Case Report

# Gait Re-education Based on the Bobath Concept in Two Patients With Hemiplegia Following Stroke

Background and Purpose. This case report describes the use of gait re-education based on the Bobath concept to measure the changes that occurred in the gait of 2 patients with hemiplegia who were undergoing outpatient physical therapy. Case Description. One patient ("NM"), a 65-year-old woman, was referred for physical therapy 6 weeks following a right cerebrovascular accident. She attended 30 therapy sessions over a 15-week period. The other patient ("SA"), a 71-year-old woman, was referred for physical therapy 7 weeks following a left cerebrovascular accident. She attended 28 therapy sessions over a 19-week period. Clinical indexes of impairment and disability and 3-dimensional gait data were obtained at the start of treatment and at discharge. Therapy was based on the Bobath concept. Outcomes. At discharge, NM demonstrated improvements in her hip and knee movements, reduced tone, and improved mobility. At discharge, SA demonstrated improved mobility. During gait, both patients demonstrated more normal movement patterns at the level of the pelvis, the knee, and the ankle in the sagittal plane. SA also demonstrated an improvement in hip extension. Discussion. These cases demonstrate that recovery of more normal movement patterns and functional ability can be achieved following a cardiovascular accident and provide insight into the clinical decision making of experienced practitioners using Bobath's concept. [Lennon S. Gait re-education based on the Bobath concept in two patients with hemiplegia following stroke. *Phys Ther.* 2001;81:924–935.]

**Key Words:** *Bobath concept, Gait re-education, Stroke.*

***Sheila Lennon***

Walking is possible for the majority of patients following stroke, but it rarely returns to normal.[1] Therefore, gait re-education is an important physical therapy intervention for patients following stroke. The walking patterns of both individuals without mobility problems[2] and patients with hemiplegia[3] have been well documented. The gait of people following stroke is characterized by problems with generating, timing, and grading of muscle activity, hypertonicity, and mechanical changes in soft tissues.[3] Gait speed, stride length, and cadence are lower than normal values.[3] Common kinematic deviations during the stance phase of the gait cycle are decreased peak hip extension angles, decreased lateral pelvic displacement, changed knee extension, and decreased plantar-flexion angles.[4] Common kinematic deviations during the swing phase of the gait cycle are decreased hip flexion, knee extension, and dorsiflexion.[5] Kinetic characteristics and abnormal motion of the unaffected side have not been commonly documented in patients following stroke.[3,6] The most effective treatment strategies to use in gait re-education following stroke remain unknown.[7] This case report describes gait re-education based on the Bobath concept, which is one of the leading treatment approaches in Europe for rehabilitation of patients with stroke.[8,9]

Bobath considered abnormal coordination of movement patterns and abnormal tone to be the main problems of people with hemiplegia.[10] *Tone* is defined as the amount of tension in a muscle (muscle tone) or the overall state of tension in the body (postural tone).[11] Therapists using Bobath's concept believe that abnormal tone, which can be lower or higher than normal, influences the patient's movement patterns adversely. Normalizing tone is seen as necessary preparation for practicing functional activities such as walking.[11] Facilitation of selective control of movement, achieved by the re-education of basic movement patterns of the trunk, the pelvis, and the limbs, is a key feature of the approach.[12] Therapists believe that too much effort by the patient and overuse of the unaffected side reinforce abnormal tone and movement of the affected side.[8,12] This is why there is an emphasis on "hands-on" therapy to encourage the use of the affected side and an avoidance of resisted exercise to strengthen muscle. Therapists use their handling techniques to correct alignment, to assist movement that the patient struggles to perform independently, and to block atypical movements (ie, movements that differ from patterns of coordination used in everyday tasks).[11] This reduces the patient's effort during movement, thus normalizing tone and producing more selective movement as opposed to stereotypical mass patterns.[11] Resisted exercise also may result in excess effort by the patient. Therapists using Bobath's concept believe that this overexertion will produce overflow and irradiation through the body, thereby reinforcing abnormal tone and stereotypical mass patterns of the affected side. Therefore, resisted exercise is usually avoided in patients with abnormal tone, mass movement patterns, and malalignment.

***In the Bobath concept, abnormal coordination of movement patterns and abnormal tone are considered the main problems for people with hemiplegia.***

The therapist's handling techniques provide postural stability and alignment and guide the patient toward

S Lennon, MSc, BSc (Physical Therapy), MCSP, is Lecturer in Physiotherapy, Rehabilitation Sciences Research Group, School of Health Sciences, University of Ulster at Jordanstown, Newtownabbey, County Antrim, Northern Ireland BT 37 OQB (s.lennon@ulst.ac.uk).

*This article was submitted September 29, 1999, and was accepted August 10, 2000.*

achieving more normal movement patterns.[12] The principle underlying the treatment is the capacity of the central nervous system to recover function following damage.[12] It is important, therefore, to work at regaining normal movement of the affected side, thus achieving functional independence by using both sides of the body. Gait re-education based on the Bobath concept uses techniques aimed at the normalization of muscle and postural tone; facilitation of more normal movement patterns in the trunk, pelvis, and limbs; and facilitation of the act of walking.[11,12]

Although experimental evidence demonstrates that rehabilitation leads to improved functional ability, it does not demonstrate that motor recovery has occurred on the affected side.[13] The majority of studies have only measured treatment effects using activities of daily living (ADL) scores.[7] Therefore, patients could have become independent without regaining the use of the affected side by compensating with the unaffected side.

Therapists using the Bobath concept believe that treatment contributes to better recovery of movement of the affected side and functional activity. To evaluate therapy based on the Bobath concept, both recovery of movement and improvement in function need to be measured. The primary aim of this case report is to describe the use of outcome measures to document recovery of movement within the gait cycle and walking ability in 2 patients with hemiplegia following stroke. A secondary aim is to describe the treatment process used by experienced Bobath practitioners to re-educate gait following stroke, as few studies to date have provided a detailed description of the content of therapy.[7]

## Case Description

### *Therapists*

The treating physical therapists had attended a 3-week Bobath course on adult hemiplegia. One patient's ("SA's") therapist had attended the basic course 11 months prior to treating the patient. The other patient's ("NM's") therapist had attended a basic course 8 years previously and an advanced course within the past 2 years. Both therapists, therefore, were up-to-date with current Bobath practice. Both therapists were more than 10 years qualified, with at least 6 years of daily experience working with patients with stroke.

