

Effect of PNF and NDT Bobath Concepts in Improving Trunk Motor Control in Ischemic Stroke Patients – a Randomized Pilot Study

Efekty rehabilitacji tułowia według koncepcji PNF i NDT Bobath u pacjentów z niedokrwiennym udarem mózgu – randomizowane badanie pilotażowe

Michał Kuciel^{1 (A,B,D,E,F)}, Sebastian Rutkowski^{2 (A,B,C,D,E,F)}, Patryk Szary^{3 (E,F)}, Paweł Kiper^{4 (D,E,F)}, Anna Rutkowska^{2 (A,B,C,D,E,F)}

¹ Department of Neurorehabilitation of the Public Hospital in Chrzanów, Poland

² Faculty of Physical Education and Physiotherapy, Opole University of Technology, Opole, Poland

³ Student scientific circle Descartes' Error, Faculty of Physical Education and Physiotherapy, Opole University of Technology, Opole, Poland

⁴ Laboratory of Neurorehabilitation Technologies, Fondazione Ospedale San Camillo IRCCS, Venice, Italy

Key words

NDT Bobath, PNF, stroke, rehabilitation

Abstract

Introduction: Recently, in various systematic reviews and evidence-based clinical practice guidelines, the efficacy of stroke rehabilitation interventions has been evaluated. Among them, proprioceptive neuromuscular facilitation (PNF) and neuro-developmental treatment (NDT) Bobath turned out to be effective and widely used therapeutic approaches.

Objective of the work: The aim of the study was to evaluate therapeutic effectiveness of the PNF and NDT Bobath concepts for improvement of trunk motor control in patients after ischemic stroke.

Materials and methods: The study consisted of 30 patients up to 3 months after ischemic stroke. Participants were randomly assigned to 2 study groups. Both groups consisted of 15 patients who underwent rehabilitation according to the PNF or NDT Bobath concept. Comparison of the changes in Trunk Impairment Scale (TIS) was the primary outcome.

Results: Analysis of values for the total TIS scale showed statistically significant improvement in both groups. Within-group analysis showed statistical significance among baseline and intermediate measurements, as well as for baseline and final measurements within both groups. Analysis of the total TIS scale indicators between the PNF and Bobath groups showed no statistically significant differences.

Conclusions: Both the PNF and Bobath concepts have proven to be effective in the treatment of posture control and significant improvement has been noted in patients from both groups.

Słowa kluczowe

NDT Bobath, PNF, udar, rehabilitacja

Streszczenie

Wprowadzenie: W ostatnim czasie różne przeglądy literatury i wytyczne dotyczące praktyki klinicznej oparte na dowodach naukowych oceniły skuteczność interwencji w zakresie rehabilitacji udaru mózgu. W badaniach tych oceniono efekty proprioceptywnego torowania nerwowo-mięśniowego PNF oraz koncepcji NDT Bobath, uznając te dwie metody jako skuteczne i szeroko stosowane w podejściu terapeutycznym.

Cel pracy: Celem pracy była ocena skuteczności terapeutycznej koncepcji PNF i NDT Bobath w poprawie kontroli motoryki tułowia u chorych po udarze niedokrwiennym.

The individual division of this paper was as follows: A – research work project; B – data collection; C – statistical analysis; D – data interpretation; E – manuscript compilation; F – publication search

Article received: 16.03.2020; Accepted: 03.09.2021

Please cite as: Kuciel M., Rutkowski S., Szary P., Kiper P., Rutkowska A. Effect of PNF and NDT Bobath Concepts in Improving Trunk Motor Control in Ischemic Stroke Patients – a Randomized Pilot Study. Med Rehabil 2021; 25(2): 4-8. DOI: 10.5604/01.3001.0015.2537

Internet version (original): www.rehmed.pl

This article is licensed under the Creative Commons Attribution-ShareAlike 4.0 International License CC BY-SA (<http://creativecommons.org/licenses/by-sa/4.0/>)

Materiały i metody: Badaniami objęto 30 pacjentów w okresie do 3 miesięcy po udarze niedokrwiennym. Uczestników przydzielono losowo do dwóch grup badanych. Obie grupy składały się z 15 pacjentów poddanych rehabilitacji zgodnie z koncepcją PNF lub NDT Bobath. Podstawowym wynikiem było porównanie zmian parametrów badanych przy użyciu skali TIS (Trunk Impairment Scale).

