PANat

PRO-**A**ctive approach to **N**eurorehabilitation
integrating **a**ir splints* and other **t**herapy tools
(* Urias® Johnstone air splints)

Theoretical framework and clinical management of PANat

G. Cox Steck, dipl. Physiotherapist FH, accredited Teacher of PANat
Manuscript reviewed and accepted by the PANat group of teachers March 2009, revised February 2015

2017

Keywords: PRO-Active, hemiplegie, repetitive, Johnstone air splints, self-directed training, low motor recovery, external focus of attention

Summary

This document gives an overview of the theoretical framework and clinical management of PANat.

PANat*:* **P**RO-**A**ctive approach to **N**eurorehabilitation integrating Urias® Johnstone **a**ir splints, and other **t**herapy tools. PANat is a further development of the Johnstone concept. (Margaret Johnstone, FCSP 1919-2006)[1]

In the 1970's Margaret Johnstone FCSP[2-3] pioneered the use of air splints in active training of the hemiplegic limb in the severely impaired stroke patient. This concept has been updated by integrating contemporary principles of movement science and evidence based guidelines into the theoretical and practical framework of PANat. It incorporates low-tech therapy tools in training sessions developed by therapists and ideas of stroke patients to meet their specific needs.

Introduction

Movement is necessary for the individual to participate and enjoy life at home, in the community and workplace.

Many stroke patients with low sensory-motor recovery use the unaffected side to accomplish daily tasks; as such they reinforce failure to integrate the severely impaired hemiplegic limb into meaningful functional activity. As a consequence they may develop learned nonuse, muscle stiffness, contractures and pain.

Studies have shown that using the air splint for repetitive and early stimulation in training the upper hemiplegic limb of the stroke patient, with pronounced muscle weakness or a severely paralyzed arm, can have an effective long lasting effect on motor function[4-5].

Interventions encouraging specific and intensive training with the hemiplegic limbs are made possible by adapting the task and the environment using Urias® Johnstone air splints and other therapy tools (e.g. rocking chairs, PANat-Laptool[1])[6-8] This adapted situation becomes a learning environment, to motivate patients to train selectively control of movements with their severely impaired hemiplegic limbs in a part task activity. This can then contribute over time to a better performance of the agreed upon goal task.

The PRO-Active approach is particularly suited to treat stroke patients with severe sensory motor impairments. Incorporating the principles of PANat using interventions with the hemiplegic limb that are repetitive, intensive and selective in all phases of stroke rehabilitation, is one method with the potential to enhance the mechanism of neuroplasticity and to promote effective and efficient goal-directed motor training. Emphasis is placed on giving the individual an opportunity for self-directed practice with the hemiplegic limbs both during and outside supervised therapy sessions and in the home setting.

[1] www.panat-laptool.ch

Theoretical Framework of PANat

The theoretical framework of PANat is based on the contemporary systems theory of motor control and motor learning[9-16]. This theory suggest that movement patterns emerge as a result of the interaction of multiple processes and include intrinsic (perceptual, cognitive and motor processes within the individual) and extrinsic (interactions between the individual, the task and the environment) factors.

The principles of motor learning and cognitive science, contemporary understanding of the effects of impairments and secondary adaptations, biomechanics of functional activities and the clinical applications of neural plasticity are used to guide the treatment [13].

Air splints and other therapy tools play an important role in training. The exercises, integrating the environment using externally focused instructions[32] and adapting the task allow self-directed practice with the hemiplegic limbs. This problem solving process promotes planning, initiation and execution of the movement sequence with feedback in `hands-off` situations. Self directed practice is therefore on-going in both supervised and unsupervised therapy sessions and at home.

Clinical Management

Clinical management with PANat evaluates the sensory-motor deficits caused by the stroke in the following way:[16]

1. **Function task level:** What intervention goal or activity has been agreed upon with the patient?
2. **Strategy:** What is the movement strategy: restorative or compensational? (Activity/strategy level)
3. **Impairment:** What underlying resources and limitations cause the movement pattern?(sensory, motor and cognitive impairment- level)

The task is analyzed to give a baseline performance level. A training programme is set up incorporating the principles of motor learning[17].