### *Examination*

The examination was based on the principles described by Bobath.[10] Each therapist gathered general information about the history of the stroke and the patient's past medical history, current level of function, and goals. The therapists observed the patients' available patterns of movement and posture in sitting, standing, moving from a sitting position to a standing position, in a supine position, and during walking, identifying the patient's deviations from normal in each of these positions and movements.[14] The therapists initially asked the patients to move independently, then used their manual skills to correct the patients' alignment, to assist the patients' movement, and to block atypical movements.[11] Muscle and postural tone were assessed by observation of body and limb postures and by passive or active-assisted movement, while noting any restrictions in range of motion.[11] Light touch and proprioception in the limbs were tested. Gait was assessed visually.[14] During the examination, the therapists also assessed the patients' mental status, vision, hearing, ability to communicate, and presence of neglect. All of the above relied on observation and palpation using the therapists' clinical judgment; no standardized tests were used.

Following analysis of the examination findings, each therapist formulated a problem list for the patient representing the main reasons underlying the patient's movement abnormalities. Functional goals were agreed on with the patients; the therapists established treatment goals and a treatment plan to address the problems and achieve the patients' functional goals.[11]

Both patients were independent prior to their stroke. They had been diagnosed with an internal capsule infarct of sudden onset, resulting in admission to 2 different stroke units. At the time they were referred for physical therapy, they were about 6 weeks poststroke. Both patients each been discharged to their own homes and had just started attending different hospitals twice a week for outpatient physical therapy. One patient (SA) also was receiving outpatient occupational therapy.

The physical examination was carried out by the treating physical therapist according to the principles described in the previous section. The outcome measures included various clinical scales, and a 3-dimensional gait analysis (described in the "Outcomes" section) was performed by the author, who acted as an independent assessor. Postural alignment, muscle tone, selective movement, and functional ability were assessed with the patients in supine, sitting, and standing positions. The patients did not have any restrictions in range of motion or show any signs of neglect. Both patients were mentally alert and had intact sensation, vision, and hearing. The main findings of the patient assessments are summarized in the therapists' problem lists, which are presented in the following sections. In neurological physical therapy, the problem list represents the therapist's interpretation of the main reasons underlying the patient's abnormal movement. The problem list, therefore, can be considered as the key to providing insight into the therapist's clinical reasoning process. I did not consider it necessary to present the full details of each treating therapist's examination in these reports.

*Patient 1*

NM, a 65-year-old woman, was referred for physical therapy with a diagnosis of left hemiparesis affecting mainly her pelvis and left lower extremity. Her arm function was normal. She had a history of osteoporosis of the spine, which had been diagnosed 5 years prior to her stroke. Although her osteoporosis led to spinal pain and difficulty in maintaining a supine position, she stated that it had not interfered greatly with her daily activities prior to her stroke. NM lived with her daughter, who worked full-time. She was independent in all ADL except bathing. Her bed and a commode for toileting had been moved downstairs because she was unable to manage stairs. Although NM could walk independently indoors with a cane in her right hand, she tended to remain seated most of the day because of pain in her left thigh. She could walk for about 20 m before needing to sit down due to pain.

The therapist identified the following problems based on her assessment: reduced selective control of the pelvis (limited anterior, posterior, and lateral tilt); reduced selective control of the lower extremity (decreased hip extension, knee flexion and extension, and ankle dorsiflexion); and increased tone in the left quadriceps femoris and adductor muscles, leading to pain in the left thigh. *Selective control* refers to the ability to perform movement patterns at isolated joints without using stereotyped flexor or extensor patterns of movement. These problems contributed to the following deviations from normal gait, as determined by observational gait analysis: excessive hip flexion bilaterally, a posteriorly tilted pelvis, knee hyperextension during stance, and intermittent foot drop. The pain also interfered with the movement of the left hip and knee, walking, and any functional activity involving the left lower extremity, such as rolling over in bed, getting in and out of bed, standing up, and walking. NM complained of the following problems: pain in the affected lower extremity, limited ability to walk indoors, inability to walk outdoors, being off balance in standing, difficulty bending her right knee, difficulty getting in or out of a car and in or out of the shower without assistance, inability to ascend or descend stairs, and a lack of confidence with mobility.

*Patient 2*

SA, a 71-year-old woman, was referred for physical therapy with a diagnosis of right hemiparesis mainly affecting her right arm and pelvis. She did not have any relevant medical history. Although the movement patterns in her lower extremities were normal, her gait was slow and unsteady. She walked independently indoors with a high cane (at waist level) in her left hand for about 20 m without needing a rest. The aim of using a high cane was to give her some stability without encouraging too much weight bearing through the unaffected side, thus minimizing asymmetry. Prior to her stroke, SA managed her own farm (mainly administrative work) and lived alone. Following hospital discharge, her sister moved in with her to assist her with ADL. Her bed and a commode for toileting were moved downstairs because she was unable to manage stairs.

The therapist identified the following problems based on her assessment: reduced selective control of the pelvis (limited lateral tilt) and increased tone in the right elbow, wrist, and finger flexors, with reduced selective control (better motor recovery in the elbow than in the hand or shoulder). SA tended to move her right arm in a flexor pattern (ie, combined shoulder, elbow, and wrist and finger flexion), and she was unable to use her right arm during any ADL task. During walking, SA's right arm assumed a flexed posture with a retracted scapula. These problems interfered with her gait; the increased tone and flexor pattern of the arm made SA feel off balance by restricting the alignment and movement of her pelvis. SA's arm was held adducted to her side, with the elbow in about 30 degrees of flexion. She felt that this fixed arm posture put her off balance and interfered with the swing phase of gait on her affected side. These problems contributed to the following deviations from normal gait, as determined by observational gait analysis: decreased weight transference to the right; an adducted right foot placement during stance, with weight bearing on the lateral border of the foot; and reduced hip flexion during the swing phase. SA complained of the following problems: inability to use her affected hand for eating or light housework, inability to walk outdoors or to manage stairs, having to adjust the bedclothes to get in and out of bed, needing help to get in and out of the bath, and feeling off balance.