Wyniki: Analiza wartości łącznej skali TIS wykazała istotną statystycznie poprawę w obu grupach. Analiza wewnątrzgrupowa wykazała istotność statystyczną pomiędzy pomiarem wstępnym i pośrednim wykonanym po 5 dniach oraz pomiędzy pomiarem wstępnym i końcowym w obu grupach. Analiza wartości łącznej skali TIS pomiędzy grupami PNF i Bobath nie wykazała różnic istotnych statystycznie.

Wnioski: Zarówno koncepcje PNF jak i Bobath okazały się skuteczne w terapii kontroli postawy ciała. Nastąpiła znaczna poprawa w badanych parametrach u pacjentów z obu grup.

INTRODUCTION

Stroke accounts for approximately 6 million of deaths worldwide each year¹. It is one of the most devastating neurologic diseases, often resulting in severe disability. The physical consequences of stroke related to motor impairment result in functional reduction of muscle control or mobility. The repercussions of a stroke may also be related with involvement of cognitive impairment². However, other non-cognitive symptoms may also occur following stroke, such as depression, anxiety, apathy, sometimes fatigue, and reduction of quality of life³. Most frequent disorders in patients after stroke result in the formation of hemiparesis or hemiplegia of the upper and lower limb, including trunk control⁴.

The rehabilitation process aims to restore lost function. The correct mechanism of postural control plays an essential role in performance of selective limb movements, thus, the principles of motor control need to be applied to trunk rehabilitation. An example of a diagnostic tool used to assess trunk function may be the Trunk Impairment Scale (TIS)⁴. This scale enables assessment of the patient in a sitting position so it is very useful in the initial period when the patient is not able to stand and/or walk.

Recently, various systematic reviews⁵⁻⁷ and evidence-based clinical practice guidelines⁸ have been implemented to evaluate the efficacy of stroke rehabilitation interventions. Among them, proprioceptive neuromuscular facilitation (PNF) and neuro-developmental treatment (NDT) Bobath are effective and widely used therapeutic approaches^{9,10}. PNF in-

creases performance, along with range of motion. While, the NDT Bobath concept is used to underline the role of postural stability.

OBJECTIVES

The aim of the study was to evaluate therapeutic effectiveness of the PNF and NDT Bobath concepts for improvement of trunk motor control in patients after ischemic stroke.

MATERIAL AND METHODS

Patients

The study consisted of 30 patients up to 3 months after ischemic stroke. The participants were randomly assigned to 2 study groups according to the simple block randomisation technique (computerised random numbers). The randomisation sequence was generated at the beginning of the trial using a computerised block randomisation generator (randomization.com). The allocation sequence was concealed from the principal investigator enrolling patients in sequentially numbered, opaque and sealed envelopes. Single blind randomisation was applied to assessors, assuring blindness to treatment allocation and randomisation procedures. The PNF group comprised 15 patients who underwent rehabilitation according to the PNF concept. The NDT Bobath group included 15 patients subjected to rehabilitation according to the NDT Bobath concept. All patients signed written informed consent prior to their participation in the study. The collection of data was

managed and protected by the research team and hospital staff members. The research was conducted at the Department of Neurorehabilitation of the Public Hospital in Chrzanów, within the period from October 2017 to February 2018. The inclusion criterion were as follows: cardiovascular stability, self-maintaining seated position in a wheelchair, Mini-Mental State Examination score <24, signed consent form to participate in the study. Exclusion criteria included: aphasia, neglect and/or other spatial representation defects, cardiovascular instability, arrhythmias, myocardial infarction, other neurological diseases, chronic inflammatory disease, fractures, amputation. Age, sex, BMI, post-stroke time and hemiplegic-side characteristics were similar for the PNF and Bobath groups ($p < 0.05$).

Outcome measures

The comparison of the changes on the Trunk Impairment Scale was the primary outcome. The TIS was designed to assess static and dynamic balance, as well as coordination of individual trunk sections. According to the ICF, the TIS is used for evaluation at the level of body structure, function and activity. The difficulties of the tasks arise progressively. Examination is based on observation, quantitative and qualitative assessment of motor tasks performed independently by the patient. Individual tasks are performed in the same starting position. Possible scores range from 0 to 23 points. A higher score indicates better trunk performance. Patients must be able to sit independently for 10 seconds to be tested^{4,11}.