The rehabilitation process is guided by the theory of neuroplasticity[18]. Motivation and commitment is encouraged by focusing on patient specific goal directed activities.
The aim is to encourage repetitive, intensive and targeted training strategies of the hemiplegic side in a set task or part task activity in order to improve movement speed and force in the weaker movement pattern of the hemiplegic limbs. The acquired limb (part-) activity is then immediately linked back to the desired goal of the patient.

Integration of PANat into the rehabilitation process

Integrating PANat into the rehabilitation process will incorporate patient centered goals and use task specific strategies to minimize compensatory movements that occur during functional activity. This is achieved by maintaining muscle flexibility and extensibility, strengthening weak muscles, stimulating muscle activity in a functional context and increasing sensory stimulation[19].

The aim of training is to promote the quality and quantity of activities with the hemiparetic limbs, in uni- /bi-lateral and bimanual movements whilst preventing detrimental compensatory strategies. The choice of activity in the training session is based on the impairments that constrain the patient from performing or completing a task.

Exercises are performed with an increasing number of repetitions within a well structured and mostly closed environment. Variability is introduced into the training plan by changing the complexity of each task, altering the speed and/or the support surface, adjusting the lever effect with air splints or other therapy tools and introducing cognitive elements: e.g. dual tasking.

The appropriate choice and use of air splints and therapy tools may be used to reduce the complexity of multi-joint movements by limiting the ´degree of freedom of movement´[20] of the joint during a specific activity. They promote selective motor control of the affected limb in a meaningful task and provide opportunities for repetition and high intensity training in either individual or group sessions. Finding a balance between ´hands-on´ and ´hands-off´ practice or self-directed training can improve the patient's ability to problem-solve.
The patient's goal and performance must be re-evaluated regularly and the therapeutic interventions modified to ensure they maximise their rehabilitation potential.

Air splints and other therapy tools can be used in all phases of rehabilitation from the acute stage to that of long term management. The emphasis within the training programme will vary from prevention and treatment of adaptive changes to mobilization and recruitment of muscle activity.
Sensory-motor deficits respond slowly to change, but the task and the setting can be structured in a learning environment to stimulate muscle groups needed to accomplish the planned activity.

Conclusion

Effective and efficient training for neurological patients in all phases of rehabilitation with severely impaired sensory-motor control is challenging. One aim of rehabilitation is to achieve effective motor behaviour. It is therefore essential that emphasis is also placed on intensive training and practice with the hemiplegic side throughout the rehabilitation process.

The PRO-Active approach is well incorporated into different phases of the rehabilitation process; it integrates current dynamic systems theory of motor control and motor learning, is evidence based on sensory motor training[4,5,19,28], promotes early involvement of the carers and enables autonomous training.

Motor learning after stroke is a life-long process. Therapists integrating PANat into stroke rehabilitation incorporate strategies that can help to treat motor behaviour with compensatory strategies that occurs during functional tasks. This is achieved on an impairment level by strengthening weak muscles, maintaining muscle flexibility and extensibility, stimulating muscle activity in a functional context and increasing sensory stimulation. On a behavioural level it is achieved by incorporating intensive and repetitive practice using external focus instructions and feedback during ´hands-on/-off´ training. This can be practiced when severe sensory, motor, cognitive and perceptual problems are present.

In addition, the judicious use of the air splints and therapy tools help to reduce the complexity of multi-joint movements during training, and enhance self-controlled and targeted motor control within meaningful activities. Time spent in self-directed training with the hemiplegic limbs in all phases of rehabilitation is increased.
In this approach stroke patients and their carers are encouraged and coached to be proactive in managing their ongoing rehabilitation. All together they address the specific problems or limitations caused by stroke and continuously update the treatment programme.

