Theoretical Assumptions and Clinical Practice [1]

The Bobath concept is a problem-solving approach to the assessment and treatment of individuals with disturbances of function, movement and postural control due to a lesion of the central nervous system (IBITA 1996, Panturin 2001, Brock et al 2002, Raine 2006).

This approach to the rehabilitation of adults with central nervous system pathology originated in the work of Berta and Karel Bobath and has evolved over more than 50 years. The rationale for current practice is based partly upon present-day knowledge of motor control, motor learning, neural and muscle plasticity, and biomechanics. It is also based upon the experience of expert clinicians and takes client needs and expectations into account (Sackett 2000).

The process of developing a set of statements which would clarify current theoretical assumptions and clinical practice was initiated by the 12th Annual General Meeting of IBITA in 1996.

This latest review has received input from several sources, which are acknowledged at the end of the document.

Structure of the document

[1] IBITA Annual General Meeting, September 2006

KEY THEORETICAL ASSUMPTIONS

Linking participation, activities and underlying impairments

Together with the person, his family and caregivers we work to identify participation restrictions and analyze the relevant functional activities which are needed to overcome these restrictions. Our skills in movement analysis enable us to identify the specific underlying impairments related to both the task-directed movement and the underlying postural control. This ensures that relevant, achievable, short-term goals are set and that only the applicable underlying impairments are addressed in order to attain the desired function. Working on the appropriate functional activities in daily life situations ensures that contextual factors are taken into consideration and allows us to measure meaningful outcomes. The importance of specific functional use and treatment in situations of daily life was stressed as early as 1977 (Bobath B 1977).

Both the Bobath concept and the International Classification of Functioning, Disability and Health (WHO 2001) stress the entirety of human functioning in all spheres of life. Disability is regarded as the outcome of a complex relationship between the individual's health condition, personal factors and the external factors of the environmental circumstances in which the person lives. The Bobath concept has always stressed the individual nature of each person's problems and the necessity for goal setting and intervention to be determined for the specific individual.

Organization of human behaviour and motor control

Human behaviour involves an interaction between the individual, the environment and the task. When learning motor skills, the individual concentrates on the task rather than on the specific movement components of the task (Woollacott and Shumway-Cook 1990).

One model of motor control that is relevant to the Bobath concept is systems theory (Mulder and Hochstenbach 2001). This comprises three basic tenets.

- A non-hierarchical, self-organizing system driven by multi-sensory input.
- The interaction of motor processes with cognitive and perceptual processes.
- Interaction between the environmental context and the state of the organism, which shapes the output.

Mayston (1999) expands these tenets into five aspects which need to be considered in the control of movement.

- Motor aspects - postural and task related activity.
- Sensory aspects - selective attention by the CNS to relevant stimuli.
- Cognitive - motivation, judgement, planning and problem-solving.
- Perceptual - spatial and visual including figure-ground.
- Biomechanical - complementary neural and biomechanical aspects of control.

Massion (1994) presents a model of motor control that encompasses both movement and postural control. This model stresses the importance of adaptability and flexibility of postural systems. The organization of postural systems requires interaction between external forces (gravity), the mechanics and kinetics of the body, multisensory inputs, and ever-adapting responses to voluntary movements.

The central nervous system functions through a system of distributive processing. Different components of a task are processed in several different areas of the nervous system through serial and parallel linking of different structures at different levels. Parallel systems provide both postural control and task-directed movement. The unit of organization and co-ordination of CNS activity is the neuronal set. Neurons in the set may extend over many segments and work together to produce a functional outcome. The sum of the excitatory and inhibitory input to the set determines the output to the relevant motor neurone pools.

Muscle architecture and fibre-type also determine the motor response to input from the nervous system (Lieber and Friden 2000).

Postural control is both anticipatory and associative, resulting from feed-forward and feed-back mechanisms that are influenced by learning, experience and sensory inputs (Horak 1991). Anticipatory control activates the trunk stabilizers prior to limb movements (Hodges and Richardson 1997, Hodges et al 2000). This type of preparatory postural activity supports selective movements of the limbs. Postural alignment of the individual determines the movement strategies that will be effective (Forssberg and Hirschfeld 1994, van der Fitz et al 1998). During movement, anticipatory and associative postural control is on-going.