Both patients had difficulty in standing up and in getting in and out of a chair or a bed. They tended to keep more weight on the unaffected side during these activities. SA tended to leave her right arm behind, whereas NM had problems including her left lower extremity in the movements. For example, NM struggled to flex her left hip and knee to roll onto her right side or to swing her legs over the edge of the bed in order to sit up.

## Intervention

The therapists used principles that were based on the Bobath concept and aimed at re-educating normal movement during functional activities that were meaningful to the patients. To document the content of each therapy session, the therapists completed a checklist that I derived from the literature, clinical experience, and interviews with 3 experienced Bobath therapists.[10,11,15,16] Thirty-five potential treatment techniques or activities in sitting, standing, and supine/side-lying positions were identified. For the purpose of analysis, with the assistance of the 3 therapists who were experienced in the use of the Bobath concept, the treatment techniques and activities were grouped into 4 categories according

to the treatment goals of preparation, facilitated movements, gait-specific activities, and functional activities. The treatment techniques and activities are categorized and listed in the Appendix.

NM's therapist decided to concentrate on improving selective control of the pelvis to reduce excessive hip flexion and improve weight transfer, as well as mobilization of the soft tissues of the thigh in correctly aligned weight bearing in standing to normalize tone and relieve pain. The therapist hypothesized that mobilizing the soft tissues (specific mobilization) of the thigh—in particular, the adductor and rectus femoris muscles—would normalize increased tone and reduce the patient's pain. Specific tissue mobilization according to the Bobath concept is defined in the Appendix. The therapist judged that working on gaining anterior and posterior pelvic tilt would improve weight transfer and hip extension during gait, leading to improvements in selective distal control of the knee and the foot. Trunk control and alignment can affect limb tone, range of motion, and control. Muscle activity in the trunk is necessary to maintain the body erect against gravity and to adapt to the moving upper and lower extremities. Trunk movements contribute to the functional abilities of the upper and lower extremities.[11]

NM attended 30 therapy sessions over a 15-week period, twice a week for sessions 1 to 10, then once a week until discharge. Each session lasted for about 1 hour. The treatment checklist was completed in 23 sessions. Omissions occurred because another therapist had treated the patient on those days.

Table 1 lists all of the techniques used for each patient. The percentages represent the number of sessions in which each technique was used. From sessions 1 to 10, treatment for NM consisted of mobilization of the soft tissues of the thigh in sitting (6 sessions), weight transfer in sitting and standing (9 sessions), and standing up and sitting down from a raised therapy bed (height of the therapy bed was about 65 cm) (7 sessions). Gait re-education consisted of stance-phase gait re-education incorporating stepping in different directions and on and off a 15-cm-high step (all sessions), stepping with the affected lower extremity (2 sessions of swing-phase re-education), and walking (4 sessions). Stair-climbing practice was included (3 sessions).

For the remaining 13 sessions, there was less emphasis on preparation (2 sessions) and weight transference (2 sessions). There was more emphasis on knee control during knee flexion and extension in standing with the unaffected on a 15-cm-high step (all sessions) and facilitated knee and ankle movements (6 sessions). Gait-specific activities became more varied and emphasized stance (9 sessions), swing (7 sessions), and walking practice (11 sessions). Stair-climbing practice was included (10 sessions). The therapist continued to have the patient practice sitting down and standing up (7 sessions, with height of the therapy bed about 49 cm).

**Table 1.**
Frequency of Treatment Techniques/Activities Across Therapy Sessions for Each Patient

| | Patient | |
|---|---|---|
| **Technique/activity** | **NM (% of 23 sessions)** | **SA (% of 19 sessions)** |
| Mobilizations | 34.78 | 15.78 |
| Weight transfer | 47.82 | 52.63 |
| Pelvic tilting | 0 | 26.31 |
| Bridging | 0 | 26.31 |
| Selective hip movement | 26.08 | 10.52 |
| Selective knee movement | 26.08 | 10.52 |
| Knee flexion/extension with unaffected lower extremity on a step | 34.78 | 21.05 |
| Selective foot movement | 13.04 | 10.52 |
| Selective upper-limb movement | 0 | 100 |
| Reaching with affected arm | 4.34 | 63.15 |
| Reaching with unaffected arm | 4.34 | 63.15 |
| Stepping with unaffected lower extremity (stance) | 82.60 | 68.42 |
| Stepping with affected lower extremity (swing) | 39.13 | 52.63 |
| Facilitated walking | 65.21 | 31.57 |
| Sit to stand | 69.56 | 5.26 |
| Stairs | 56.52 | 31.57 |

For SA, the therapist's hypothesis was that facilitating correct weight transfer would improve lateral pelvic tilt and weight acceptance through the affected foot. The increased tone and positioning of the upper limb in a flexor pattern interfered with gait by holding the pelvis in increased side flexion and interfering with the swing-through of the affected lower extremity. Therefore, the therapist worked on mobilizing the shoulder girdle and re-educating selective control of the arm in a supine position with the dual aim of obtaining more normal movement patterns in the arm and re-educating pelvic movement, which the therapist believed would improve SA's walking pattern.

SA attended 28 therapy sessions over a 19-week-period, twice a week for weeks 1 to 10, then once a week until discharge. Each session lasted for about 1 hour. The checklist was completed in 19 sessions. The content of therapy sessions for SA is detailed in Table 1.