Intervention

Participants were assessed via the TIS scale before and after 10 days of the neuro rehabilitation programme (Figure 1). The time of a single therapeutic session with the PNF or Bobath methods was 50 minutes per day. Therapy was performed by a therapist certified in the usage of PNF and Bobath concepts. Patients from both groups were additionally stimulated by standard, 100-minute daily physical therapy, including the following exercises: passive, active-passive, isometric, manual, self-care, motor coordination, respiratory, learning locomotion activities.

The PNF Concept. PNF therapy was carried out in accordance with the philosophy of the method and principles of facilitation, such as: resistance, irradiation and reinforcement, traction and approximation, stretching, movement patterns, manual, verbal, visual contact, correct position and the therapist's body position. The therapy was carried out in sitting and standing, supine and side-lying position. Focus was on the shoulder and pelvic patterns, as well as their combinations in the rotation trajectory. Chopping, lifting, rotation of the upper and lower trunk

were used in work with the trunk. Stabilisation and balance exercises were carried out on a kinesiotherapy couch and rehabilitation ball. The following techniques were applied: rhythmic initiation, dynamic reversals, combination of isotonic, stabilising reversals, rhythmic stabilisation and replication¹².

The NDT Bobath concept. Rehabilitation according to the Bobath Concept for adults was carried out in accordance with the principles, the observance of which ensures effectiveness of this method: time to start the therapy, 24-hour therapy principle, adjustment of assistance degree, pain-free therapy, regulation of muscle tension, therapy taking the affected side into account and balance development. The therapy involved a number of manual interventions through key control points (trunk, pelvis, shoulder, hip and head). Facilitation and assistance techniques were used to support muscle activity as well as inhibition to maintain and control movement and posture. Stretching the contracted muscle structures was performed following the proper sequence of movement: alignment of body segments, muscle activation, support of body weight transfer. The therapy was carried out

in supine and side-lying positions, sit-to-stand and stand-to-sit exercises. The therapy was conducted using the Bobath rehabilitation table, while in sitting position, a rehabilitation ball was used¹³.

Statistical Analysis

The outcome data were collected in an Excel spreadsheet and then transferred to the STATISTICA 13 program for statistical analysis. The normality of sample size distribution was tested with Shapiro-Wilk test. Parametric tests were used. The Fractional ANOVA was applied to assess differences in the value of results. Statistical significance of the results was accepted at $p < 0.05$. The G*power 3.1.7 software was implemented to calculate sample size. Calculation was based on ANOVA, repeated measures, within factors, type I error rate was set at 5% (alpha-level if 0.05), the effect size of the main outcomes was 0.2, and the type II error rate gave 90% power, 1 groups and 8 numbers of measurements, correlations among repeated measures = 0.5, and non-sphericity correction of $\epsilon = 1.0$. Considering a 15% drop-out rate, the appropriate minimum sample size for this study was 30 subjects.

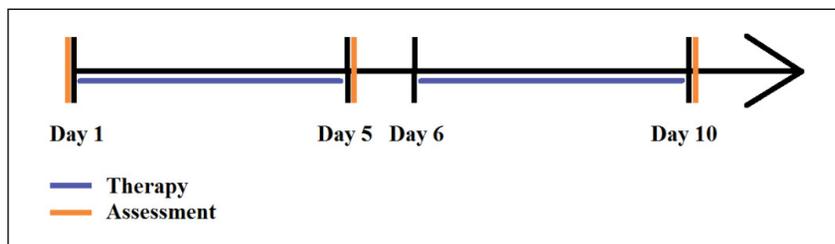


Figure 1
Study course

RESULTS

Analysis of the values for total TIS scale showed a statistically significant improvement in both groups. During the initial assessment, patients from the PNF group scored 9.3 ± 5.4 points in the first measurement, 16.6 ± 3.6 after 5 days

Table 1

Group characteristics	PNF group (n=15) Mean \pm SD	NDT Bobath group (n=15) Mean \pm SD
Age [y]	73.5 \pm 7.6	63.5 \pm 16
Male/female	6/9	10/5
BMI [Kg/m ²]	27.5 \pm 4.0	24.7 \pm 3.2
Post-stroke time [weeks]	5.4 \pm 2.5	5.4 \pm 1.7
Right-sided hemiplegia	7	5
Left-sided hemiplegia	8	10