While the exact mechanisms of postural control are unknown, recent research in conceptual modeling suggests that an internal representation of body movements exists and that proprioception is the essential element of this representation (Mergner et al 2003, Maurer et al 2000, Mergner and Rosemeier 1998, Wolpert et al 1995, Mergner et al 1993). The thalamus has been shown to have a role in maintaining this internal representation (Karnath et al 2000, Wolpert et al 1998). Proprioceptive mechanisms include somatosensory, visual and vestibular inputs. Somatosensory messages mediating position sense come from both distal (foot and hand) and proximal (neck and trunk) receptors (Kavounoudias et al 2001, van der Fitz et al 1998, Allum et al 1995, Forssberg and Hirschfeld 1994). The vestibular and visual systems provide information about verticality and position in space (Keshner et al 1988, Keshner and Peterson 1995 a and b).

Proficient human motor behaviour allows the individual to limit and combine movements selectively into the desired functional activity under a wide variety of environmental conditions (Schmidt 1992).

The consequences of injury and dysfunction in the execution of movement

Neurophysiological dysfunction as a result of damage to the central nervous system is the primary cause of movement dysfunction. Due to the interactive nature of the nervous system, even neurons distant to the lesion may demonstrate altered function as a result of reduced input and consequent reduction of their dendritic trees (Nudo -, Steward 1989). The neurological dysfunction results in deficits of motor control as well as changes in sensation and perception, and may be accompanied by behavioural, emotional and cognitive changes. Disruption of postural control can result in delayed anticipatory postural adjustments, disturbed temporal sequencing and decreased amplitude of postural responses (Dickstein et al 2004, Slijper et al 2002, Horak et al 1984). Motor control deficits present as paresis, weakness and neuro-muscular fatigue, (Landau and Sahrman 2002, Bohannon 1995, Bourbonnais and van den Noven 1989), loss of dexterity (Zackowski 2004), and dyssynergic patterns of muscle activation (Bourbonnais et al 1989), including co-activation of agonists and antagonists (Chae et al 2002, Dewald and Beer 2001, Kamper and Rymer 2001, Levin et al 2000, Gracies et al 1997, Dewald et al 1995). Changes within the muscle itself present as increased stiffness, shortening and weakness (Lieber et al 2004, Friden and Lieber 2003, Lieber et al 2003, Lieber and Friden 2002).

Weakness of muscles following stroke is recognized as being due to multiple causes (Andrews and Bohannon 2000)

- Lack of excitation in descending pathways responsible for voluntary movement. (Kamper and Rymer 2001, Newham and Hsiao 1999).
- Muscle fibre atrophy and contracture. (Lieber et al 2004, Friden and Lieber 2003, Lieber et al 2002, Lieber and Friden 2002).
- Changes in the spatial and temporal patterns of muscle activation, resulting in an inefficient EMG-torque relationship. (Kautz and Brown 1998, Davies et al 1996).
- Loss of functioning motor units and changes in the properties of the remaining ones.

These underlying impairments result in disturbances of the selective patterns of movement necessary for skilled task performance.

Whereas increased tone is recognized as part of the upper motor neurone syndrome, it is no longer regarded as the primary cause of movement dysfunction (Zackowski 2004, Ada et al 1988). Spasticity is defined as disordered sensory control, resulting from an upper motor neurone lesion, presenting as intermittent or sustained involuntary contraction of muscle (Burridge et al 2005). Increased tone has both neural and non-neural elements. The neural elements of tone include inability to modulate reflex activity over the contraction range and inability to reduce background levels (Burne et al 2005, Thilman et al 1991). The non-neural elements involve intrinsic changes in the passive mechanical properties of muscle. These changes occur both in the muscle cell and in the extracellular matrix (Lieber et al 2004, Dietz 2003, Dietz and Berger 1983).

An important consequence of the initial loss of dynamic stability is the development of compensatory mechanisms. At a functional level the compensatory mechanisms may achieve the task. If they do, they will reinforce the behaviour and may prevent the acquisition of other behaviours. At a neural level, the compensatory activity may limit the recovery of spared neural mechanisms (Michaelsen and Levin 2004, Michaelsen et al 2001, Levin et al 2002, Cirstea and Levin 2000).