**Table 2.**
Categories of Treatment Across All Sessions

| Category | Patient | |
|---|---|---|
| | NM (% of 23 sessions) | SA (% of 19 sessions) |
| Preparation | 34.8 | 21.1 |
| Facilitated movement | | |
| Proximal | 73.9 | 63.2 |
| Distal | 26 | 10.6 |
| Upper limb | 0 | 100 |
| Gait-specific activities | | |
| Stance | 82.6 | 68.4 |
| Swing | 39.1 | 52.7 |
| Walking | 65.2 | 31.6 |
| Other functional activities | | |
| Sit to stand | 69.6 | 5.3 |
| Stairs | 56.5 | 31.6 |

From sessions 1 to 8, treatment consisted of mobilization of the shoulder girdle in a supine position (4 sessions), weight transference in sitting and standing (all sessions), reaching with both upper limbs in different directions in standing (all sessions), and facilitation of selective control of the upper limb in a supine position (all sessions). Gait was re-educated by stance-phase re-education (all sessions), swing-phase re-education (7 sessions), and walking (6 sessions). For the remaining sessions, therapy continued to focus on re-educating selective control with the upper limb in supine and sitting (all sessions) and stair-climbing practice (7 sessions). Gait-specific activities consisted of stance-phase re-education (5 sessions), swing-phase re-education (4 sessions), and walking (2 sessions).

The content of therapy for each patient is summarized in Table 2 according to the 4 main categories of treatment across sessions described in the Appendix: preparation, facilitated movements, gait-specific activities, and functional activities.

## Outcomes

The author, who was not involved in the treatment program, assessed each patient, using the following measures, at referral and at discharge:

1. The Motor Assessment Scale (MAS), which is reported to have high interrater reliability ($r$=.89–.99).[17]

2. Subtests (ie, hip and knee flexion in a supine position, knee flexion in a side-lying position, and dorsiflexion with the knee extended in a supine position) of the Motor Club Assessment (MCA), which is reported to have high interrater reliability (no statistics reported).[18]

3. A modified Ashworth scale, which is reported to have high interrater reliability (Kendall's tau correlation=.89–.99).[19]

4. Temporal-distance variables and joint angles, moments, and powers using a 3-dimensional motion analysis system (no reliability statistics available; the author was assisted by an experienced gait laboratory engineer).

These measurement tools were chosen for 2 reasons. First, they have been subjected to reliability testing and, in varying degrees, to validity testing. The MAS has been tested for both concurrent and predictive validity.[17] Only face validity for the MCA has been reported.[18] Second, they directly reflect the aims of physical therapy based on the Bobath concept. The MAS is a brief, easily administered clinical scale of 8 categories of motor function, consisting of 5 categories of functional mobility (rolling to the side, sitting up from lying, balanced sitting, sitting to standing, and walking) and 3 categories of recovery of movement and functional abilities related to the upper limb. Each category contains 6 items, which are scored from 0 (unable to perform) to 6 (optimal motor behavior). Because the MAS does not measure recovery of movement of the lower limb, 3 subtests of the MCA related to the lower limb were monitored. Each of these subtests is scored from 0 to 2 (0=no movement, 1=partial range of movement, 2=full range of movement). The modified Ashworth scale was included because the normalization of tone is an important treatment aim for therapists using the Bobath concept. The author of these reports, a physical therapist with 18 years of experience in neurological rehabilitation, had been using these scales in clinical practice for 9 years and had previously assessed her intrarater reliability by repeating these scales on 2 occasions on 6 patients.

Gait analysis was carried out on each patient using a Vicon motion analysis system,* based in the gait analysis laboratory of Green Park Healthcare Trust (Belfast, Ireland). This system consists of 6 cameras linked to 2 Kistler force plates. Reflective spheres were attached to 13 standardized bony landmarks according to the gait laboratory protocol. Each patient was filmed while walking at her preferred speed barefoot without a walking aid. The patients were filmed without their walking aid because therapists usually facilitate walking without using walking aids; they often aim to wean the patient away from using the aid. Both patients required standby supervision to complete the trials. The 3 best trials for each lower limb were analyzed. The reliability of the data obtained with the Vicon system is dependant on the accuracy of the marker placement during testing and the reliability of the investigator in identifying initial contact and toe-off within the gait cycle when processing the

* Oxford Biometrics, Unit 14, 7 West Way, Botley, Oxford, 0X2 0JB England.

**Table 3.**
Changes in Impairment and Disability

| Measure | Patient | | | | | | Maximum Score |
|---|---|---|---|---|---|---|---|
| | NM | | | SA | | | |
| | Pretherapy | Posttherapy | Change | Pretherapy | Posttherapy | Change | |
| Motor Club Assessment | | | | | | | |
| Hip/knee flexion (supine) | 1 | 2− | 1 | 2− | 2 | 0 | 2 |
| Knee flexion (side lying) | 1 | 2− | 1 | 2 | 2 | 0 | 2 |
| Dorsiflexion with knee extension | 2 | 2 | 0 | 2 | 2 | 0 | 2 |
| Motor Assessment Scale | | | | | | | |
| Supine to side lying | 4 | 6 | 2 | 3 | 6 | 3 | 6 |
| Supine to sitting up | 6 | 6 | 0 | 2 | 6 | 4 | 6 |
| Balanced sitting | 2 | 6 | 4 | 5 | 6 | 1 | 6 |
| Sitting to standing | 2 | 2 | 0 | 3 | 5 | 2 | 6 |
| Walking | 4 | 4 | 0 | 1 | 5 | 4 | 6 |
| Upper arm function | 6 | 6 | 0 | 1 | 2 | 1 | 6 |
| Hand movements | 6 | 6 | 0 | 0 | 1 | 1 | 6 |
| Advanced hand | 6 | 6 | 0 | 0 | 0 | 0 | 6 |
| Modified Ashworth scale | | | | | | | |
| Hip | 2 | 0 | 2 | 0 | 0 | 0 | 0 |
| Knee | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Foot | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

data. The author, therefore, was assisted in data collection and processing by the gait laboratory team in Belfast.

### *Changes in Data Obtained With the Clinical Scales*

The changes that occurred in data obtained with the MCA, the MAS, and the modified Ashworth scale are highlighted in Table 3. For the MCA and the MAS, the higher number represents the best score, indicating more normal movement and function. The modified Ashworth scale is scored from 0 to 5 (0=no increase in tone, 5=affected parts are rigid in flexion or extension).