Practical examples can be looked at

- *In the PANat User guide*
- *in the Poster – presented in Leuven, Belgium in 2006: Promoting `Force to use it`- Strategies of the Hemiplegic Limbs of a Patient with Severely Impaired Motor Control Following Stroke: A Case Report. Cox Steck G., Signer S.*
- *in the article in NOT: "Independent, repetitive arm motor training in severe hemiparesis using the Johnstone Air Splint / Selbsttatiges, repetitives Armmotoriktraining bei ausgepragter Hemiparese mit den Johnstone-Luftpolsterschienen nach PANat* / Traitement autonome et repetitif de la motricite du bras lors d'une hemiplegie prononcee, a l'aide de les attelles gonflables de Johnstone d'apres PANat." Wälder F. 2008*

PRO-Active - What is in the word?

PRO-**A**ctive approach to **N**eurorehabilitation integrating **a**ir splints* and other **t**herapy tools (PANat)
*Urias® Johnstone air splints

PRO-Active: Summarizes the clinical management process of PANat

PRO: The decision making process and clinical reasoning to justify the use of air splints and other therapy tools. (Who, what and why)
Active: The training programme is based upon the principles of contemporary motor learning theories. (How)

P: Pathology
PANat is primarily for stroke rehabilitation. It can also be used for other neurological problems e.g. multiple sclerosis and acquired brain injury. The objective and emphasis of the treatment will depend on the diagnosis.

R: Reframe
The International Classification of Functioning and Health (ICF)[21] is used as the underlying structure to reframe the problems relating to pathology or diagnosis. Activities, participation and quality of life (enablement) and underlying impairments (disablement) are taken into account.
The Upper Motor Neurone Syndrome (UMNS) is used to understand the relationship of primary motor impairments to secondary motor impairments and their relationship to disability after stroke.

O: Objectives
Goal setting is used as a motivational technique to enable the patient to understand why training is necessary [22-23].

- What is the patient's goal?
- What are the therapy objectives to meet this goal?

A: Acquisition of skills
The guidelines for acquisition of skills are integrated in the training programme[15].
Emphasis is placed on the initial or cognitive phase of skill acquisition. Using the severely motor impaired limb to learn a task in an adaptive situation is comparable to learning a new task.

c: carers
An integral part of PANat is the education of carers, family members and friends in understanding and managing the disease process. Through training they develop skills to continue long term rehabilitation in the home and to minimize anxiety, boost confidence and facilitate a successful discharge home and social reintegration. [24].

t: training
Training after damage to the CNS has been shown to improve functional return[15]. The aim is to maximize recovery and prevent compensatory strategies. Integrating PANat into the rehabilitation process enables the therapist to initiate early specific training to activate the appropriate muscle groups in a goal-directed, task oriented context.
Evidence-based guidelines for training are incorporated into the programme[13,16,31].

i: intensity
PANat allows intensive, repetitive, focused, self-directed movements of the hemi paretic arm, and the leg with integration of the trunk by patients with severely impaired motor control. Air splints and tools can be applied by all members of the team and carers. This allows on-going sensory-motor training at weekends or in the home setting. Training can also be practiced in group sessions to encourage efficient use of time and resources[25-26].

v: variation
The air splints and tools are used as a part of the environment to constrain and promote quality of movement in meaningful activities or goals[6-8]. This enables task modification or part task in an activity and makes repetition in multiple variations possible. External focus is used as a form of feedback and instruction.

e: evidence
How effective has the intervention been for these patients? Progress must be continuously re-assessed; the choice of assessment tool will depend on what is being evaluated.

- Quantitative methods measure statistics (how much).
- Qualitative methods assess planning and adaptive behavioural changes[27].
- Individual objective measures show changes in performance over time.

Appendix

Johnstone air splints

The Urias® Johnstone air splints were specifically developed and designed since 1966 for training stroke patients with severely impaired motor control. The choice of air splint or therapy tool is dependent on the level of motor recovery, performance capability of the patient and the specific task or activity.