Secondary impairments may arise from misuse or from inappropriate compensatory strategies. These impairments may develop within the nervous system itself, or in the target tissues. Physical deconditioning (related to both cardio-respiratory function and muscle endurance) may result from a combination of the pre-morbid condition and the lack of activity post-stroke (Leroux 2005, Macko et al 2005, MacKay-Lyons and Makrides 2002).

Recovery

Because different components of a single task are processed in different areas of the brain, damage to a single area need not result in the complete loss of task performance. Even if the behaviour initially disappears, it may partially return as undamaged parts of the brain reorganize their linkages.

Mechanisms involved may include recovery of penumbral tissues, neural plasticity, resolution of diaschisis and behavioural compensation strategies. Rehabilitation is believed to modulate recovery by interacting with these underlying processes (Kwakkel et al 2004). Potential for recovery in the more affected parts of the body exists (Dancause et al 2005, Liepert et al 2000, Jones and Schallert 1994).

Recovery does not take place randomly. It is influenced by many factors.

- Changes within the CNS, even when far-removed from the lesion (within seconds).
- Positioning and handling by the caregivers (within a few days).
- How the individual attempts to move (within a few days).

Functional recovery is more than recovery from impairments. The use of effective behavioural strategies may result in improvements in motor skills (Kwakkel et al 2004).

Neural and muscle plasticity

Neurological rehabilitation is the management of recovery (Gordon 2005) and neural plasticity is a key element of functional recovery. Neural plasticity is the adaptive capacity of the nervous system and its ability to modify its own structural organization and function (Nudo et al 2001, Bach-y-Rita 2001, Merzenich et al 1983). Plastic adaptation of the neural and musculoskeletal systems occurs in response to trauma or to changes in the internal and external environment, such as occur following trauma or as a result of sensorimotor learning and experience.

Neural plasticity allow strengthening of synaptic chains and alteration of functional connections in response to specific input as well as to repetition of patterns of posture and movement (Nudo 2003, Liepert *et al* 2000, Jones and Schallert 1994). These changes include reorganization in the cortex (Dancause *et al* 2005, Nudo 1999, Nudo and Friel 1999), axonal sprouting and reclaiming of synapses (Jones *et al* 1999) and improved synaptic transmission (Jones *et al* 1999).

Remodeling occurs at molecular and cellular level. Short-term changes involve changes in presynaptic efficiency (Leenders and Sheng 2005, Lonart 2002), whereas medium-term changes relate to the post-synaptic membrane. Changes in the genetic expression of the cell evolve over the longer term (Kleim et al 2004).

The interaction between form (the anatomy of the neuromuscular system) and function (the behavioural strategy utilized to perform a task) influences the remodeling. Neural plasticity can result in disadvantageous compensatory motor behaviour, or it can lead to the development of alternative pathways for the acquisition of more normal function (Michaelsen and Levin 2004, Michaelsen et al 2001).

Plastic changes in muscle occur readily in response to alteration in muscle length as well as to the way in which the muscle is used. These include alteration in sarcomere number and length, increase in cross-bridge formation, changes in muscle fibre type and alterations in the extra-cellular elements (Lieber et al 2004, Friden and Lieber 2003, Lieber et al 2002).

Knowledge of the mechanisms of plasticity enables the therapist to specify the neural recovery processes that will bring about rehabilitation goals (Gordon 2005).

Motor learning

Motor learning refers to the acquisition and modification of movement (Shumway-Cook and Woollocott 2001). Skill acquisition is dependent upon motor learning. Motor learning requires the intention to perform a task, practice and feedback (both intrinsic and extrinsic) (Boyd and Winstein 2003). Certain types of feed-back are more beneficial for motor learning than other (Boyd and Winstein 2004). Certain types of practice are also more beneficial for task acquisition as well as task transference (Winstein 2005, 1991).

The time course of motor skill learning is practice dependent and consists of specific phases related to consolidation, specificity, transfer and interference (Karni and Sagi 1993, Karni et al 1998, Korman et al 2003). Understanding these learning processes enables optimizing the content of each therapy session, the number of repetitions and the interval between sessions.

Skill recovery is characterized by:

- Gradual decrease in cognitive control.
- Gradual decrease in perceptual and visual control.
- Improved adaptability and flexibility (task transference)
- Improved ability to cope with contextual interference.