BMI – Body Mass Index; PNF – Proprioceptive Neuromuscular Facilitation; NDT – Neuro-Developmental Treatment; SD – standard deviation; y – years

of therapy and 21.3 ± 1.6 after 10 days of therapy. Within-group analysis demonstrated statistical significance among baseline and intermediate measurements ($p < 0.005$), and among baseline and final measurements ($p < 0.001$). Analyses did not show significant differences among intermediate and final measurements ($p < 0.182$). While in the initial assessment, patients from NDT Bobath group scored 8.6 ± 7.2 points, 15.5 ± 7.1 after 5 days of therapy and 20.1 ± 4.5 after 10 days of therapy. Within-group analysis showed statistical significance among baseline and intermediate measurements ($p < 0.010$), and among baseline and

final measurements ($p < 0.001$). Analyses did not reflect statistically significant differences among intermediate and final measurements ($p < 0.195$). The analysis of total TIS scale indicators between the PNF and Bobath groups showed no statistically significant differences (Figure 2) (Table 2).

DISCUSSION

In the present study, it has been demonstrated that both the PNF and Bobath methods, used in adults, significantly reduce the deficit of trunk control in patients after ischemic stroke. The results revealed that the

highest improvement appeared in the first week of treatment. This phenomenon continued but to a lesser extent in the second week. The improvement of patients was similar in both training groups. In the literature, the best-known methods for post-stroke neuro-rehabilitation are the PNF and Bobath for adults, particularly when patients are suffering from perception disorders⁹. In this study, the TIS scale was used to assess trunk impairment, the components of which are used to evaluate static and dynamic balance, as well as coordination. According to Verheyden et al., the TIS scale (used for testing in patients with focal brain damage) is highly effective in the assessment of motor trunk impairment among post-stroke patients⁴. The TIS scale provides the opportunity to measure improvement progress and gives guidance for consecutive stages of therapy. According to the authors, improvement of trunk function has impact on breathing, speech, balance, gait and upper limb efficiency. The advantage over other methods is the assessment of a patient in sitting position, i.e. relatively possible in the acute phase following stroke. In the current available literature, a functional approach towards the patient is indicated using the PNF and Bobath methods for adults as key for improving trunk and limb function¹⁴⁻¹⁷. In the research by Ezem et al., the authors evaluated the effects of Bobath and PNF therapy on postural control¹⁷. The Berg and Barthel scales were used for assessment. The patients' improvement period lasted 3 months. Analysis of the results showed statistically significant improvement of postural control in

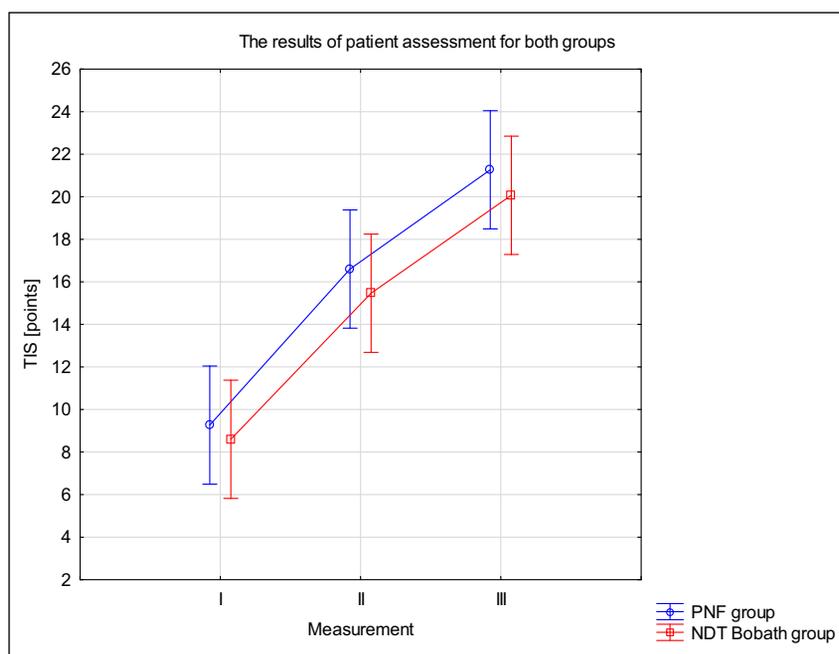


Figure 2
The results of total TIS

PNF – Proprioceptive Neuromuscular Facilitation; NDT – Neuro-Developmental Treatment; TIS – Trunk Impairment Scale; I – baseline assessment; II – intermediate assessment; III – final assessment