NM demonstrated improved movement in the hip and knee as measured by the MCA (2=almost through full range of movement) and reduced tone in the hip as measured by the modified Ashworth scale (2=slight increase manifested by a catch followed by minimal resistance throughout less than half of the range of movement). She improved on the MAS in supine to side lying and balanced sitting; there was no change in the walking category (4=walks 5 m without assistance in 15 seconds).

Maximum scores were obtained with the MCA and the modified Ashworth scale at the start of the therapy sessions for SA. She improved in all categories on the MAS except for the advanced hand activities. She received a score of 5 in the walking category (walks 10 m without assistance, turns around, picks up a small sandbag from the floor, and walks back in 25 seconds). All temporal-distance variables improved for NM, but only step length with the unaffected lower extremity and walking speed improved for SA (Tab. 4).

### *Changes in the Kinematics and Kinetics of the Gait Cycle*

The thin lines in the graphs in Figures 1 to 4 represent the normal band based on the laboratory database of children and young adults. It would be preferable to compare the patients' data with older adult norms because gait changes with aging. These changes, however, relate mainly to temporal-distance variables (a reduced stride length and slower walking speed).[20] Because joint angles show only minor differences and there are similar profiles for moments apart from a reduced plantar-flexor moment at push-off[20] and because a database for older people did not exist, as the gait analysis service was available only for children with cerebral palsy, it was deemed acceptable to use the normative data of the laboratory for illustration purposes.

As shown in Figure 1, NM demonstrated more normal movement patterns of the pelvis at discharge, she had less anterior tilt with better knee extension during stance and a more normal ankle pattern during the swing phase. After treatment, abnormal movement persisted at the ankle during stance. Her ankle was plantar flexed at initial contact, with inadequate dorsiflexion during stance. These findings may be related to the therapist's treatment hypothesis (see previous section on intervention); treatment had focused on improving the stance phase of gait, including pelvic control and weight transfer. Perhaps more change would have occurred if the therapist had worked more on selective control of the hip or the swing phase. These abnormal motions are mirrored on the unaffected side. Hip extension remained more limited on this side after therapy. The unaffected ankle looked more abnormal than the

**Table 4.**
Changes in Temporal Distance Variables (Normal Values Based on Perry[a])

| Variable | Patient | | | | | | Normal Values |
|---|---|---|---|---|---|---|---|
| | NM | | | SA | | | |
| | Pretherapy | Posttherapy | Change | Pretherapy | Posttherapy | Change | |
| Step length (m), unaffected lower extremity | 0.35 | 0.38 | 0.03 | 0.33 | 0.40 | 0.07 | 0.64 |
| Step length (m), affected lower extremity | 0.32 | 0.36 | 0.04 | 0.37 | 0.36 | −0.01 | 0.64 |
| Single support time (s), affected lower extremity | 0.36 | 0.39 | 0.03 | 0.60 | 0.57 | −0.03 | |
| Single support time (s), unaffected lower extremity | 0.39 | 0.44 | 0.05 | 0.58 | 0.55 | −0.05 | |
| Walking speed (m/s) | 0.53 | 0.58 | 0.05 | 0.33 | 0.47 | 0.14 | 1.28 |

[a] Perry J. *Gait Analysis: Normal and Pathological Function.* Thorofare, NJ: Slack Inc; 1992.

affected ankle in relation to terminal stance and swing. One reason for this observation may be that the patient was still having to adapt her gait to cope with the deviations that remained following therapy.

Figure 2 demonstrates that pelvic obliquity (lateral tilt), hip abduction angles, and abductor moments remained unchanged following treatment on both sides apart from the abductor moment of the unaffected side, which was within the normal database band.

Figure 3 demonstrates that many of SA's stance and swing variables improved following discharge. The pelvis was held in less anterior tilt during stance, but it remained in posterior tilt during the swing phase. There was better hip and knee extension. There was improved dorsiflexion on both sides during stance, but the swing phase remained abnormal bilaterally.

Figure 4 shows that initially SA's pelvic curve was flattened during stance, rising up from mid-stance through swing. There was some improvement on the unaffected side following treatment; however, there was more asymmetry in the abductor angles, and the hip remained adducted with an even larger abductor moment. Perhaps more change would have occurred if the therapist had worked more on abductor activity directly to control the pelvis and had encouraged weight transfer as opposed to working on lateral pelvic tilt and mobilizing the shoulder girdle to improve control of the pelvis.

### *Changes in Function and Patient Goals*

Changes were noted in the patients' function. By discharge, both patients could walk indoors without their walking aids, could walk outdoors using a one-point cane, and could manage stairs independently. NM was also able to get on and off buses when accompanied by her daughter. Unfortunately, at discharge, SA's right arm remained of little functional use, as she had only gross grasping ability and difficulty with release in the affected hand, although she had some return of shoulder and elbow movement.

NM was pleased with her progress. She had achieved her goals of walking indoors without a walking aid, managing the stairs, getting in and out of the shower, and getting out into the garden independently with her cane. She now described the pain in her affected lower extremity as more of a pressure and a tightness that no longer interfered with her walking. Her balance was better, and her knee movement was easier. She now felt able to work at home with her daughter on achieving her next goal of getting on and off a bus to go shopping in town.

SA also reported progress toward her goals. She believed that her walking was steadier and that she had better balance. She could manage stairs, and she could walk outdoors with her cane. Her arm movement was better, but she felt there was no power in her arm. She could now manage to adjust the bedclothes getting in and out of bed and adjust her position by herself. She was disappointed with the progress in her hand, although some progress had been made. She could use her affected hand for dusting and holding light objects, but she could not feed herself with that hand.