Measurement of outcome

Current practice is only as good as the outcomes achieved. Motivation and expectations are factors which also influence outcome, and training which is relevant for the specific individual, his family and caregivers contributes significantly to the overall effects of treatment. There is a need to provide evidence which goes beyond reduction of impairment or the achievement of activity and includes a real, meaningful and sustainable change in the lives of individuals and their families (Winstein 2005). The goal is to maximize skill acquisition, rather than merely to achieve independence (Gordon 2005).

Intervention should bring about change at all three levels - participation, activity and impairment. Measuring clinical change requires tools that are sensitive to the types and degrees of change that are clinically important (Wood-Dauphinee 2005, Whyte 2005). Measurement at impairment level only does not guarantee a clinically meaningful change. Finch et al (2002) give guidance on the selection and use of outcome measures in rehabilitation, with the focus on activity and performance. It is, however, recognized that research into outcomes has, to date, not used measures which are sensitive to qualitative improvement in movement performance (Paci 2003)

Tools are available for measurement at all three levels of functioning - participation, activity and impairment.

KEY ASPECTS OF CLINICAL PRACTICE

The Bobath concept has already been defined as a problem-solving approach to the assessment and treatment of individuals with disturbances of function, movement and postural control due to a lesion of the central nervous system (IBITA 1996). Mayston (2000) observes that the concept is primarily a way of observing, analyzing and interpreting task performance. These definitions focus on the Bobath concept as a clinical reasoning process, rather than a series of treatments or techniques.

The Bobath approach is an inclusive one and is used with persons of any age who have incurred damage to their central nervous system, regardless of the degree of severity (Raine 2006).

Clinical reasoning and movement analysis

The process of assessment, goal-setting and intervention requires the therapist to explore both their underlying theoretical assumptions and their knowledge of the evidence base. This process is interactive, with ongoing re-assessment, revision of goals and changing intervention in accordance with the needs and progress of the person.

The ICF provides a framework for describing problems of functioning, disability and health. Identifying participation restrictions requires effective communication with the individual, his family and any other caregivers.

Analysis of movement and task performance enables the therapist to identify activity limitations as well as underlying problems of movement dysfunction (Bernhardt et al 2002, Lazaro et al 2001). This analysis leads to the formation of hypotheses regarding underlying impairments which need further evaluation. These impairments may be either primary or secondary.

Appropriate, relevant and patient-centred goals can be set on the basis of the assessment.

Initial intervention might be made at the level of participation, in the form of adapted seating or an environmental adjustment. It may, however, be necessary to intervene initially at the impairment level, but impairment-directed interventions should be linked to task-directed activities initiated by the individual.

Integrating postural control and task-directed movement

Postural control provides the background for selective patterns of movement, which are combined in many and varied patterns that provide task-directed activity and enable participation in daily life situations. The use of task-directed movement during treatment does not presuppose independent postural control; by changing the environment and providing external support, the individual can be enabled to maintain the upright position early following stroke. This allows work on selective patterns in the limbs in order to improve postural control. Alternatively, activation of the trunk stabilizers can be used to support use of the limbs.

Treatment utilizes both symmetrical and asymmetrical patterns of movement, as are reflected in the use of the upper limbs as well as in walking. Alternating asymmetry implies using the whole body, and this is integral to the Bobath concept. Use of the affected side is encouraged by utilizing strategies during which the individual has to use his more affected limbs, rather than by using restraints to prevent his use of his less affected limbs. This principle of enforced use is applied to the whole body, and not only the more affected arm.

The use of sensory and proprioceptive input

The role of the nervous system in giving selective attention to sensory and proprioceptive input is critical to its function of providing appropriate motor output. Afferent information is important in initiating and modifying movement, and in forming internal representations of posture and movement. In movement dysfunction, paucity of movement and the use of compensatory strategies severely restrict the individual's experience of movement.

Sensory input provided by the therapist must be relevant and appropriate, and the timing of giving and removing sensory input is critical. The sensory input should not be contradictory. The objective is to provide afferent information approximating that which usually would be experienced during movement or task performance.

The role of facilitation

Facilitation is one way of using sensory and proprioceptive controls to make movement easier. Facilitation is part of an active learning process (IBITA 1997) in which the individual is enabled to overcome inertia, initiate, continue or complete a functional task. Facilitation is used to assist the individual in problem-solving, enabling him to experience the patterns of movement required as well as success in achieving the task. Facilitating task-performance allows increased repetition of the task.

