as a result of the therapy were statistically significant and favorable. The relapses observed in the study may be the result of a particular aspect of the NDT-Bobath method: NDT-Bobath therapists have to pay particular attention to gait quality as a foundation for the next stages of the therapy. This is one of the central principles of gait re-education according to the NDT-Bobath method: Full gait re-education entails paying particular attention to gait quality, especially during the first stages of the therapy, and only then paying particular attention to achievements in spatio-temporal gait parameters.

In the study group, many different deviations from physiological gait patterns were observed, depending on various factors, such as the level of paralysis/paresis. Two gait patterns were predominant:

- hemiplegic gait:

– a pathological tilt in the frontal plane towards the unaffected side;

– the weight load on the unaffected leg;

– during the swing phase, the paretic leg is in abduction, the knee in extension and the foot in plantar flexion;

– during the stance phase, a lack of full foot-floor contact (toes and metatarsus only);

– during both the swing and stance phases, the pelvis rises on the affected side.

- high-stepping gait:

– a lack of pathological tilt in the frontal plane;

– during the swing phase, high knee rising occurs;

– the foot is in plantar flexion,

– during the stance phase, a loud sound of the foot hitting the floor is audible.

Relapses in the measured spatio-temporal gait parameters mainly reflect a decrease in gait velocity due to a significant increase in gait quality as observed in the video recordings. This increase in gait quality would probably be reflected in faster increas-

es in spatio-temporal gait parameters during further rehabilitation. The NDT-Bobath method treats gait quality, physiological gait and the "normalization" of movement patterns as very important determinants of post-stroke recovery. The methodology presented in this article improves the possibilities for observing gait quality changes like these, because digital video recordings allow for replay, slow motion and frame-by-frame analysis. No doubt more detailed measurements can be achieved only by using advanced gait analysis systems, e.g. Vicon, but the use of these advanced methods may be not always possible, since they are time-consuming and expensive. The proposed methodology seems to be useful for everyday clinical conditions.

As has been mentioned, there is lack of studies using the NDT-Bobath method for adults to compare with the outcomes of the current study. The favorable findings in this study show the need for both further research and more independent sources of knowledge. This seems necessary to assess the effectiveness of the NDT-Bobath method in the gait re-education of adult post-stroke patients. The Evidence Based Medicine paradigm requires that clinicians should know whether clinical applications of the NDT-Bobath method for adults are an effective way to provide gait reeducation in post-stroke patients.

References

[1] **Błaszczyk B, Czernecki R, Prędota-Panecka H:** Profilaktyka pierwotna i wtórna udarów mózgu (article in Polish). Stud Med 2008, 9, 71–75.
[2] **Członkowska A:** Udar mózgu – perspektywy leczenia w Polsce w świetle osiągnięć światowych (article in Polish). Pol Prz Neurol 2005, 1, 1–7.
[3] **Członkowska A:** Osiągnięcia w zakresie udaru mózgu (article in Polish). Med Dypl 2005, Supl. 17, 5–11.
[4] **Palasik W:** Nowe tendencje w terapii udaru niedokrwiennego (article in Polish). Terapia 2006, 1, 4–8.
[5] Profilaktyka wtórna udaru mózgu. Rekomendacje grupy ekspertów Narodowego Programu Profilaktyki i Leczenia Udaru Mózgu. Neurol Neurochir Pol 2003, supl. 6, 17–43.
[6] **Muren MA, Hütler M, Hooper J:** Functional capacity and health-related quality of life in individuals post stroke. Top Stroke Rehabil 2008, 15, 1, 51–58.
[7] **Murtezani A, Hundozi H, Gashi S et al.:** Factors associated with reintegration to normal living after stroke. Med Arh 2009, 63, 4, 216–219.
[8] **Bromley I:** Tetraplegia and paraplegia: a guide for physiotherapists. 6th edition. Churchill Livingstone, London 2006.
[9] **Davies PM:** Steps to follow: the comprehensive treatment of adult hemiplegia. 2nd edition. Springer, 2000.
[10] **Howle JM:** Neuro-Developmental Treatment Approach. Theoretical foundations and principles of clinical practice. Neuro-Developmental Treatment Association 2003.
[11] **Mayston MJ:** Problem solving in neurological physiotherapy – setting the scene. In: Edwards S – Neurological physiotherapy 2nd edition. A problem solving approach. Churchill Livingstone, London 2001, pp. 4–16.
[12] **Lennon S, Ashburn A:** The Bobath concept in stroke rehabilitation: a focus group study of the experienced physiotherapists' perspective. Disabil Rehabil 2000, 15, 665–674.
[13] **Lennon S, Baxter D, Ashburn A:** Physiotherapy based on the Bobath concept in stroke rehabilitation: a survey within the UK. Disabil Rehabil 2001, 6, 254–262.
[14] **Bobath B:** Adult hemiplegia: evaluation and treatment. 3rd edition. Heinemann Medical Books, London 1990.
[15] **Paci M:** Physiotherapy based on the Bobath Concept for adults with post-stroke hemiplegia: a review of effectiveness studies. J Rehabil Med 2003, 1, 2–7.
[16] **Mikołajewska E:** Przykład terapii chodu metodą NDT-Bobath u pacjenta z hemiplegią (article in Polish). Prakt Fizjoter Rehabil 2010, 11, 16–20.
[17] **Mikołajewska E:** Metoda NDT-Bobath w praktyce klinicznej (article in Polish). Prakt Fizjoter Rehabil 2010, 11, 14–15.
[18] **Mikołajewska E:** Metoda NDT-Bobath w usprawnianiu osób dorosłych: wprowadzenie do metody (article in Polish). Prakt Fizjoter Rehabil 2010, 11, 8–13.
[19] **Mikołajewska E, Radziszewski K:** Metoda NDT-Bobath w rehabilitacji pacjentów dorosłych (article in Polish). Valetudinaria 2007, 1, 51–53
[20] **Lennon S:** Gait re-education based on the Bobath concept in two patients with hemiplegia following stroke. Phys Ther 2001, 3, 924–935.
[21] **Wall JC, Kirtley C:** Strategies for clinical gait assessment. Orthop Phys Ther Clin N Am 2001, 3, 35–54.
[22] **Whittle MW:** Gait analysis: an introduction, Third edition, Butterworth Heinemann, 2002.
[23] **Mikołajewska E:** Analiza chodu pacjentów po udarze mózgu – rozwiązanie własne. Udar Mózgu Problemy Interdyscyplinarne 2010, 1–2, 20–26.
[24] **Kirtley C, Whittle MW, Jefferson RJ:** Influence of walking speed on gait parameters. J Biomed Eng 1985, 4, 282–287.

Address for correspondence:

Emilia Mikołajewska
Rehabilitation Clinic
Military Clinical Hospital No. 10 and Polyclinic
Powstańców Warszawy 5
85-681 Bydgoszcz
Poland
Email: e.mikolajewska@wp.pl
www: http://emikolajewska.netstrefa.eu

Conflict of interest: None declared

Received: 15.07.2011
Revised: 26.06.2012
Accepted: 18.04.2013