## Discussion

Improvements in impairment (movement of the affected lower extremity and tone) and disability (walking) were documented in both patients. These changes indicate that patients had changes in the recovery of movement as well as in function. This finding gives some credence to the belief of therapists using the Bobath concept that re-education of movement following stroke is possible.[11]

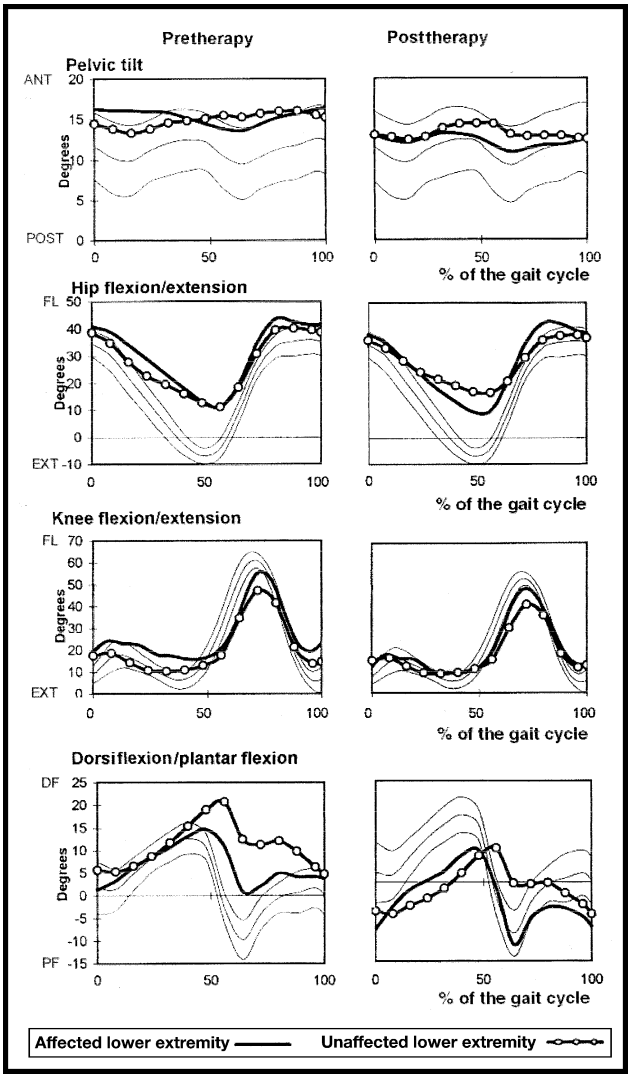



**Figure 1.**
Angular displacements and joint moments in the sagittal plane for patient NM. Joint angles and moments are presented on the Y axis, and data are normalized to 100% of the gait cycle on the X axis. The thin lines represent the normal database band within one standard deviation of the mean. ANT=anterior, POST=posterior, FL=flexion, EXT=extension, DF=dorsiflexion, PF=plantar flexion.

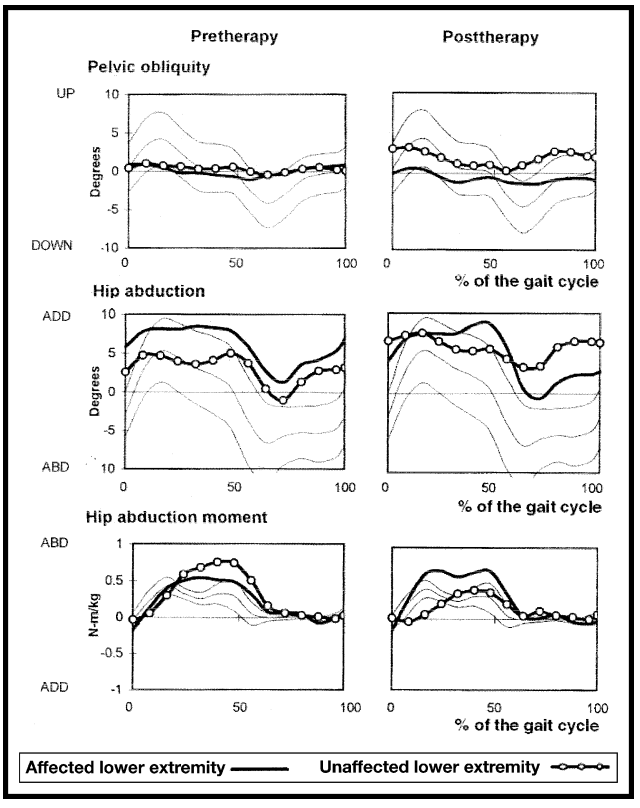



**Figure 2.**
Angular displacements and joint moments in the coronal plane for patient NM. Joint angles and moments are presented on the Y axis, and data are normalized to 100% of the gait cycle on the X axis. The thin lines represent the normal database band within one standard deviation of the mean. ADD=adduction, ABD=abduction.

This report suggests that changes in movement patterns can be documented when outcome measures linked to the aims of therapy are selected. Therapy was aimed at re-educating normal movement patterns within the gait cycle. The gait laboratory data documented change in these 2 patients. These results should be interpreted with caution because the magnitude of the changes observed was small. In future studies, the reliability of data obtained by the assessor and the consistency of the patient's gait cycle would need to be formally tested.

With regard to the clinical scales used, the gait subtest of the MAS was unable to demonstrate change at the higher end of the scale for NM, even though improvements in her biomechanical data were noted. NM was unable to progress past a grade of 4 on the walking subtest (walks 5 m with no physical assistance in 15 seconds). There are 6 items in the gait subtest of the MAS. Item 1 measures movement ability. Item 2 refers to walking with the help of one person. Items 3 through 5 refer to the ability to walk alone for 3 m with an aid (item 3), for 5 m in 15 seconds with no aid (item 4), and for 5 m in 25 seconds (item 5). Item 6 refers to the ability to walk up and down 4 steps 3 times in 35 seconds. The gait subtest measures only movement ability in item 1 (standing on the affected lower extremity and stepping forward with the other lower extremity with the affected hip extended and with supervision); the other 5 items reflect the degree of assistance required and the walking speed of the patient. This scale is unable to monitor normalization of gait patterns, which is a main aim of therapy based on the Bobath concept. The MCA and the modified Ashworth scale demonstrated change for NM, but not for SA.