When training according to PANat-principles ONLY the Urias® Johnstone air splints are recommended for following reasons:

- Margaret Johnstone and other PANat instructors designed a variety of air splints to fit the different training programmes
- The material of the Johnstone air splints is made from flexible PVC (according to European standards), double-layered and transparent. The air splints are designed to be inflated by mouth to a maximum pressure of 40 mm Hg and for training the stroke patient with severely impaired motor control.

For further information of application and some practical examples of use of the air splints, please read the user guide[6].

Self-directed training (´hands-off´)

Self-directed training combined with air splints promotes autonomous practice, incorporating repetitive and intensive training strategies of the hemiplegic limbs in a defined activity. The starting position for any activity must be in accordance with the level of motor recovery and functional ability of the patient.

Therapeutic assistance is required to position the patient, mobilize joints and soft tissue prior to applying air splints ´**hands-on**´, and in setting up the task to enhance the learning environment. The task, environment and exercise sequence are adapted to promote an autonomous, problem solving process of planning, initiation, carry through, completion and evaluation of the movement sequence ´**hands-off**´**.** The aim of training is to promote the quality and quantity of functional activities of the hemiparetic limbs in uni/bi-lateral and bimanual movements whilst preventing detrimental compensatory strategies. The choice of activity in the session is based on the impairments that constrain the patient from performing or completing a task.

Severely impaired motor control

The patients most appropriate for this training are those whose symptoms range from no selective movement to pronounced weakness with minimal of muscle activity. This approach should be considered for those patients who have developed secondary negative musculoskeletal and neurological behaviours (soft-tissue contractures). The Chedoke McMaster Stroke assessment[29] would classify this patient group on the impairment inventory: Stages 1-4. These patients and particularly those with no selective movements and with cognitive impairment have difficulty participating in evidence based training methods such as Constrained Induced Movement Therapy[30].

Degrees of freedom of movement: N.A. Bernstein[21]

A motor control problem in how to co-ordinate and regulate movement (in the body). The process of mastering co-ordination and control of movement is managed by reducing the degree of freedom of movement of specific joint or limb thus preventing inappropriate movement.

External Focus of attention[32]

External focus of attention is the focus that is directed at the effect of one's movement in relation to the environment.

PANat therapists structure the environment with visual, auditive and tactile cues to enable quality of movement for strokes with severely impaired motor control. Air splints and therapy tools can be used in the training session for additional external focus of attention.

Author's comments

This document will be reviewed regularly and any changes will be acknowledged as the scientific framework for movement analysis, motor control and motor learning in rehabilitation evolves and clinical expertise develops. It is recommended that clinical trials are undertaken to assess and evaluate the clinical response to the use of PANat with this client group.