Table 2

Results of the TIS scale							
	PNF group Mean ± SD			NDT Bobath group Mean ± SD			Between-group analysis <i>p</i>
Measurement	I	II	III	I	II	III	
Static balance	4.4 ± 2.4	6.0 ± 0.9	6.6 ± 0.5	3.7 ± 3.1	5.3 ± 2.0	6.5 ± 0.7	0.65
Dynamic balance	3.5 ± 2.4	8.0 ± 2.3	9.9 ± 0.3	3.4 ± 2.8	7.0 ± 3.6	8.9 ± 2.5	0.47
Coordination	1.2 ± 0.9	2.6 ± 1.1	4.7 ± 1.2	1.5 ± 1.5	3.1 ± 1.9	4.7 ± 1.5	0.48
Total TIS	9.3 ± 5.4	16.6 ± 3.6	21.3 ± 1.6	8.6 ± 7.2	15.5 ± 7.1	20.1 ± 4.5	0.92

PNF – Proprioceptive Neuromuscular Facilitation; NDT – Neuro-Developmental Treatment; TIS – Trunk Impairment Scale; SD – Standard Deviation; *p* – The Fractional ANOVA test; I – baseline assessment; II – intermediate assessment; III – final assessment

Bobath therapy with respect to PNF. Lederman analysed the impact of central stabilisation as a therapeutic method for various diseases, which confirms the importance of analysing the relationship between trunk stabilisation and various musculoskeletal disorders. The postural control is global, aimed at the cooperation of all muscles responsible for maintaining the body stabilised. Central stabilisation training can lead to the degradation of motor skills and the performance of the trunk muscles. Only physiological movement is capable of learning proper mobility and control of this part of the body¹⁶. Klimkiewicz et al.¹⁸ performed research to evaluate the quality of therapy for functional improvement among patients after stroke. The study group consisted of 120 people, divided into 3 groups, where the first one underwent standard kinesiotherapy and the remaining two, were subjected Bobath or PNF therapy as additional treatment. After 5 weeks, patient improvement was better in the groups where Bobath therapy was introduced in relation to standard kinesiotherapy and kinesiotherapy with PNF¹⁸.

Furthermore, studies are available in which the concepts of PNF and Bobath were compared within the context of improving upper limb function¹⁹ as well as quality of life²⁰. Luke et al. elaborated a literature review on the application of neurophysiological methods in upper limb rehabilitation among stroke patients. With regard to structural disorders, they concluded that exercises according to the Bobath concept provide better effects in reducing pathologically increased muscle tension than PNF techniques¹⁹. In her study, Nadulska assessed quality of life, locomotion and motility in ischemic stroke patients who were treated according to PNF and Bobath concepts for adults. The authors' questionnaire was used to examine 50 patients after a 3-week rehabilitation period.

Before therapy, 66% of patients rated their health condition as bad. After rehabilitation, the percentage of the examined functions decreased: standing up from bed by 12%, independent walking by 17%, maintaining balance by 26%, eating meals by 8%, and walking on the stairs by 12%. The authors have shown that proper kinesiotherapy with neuro-rehabilitation methods significantly improve patient performance, which affects the condition of patients' quality of life²⁰.

CONCLUSIONS

Both the PNF and Bobath concepts appeared effective in the treatment of postural control. For patients in the PNF and NDT Bobath groups, significant improvement was noted. This study did not allow to indicate differences between the PNF and NDT Bobath concepts for postural control treatment.

Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Bai Y., Wang Y.L., Shantsila A., Lip G.Y.H. The Global Burden of Atrial Fibrillation and Stroke A Systematic Review of the Clinical Epidemiology of Atrial Fibrillation in Asia. *Chest* 2017; 152(4): 810-820.
2. Lawrence M., Celestino Junior F.T., Matozinho H.H.S. et al. Yoga for stroke rehabilitation. *Cochrane Db Syst Rev* 2017; 12(12): CD011483.
3. Hackett M.L., Kohler S., O'Brien J.T., Mead G.E. Neuropsychiatric outcomes of stroke. *Lancet Neurol* 2014; 13(5): 525-534.
4. Verheyden G., Nieuwboer A., Mertin J. et al. The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. *Clin Rehabil* 2004; 18(3): 326-334.
5. Pollock A., Baer G., Campbell P. et al. Physical rehabilitation approaches for the recovery of function and mobility following stroke. *Cochrane Database Syst Rev* 2014; 2014(4): CD001920.
6. Veerbeek J.M., van Wegen E., van Peppen R. et al. What Is the Evidence for Physical Ther-

7. De Almeida P.M.D., Santo A., Dias B. et al. Hands-on physiotherapy interventions and stroke and International Classification of Functionality, Disability and Health outcomes: A systematic review. *Eur J Physiother* 2015; 17(3): 100-115.
8. Brosseau L., Wells G.A., Finestone H.M. et al. Ottawa Panel evidence-based clinical practice guidelines for post-stroke rehabilitation. *Top Stroke Rehabil* 2006; 13(2): 1-269.
9. Krukowska J., Bugajski M., Sienkiewicz M., Czernicki J. The influence of NDT-Bobath and PNF methods on the field support and total path length measure foot pressure (COP) in patients after stroke. *Neurol Neurochir Pol* 2016; 50(6): 449-454.
10. Wang J.S., Lee S.B., Moon S.H. The immediate effect of PNF pattern on muscle tone and muscle stiffness in chronic stroke patient. *J Phys Ther Sci* 2016; 28(3): 967-970.
11. Lombardi B., Orioli A., Casavola D., Paci M. The Italian version of the Trunk Impairment Scale: development and psychometric properties. *Eur J Phys Rehabil Med* 2017; 53(4): 516-520.
12. Smedes F., Giacometti da Silva L. Motor learning with the PNF-concept, an alternative to constrained induced movement therapy in a patient after a stroke; a case report. *J Bodyw Mov Ther* 2019; 23(3): 622-627.
13. Vaughan-Graham J., Cott C., Wright F.V. The Bobath (NDT) concept in adult neurological rehabilitation: what is the state of the knowledge? A scoping review. Part II: intervention studies perspectives. *Disabil Rehabil* 2015; 37(21): 1909-1928.
14. Kilinc M., Avcu F., Onursal O. et al. The effects of Bobath-based trunk exercises on trunk control, functional capacity, balance, and gait: a pilot randomized controlled trial. *Top Stroke Rehabil* 2016; 23(1): 50-58.
15. Koh S.B., Park Y.M., Kim M.J., Kim W.S. Influences of elbow, shoulder, trunk motion and temporospatial parameters on arm swing asymmetry of Parkinson's disease during walking. *Hum Mov Sci* 2019; 68: 102527.
16. Lederman E. The myth of core stability. *J Bodyw Mov Ther* 2010; 14(1): 84-98.
17. Ezema C.I., Nweke M.C., Uroko S.U. et al. Bobath versus Proprioceptive Neuromuscular Facilitation in Retraining of Balance and Functional Independence in Activities of Daily Living. *Asian J Res Rep Neurol* 2018; 1(1): 1-15.
18. Klimkiewicz P., Klimkiewicz R., Jankowska A. et al. [An assessment of the functional status in the neurorehabilitation of patients after ischemic stroke]. *Wiad Lek* 2018; 71(2 pt 2): 271-277.
19. Luke C., Dodd K.J., Brock K. Outcomes of the Bobath concept on upper limb recovery following stroke. *Clin Rehabil* 2004; 18(8): 888-898.
20. Nadulska A. Lokomocja i samoobsługa u pacjentów poprzybyłym udarze niedokrwiennym mózguusprawianych kinezoterapeutycznie. *Zeszyty naukowe WSSP*. 2013; 17: 97-106.

Address for correspondence

Sebastian Rutkowski, Ph.D.
Faculty of Physical Education and Physiotherapy,
Opole University of Technology, Opole, Poland
Phone: 0048 507027792; Fax: 0048 77 449 80 00
e-mail: s.rutkowski@po.opole.pl