Following examination of the patients, both therapists believed that pelvic control and weight transfer were major problems. Therefore, they worked proximally to re-educate movement of the pelvis, which may have led not only to changes in the pelvic movement patterns in the sagittal plane but also to changes distally in the

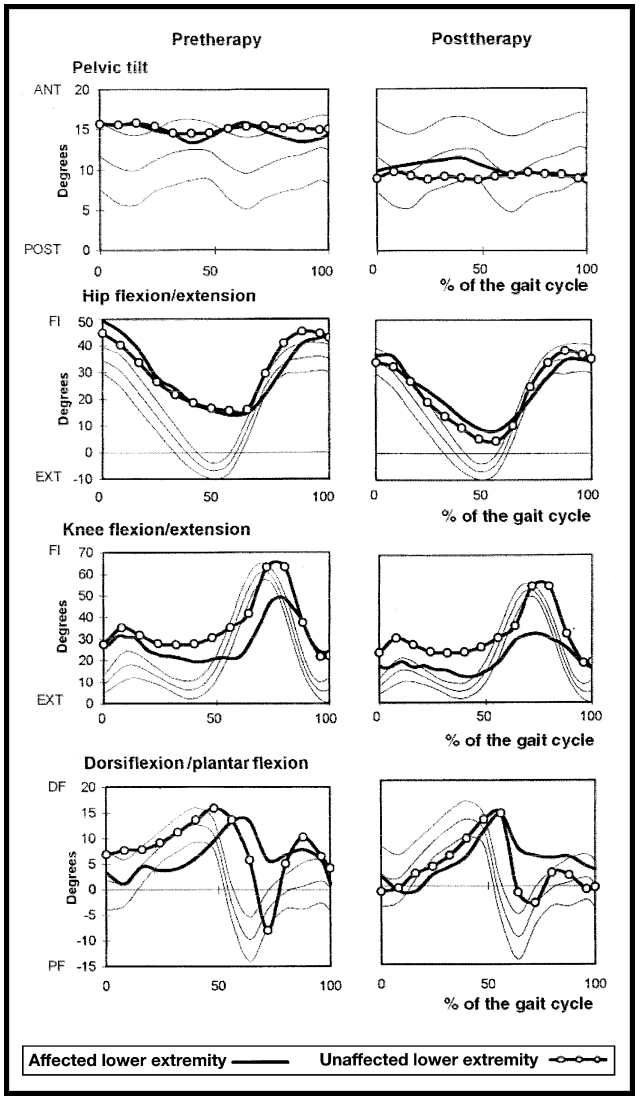



**Figure 3.**
Angular displacements and joint moments in the sagittal plane for patient SA. Joint angles and moments are presented on the Y axis, and data are normalized to 100% of the gait cycle on the X axis. The thin lines represent the normal database band within one standard deviation of the mean. ANT=anterior, POST=posterior, FL=flexion, EXT=extension, DF=dorsiflexion, PF=plantar flexion.

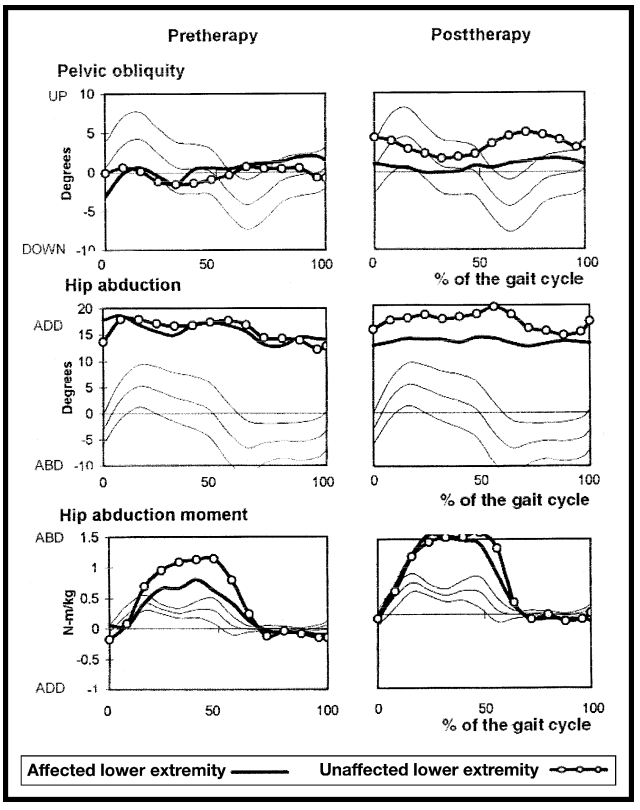



**Figure 4.**
Angular displacements and joint moments in the coronal plane for patient SA. Joint angles and moments are presented on the Y axis, and data are normalized to 100% of the gait cycle on the X axis. The thin lines represent the normal database band within one standard deviation of the mean. ADD=adduction, ABD=abduction.

movement patterns of the knee and foot. There was some change in loading of the affected limb as measured by the step length of the unaffected limb. The step length of the unaffected lower extremity improved by 7 cm in SA and by 3 cm in NM. This remained asymmetrical in relation to the step length of the affected lower extremity and far removed from normal values.[20] These changes in the coronal-plane motion in both patients were not apparent in the gait laboratory data (see hip abduction and adduction range and abductor moments in Figs. 2 and 4). It is surprising that the asymmetry persisted despite the fact that weight transfer techniques were used frequently in both patients. The results of studies by Hesse and colleagues[21,22] support this finding. They found no improvement in gait symmetry variables in 40 patients with hemiplegia after a 4-week inpatient rehabilitation program based on the Bobath concept; however, maximal speed, stair climbing, and movement as measured by the Motricity Index improved.[21,22]

One explanation for the asymmetry observed in the 2 patients described in this case report may be related to the type of treatment activities practiced. For example, it may be that too much time was devoted to working on pelvic control using weight transfer in standing and too little time was devoted to generating hip extensor and hip abductor activity during gait. The position in which the patients were treated may also have been important. For example, intervention might have been more effective if more time had been spent with the patient in standing and walking as opposed to sitting and supine. It may also be that the focus needs to shift from measuring symmetry to measuring weight transfer to the affected side. Weight transfer is a main treatment goal and implies symmetry. Key variables for identifying changes in weight transfer obtained by gait laboratory methods need to be identified.