References

1. Obituary – Margaret Johnstone 2007, www.PANat.info
2. Johnstone M. Restoration of normal movement after Stroke, Churchill Livingstone, 1995.
3. Johnstone M. Home Care for the Stroke Patient, Churchill Livingston, 1996.
4. Feys HM, De Weerdt WJ, Selz BE, Cox Steck GA, Spichiger R, Vereeck LE, Putman KD, Van Hoydonck GA. Effect of a Therapeutic Intervention for the Hemiplegic Upper Limb in the Acute Phase after Stroke. A Single-Bind, Randomised, Controlled, Multicentre Trial. Stroke. 1998; 29: 785-792.
5. Feys H, De Weerdt W, Verbeke G, Cox Steck G, Capain C, Kiekens C, Dejaeger E, Van Hoydonck G, Vermeersch G, Cras P. Early and repetitive stimulation of the arm can substantially improve the long-term outcome after stroke: A five-year follow-up study of a single-blind randomised trial. Stroke. 2004; 35: 924-929.
6. Cox Steck GA. User guide for information and instructions to familiarize application and handling of the Urias® Johnstone air splints used in PANat, Rehabilitation centre, Bürgerspital, Solothurn, Switzerland, 2009.
7. Wälder F. Selbsttätiges, repetitives Armmotoriktraining bei ausgeprägter Hemiparese mit den Johnstone-Luftpolsterschienen nach PANat. Ergotherapie & Rehabilitation. 2007; 8: 14-20.
8. Wälder F. Neurotherapeutische Rehabilitation mit den Johnstone Luftpolsterschienen nach PANat. In: Habermann C, Kolster F. Ergotherapie im Arbeitsfeld Neurologie. , 2. Auflage. Stuttgart: Thieme; 2009: 747 – 783.
9. Schmidt RA. Motor Control and Learning: A Behavioural Emphasis, edition 2. Human Kinetics; Champaign, Illinois, 1998.
10. Krakauer JW. Motor learning: its relevance to stroke recovery and Neurorehabilitation, Current Opinion in Neurology: February 2006; Volume 19(1): 84-90.
11. Majsak MJ. Application of Motor Learning Principles to the Stroke Population. In: Topics in Stroke Rehabilitation. 1996; 3: 27–59.
12. Montgomery P, Connoly PB. Clinical Applications for Motor Control, Slack, 2003.
13. Carr JH, Shepherd RB. Stroke Rehabilitation. Elsevier Limited; 2004.
14. Umphred DA. Introduction and Overview: Multiple Conceptual Models: Framework for Clinical Problem Solving. In: Neurological Rehabilitation, 3rd. Edition. Mosby; 1995.
15. Gentile AM. Skill Acquisition: Action, Movement, and Neuromotor Processes. In: Carr J, Shepherd R. Movement Science, Foundations for Physical Therapy in Rehabilitation, 2nd ed. 2000.
16. Shumway- Cook A, Woollacott MH. Motor Control Translating Research into Clinical Practice, 3rd. Edition. Baltimore: Lippincott Williams and Wilkins; 2007.
17. Cox Steck GA. A clinical decision making- goal directed training program. Rehabilitation centre, Bürgerspital, Solothurn, Switzerland. Unpublished working document 2009.
18. Byl NN. Neuroplasticity : Applications to Motor Control. In: Montgomery PC, Connolly BH. Clinical Applications for Motor Control. SLACK incorporated; 2003: 79-106.
19. Chambier DC, De Corte E. Treating sensory impairments in the post-stroke upper limb with intermittent pneumatic compression. Results of a preliminary trial. Clinical Rehabilitation. 2003; 17: 14-20
20. Bernstein NA. The Coordination and Regulation of Movements. New York: Pergamon; 1967:127-134
21. http://www.who.int/classifications/icf/site/icftemplate.cfm H
22. Hammond JS, Keeney RL, Raiffa H. Smart choices: a practical guide to making better life decisions. New York: Broadway books,1998.
23. Signer- Thöne S. Goal setting process and management in Rehabilitation Centre, Bürgerspital, Solothurn, Switzerland. Unpublished working document 2010.
24. Thorsen AM et al. A randomized controlled trial of early supported discharge and continued rehabilitation at home after stroke. Stroke. 2005;36:297-302
25. DeWeerdt W, Selz B et al. Time use of stroke patients in an intensive rehabilitation unit: a comparison between a Belgian and a Swiss setting. Disability and Rehabilitation. 2000; vol 22 no.4: 181-186.
26. Ada L, Mackey F, Heard R, Adams R. Stroke rehabilitation: does the therapy area provide a physical challenge? Aust. J Physiotherapy. 1999; 45: 33-38.
27. Kieresuk T, Smith A, Cardillo J. Goal Attainment Scaling, Applications, theory and measurement, 1994.
28. Ottawa Panel. Evidence- Based Clinical Practice Guidelines for Post-Stroke Rehabilitation. Topics in Stroke Rehabilitation. Spring 2006; vol 13/ Number 2.
29. Gowland C. et al. Chedoke- McMaster Stroke Assessment, 1995.
30. Taub E, Uswatte G et al. Constraint –Induced Movement Therapy: A new family of techniques with broad application to physical rehabilitation - A clinical review. J Rehabil Res Dev. 1999.
31. www.**stroke**center.org/prof/**guidelines**.htm, www.Americanheart.org
32. Wulf G. Attention and motor skill learning, Champaign, IL: Human Kinetics; 2007