Facilitation may be directed primarily towards the postural control needed for task-directed movement, or towards the task-directed movement itself, or towards both. It activates the components over which the person has insufficient control to initiate or complete the movement. Facilitation often requires manual contact to activate sensory and proprioceptive afferents, activate muscles or guide movement, but it is never passive. It is designed to:

- Make the activity possible.
- Demand a response.
- Allow the response to happen.

Successful facilitation demands that the therapist has explored the evidence base for the best means of facilitating a specific behaviour. The use of facilitation as an integral part of the Bobath concept is supported by the work of Hesse et al (1998) and Miyai et al (2002). Whilst the former demonstrated that certain parameters of walking improved with facilitation, the latter also demonstrated that improvement in certain parameters was accompanied by changes in cortical activity.

If facilitation is to be successful it must lead to a change in motor behaviour. In order to ensure that this occurs, the degree of facilitation is reduced both within a treatment session and withdrawn over a period of treatment, until the individual can initiate and complete the task independently. During the period in which facilitation is still being used as part of the intervention process, repetition and variability of patterns of movement and behavioural strategies are incorporated.

Issues of active tone

Tonal problems are assessed under both passive and active conditions. Changes in the passive state are differentiated from tonal changes interfering with activity. Changes which interfere with movement may be due to neural or non-neural elements. Treatment is directed at the specific underlying causes. These may include inadequate postural control, cutaneous hypersensitivity, disturbed muscle activation patterns or inability to cease firing to the muscle.

Muscles which have been maintained at one length over a period of time will undergo changes in resting length and subsequent alteration of non-neural elements. Muscle alignment, length and elasticity must be maintained or regained in order to prevent secondary impairments. The goal is to achieve active functional patterns of movement through range. If this is not possible, the person is taught alternative strategies to prevent secondary impairments.

Overall management strategies

A CNS lesion always leads to compensatory strategies. Some of these strategies limit underlying potential. Within the Bobath concept, the view is not that task performance should be prevented in order to avoid this. The objective is to identify potentially limiting strategies and to modify task performance by structuring the environment, providing adequate sensory and proprioceptive cues and giving alternative and more effective ways of performing the task.

Outcome measurement

IBITA re-affirms the need for outcome measures at all three levels of functioning in order to establish the benefits of treatment. More than one form of outcome measurement may be needed to ensure that such change has taken place. In additions to outcome measures already discussed, case studies and descriptive notes provide valuable information regarding the process and results of treatment.

FUTURE DEVELOPMENT

In 1986 Karel Bobath said: "The Bobath concept is unfinished. We hope it will continue to grow and develop in the years to come."

This document is a working document and will continue to be revised in accordance with new theoretical knowledge and the published evidence base for practice.

FOOTNOTE

At the 14th Annual General Meeting of IBITA, in 1998, a working group was established. This group was centred in the Netherlands, where a theoretical framework was already being developed (Baumgarten 1999). Concurrently, the Theory Committee of the Neurodevelopmental Treatment Association in North America was working towards the same goal and had already put forward provisional statements which were very similar to those of IBITA. The IBITA working group felt that worldwide acceptance would be strengthened if both sets of statements agreed in their main principles. At the 15th Annual General Meeting of IBITA, in 1999, the members adopted the proposed statements as a working document, with a similar format to that of the NDTA. The work of the NDTA group is acknowledged and appreciated and IBITA has recorded that they were grateful for permission to incorporate several clauses which are clearly recognizable as having been derived from the original NDTA document (NDTA Inc 1998). The theoretical foundations and principles of practice of the NDTA were later published in book form (Howle JM 2002).

Other clauses in the IBITA document reflected the work of the IBITA working group and were felt to be specifically relevant to the rehabilitation of adults with neurological disorders. The theoretical framework of the approach continued to evolve and, as a result, a revised document was adopted at the Annual General Meeting of 2003. A further revision, in an adapted format, was approved at the Annual General Meeting of 2004 and was retained for an additional period of one year by the 2005 AGM, pending a comprehensive review of our current theoretical assumptions and their application in clinical practice. This has now been completed by the members of the Education Committee. The document will continued to be revised in accordance with future scientific research and evidence base for practice.

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