This case report describes a treatment schedule for evaluating gait re-education based on the Bobath concept. For NM, the therapist used mainly techniques related to facilitated movements (proximal) and gait-specific activity. For SA, the therapist used mainly techniques related to facilitated movements (proximal) and gait-specific activity. Walking practice was used in 65% of NM's therapy sessions and in 32% of SA's therapy sessions. The interventions for these 2 patients are inconsistent with the findings of Hesse and colleagues[21,22] regarding the content of Bobath therapy. They reported that tone-inhibiting maneuvers and exercises in sitting and standing dominated therapy sessions, with little time spent on walking practice. Gait-specific practice was a key feature of the techniques described in this case report. The reports of other authors support these findings.[23] The therapists in this case report were experienced in stroke rehabilitation and had postgraduate training in the Bobath concept. The content of therapy (Tabs. 1 and 2) illustrates that therapy was guided by the principles of the Bobath concept, which aims to re-educate normal movement.

I cannot attribute changes in the gait cycle specifically to physical therapy. The cases, however, demonstrate that changes in movement and function occurred following gait re-education based on the Bobath concept. Several implications for practice arise from this case report. It was possible to describe Bobath practice and, by understanding the therapists' intervention aims, choose outcome measures to suit the aims of therapy. It would not appear sufficient to use only one scale or test to measure treatment effects. Therefore, a range of tools need to be considered. Laboratory-based gait analysis looks promising as a tool for evaluating therapy. The key variables to be monitored, however, require further reflection. Facilitated movements (proximal components) and stepping with the unaffected lower extremity were frequently used strategies in both patients, whereas facilitated walking was used mainly with NM. This reinforces the view that therapy based on the Bobath concept is tailored to suit each individual. Thus, the process of physical therapy needs to be carefully examined when comparing results across patients.

This approach would need to be replicated in large numbers of patients to evaluate the effectiveness of gait re-education based on the Bobath concept. Further exploratory work of this nature is needed to arrive at a consensus on best practice in gait re-education derived from everyday practice. This can then be put to the test in experimental studies in order to base neurological physical therapy on evidence, rather than on anecdotal clinical experience.

## References


**1** Jorgenson HS, Nakayama H, Raaschau HO, Olsen TS. Recovery of walking function in stroke patients: the Copenhagen Stroke Study. *Arch Phys Med Rehabil.* 1995;76:27–32.

**2** Winter DA, Patla AE, Frank JS, Walt SE. Biomechanical walking patterns changes in the fit and healthy elderly. *Phys Ther.* 1990;70:340–347.

**3** Olney SJ, Richards C. Hemiparetic gait following stroke, part 1: characteristics. *Gait & Posture.* 1996;4:136–148.

**4** Moseley A,Wales A, Herbert R, et al. Observation and analysis of hemiplegic gait: stance phase. *Australian Journal of Physiotherapy.* 1993; 39:259–267.

**5** Moore A, Schurr K, Wales A, et al. Observation and analysis of hemiplegic gait: swing phase. *Australian Journal of Physiotherapy.* 1993; 39:272–278.

**6** De Quervain IA, Simon SR, Leurgens S, et al. Gait pattern in the early recovery period after stroke. *J Bone Joint Surg Am.* 1996;78:1506–1514.

**7** Ashburn A, Partridge C, De Souza L. Physiotherapy in the rehabilitation of stroke: a review. *Clinical Rehabilitation.* 1993;7:337–345.

**8** Lennon SM. The Bobath concept: a critical review of the theoretical assumptions that guide physiotherapy practice in stroke rehabilitation. *Physical Therapy Reviews.* 1996;1:35–45.

**9** Hesse SA, Jahnke MT, Schaffrin A, et al. Immediate effects of therapeutic facilitation on the gait of hemiplegic patients as compared with walking with and without a cane. *Electroencephalogr Clin Neurophysiol.* 1998;109:515–522.

**10** Bobath B. *Adult Hemiplegia: Evaluation and Treatment.* Oxford, England: Heinemann; 1990.

**11** Ryerson S, Levitt K. *Functional Movement Reeducation.* London, England: Churchill Livingstone; 1997:1–13, 20, 26–43, 58–68, 458–468.

**12** Lynch M, Grisogono V. *Strokes and Head Injuries: A Guide for Patients, Families, and Carers.* London, England: John Murray; 1991:23, 114–116.

**13** Stroke Unit Trialist's Collaboration. Collaborative systematic review of the randomised inpatient (stroke unit) care after stroke. *BMJ.* 1997;314:1151–1159.

**14** Edwards S. *Neurological Physiotherapy: A Problem-Solving Approach.* London, England: Churchill Livingstone; 1997:22–32.

**15** Davies PM. *Steps to Follow: A Guide to the Treatment of Adult Hemiplegia.* Berlin, Germany: Springer Verlag; 1985.

**16** Edwards S, Partridge C, Mee R. Treatment schedules for physiotherapy research. *Physiotherapy.* 1990;76:605–607.

**17** Carr JH, Shepherd RB, Nordholm L, Lynne D. Investigation of a new motor assessment scale for stroke patients. *Phys Ther.* 1985;65:175–180.

**18** Ashburn A. A physical assessment for stroke patients. *Physiotherapy.* 1982;68:109–113.

**19** Bohannon RW, Smith MB. Interrater reliability of a modified Ashworth scale of muscle spasticity. *Phys Ther.* 1987;67:206–207.

**20** Prince F, Corriveau H, Hebert R, Winter DA. Gait in the elderly: a review. *Gait & Posture.* 1997;5:128–139.

**21** Hesse SA, Jahnke MT, Schreiner C, Mauritz KH. Gait symmetry and functional walking in hemiparetic patients prior to and after a 4-week rehabilitation programme. *Gait & Posture.* 1993:1:166–171.

**22** Hesse SA, Jahnke MT, Bertelt CM, et al. Gait outcome in ambulatory hemiparetic patients after a 4-week comprehensive rehabilitation program and prognostic factors. *Stroke.* 1994;25:1999–2004.

**23** Carr JH, Shepherd RB. *Neurological Rehabilitation: Optimising Motor Performance.* Oxford, England: Butterworth-Heinemann; 1998.

## Appendix.
Content of Treatment Sessions

Techniques/activities were grouped into 4 categories according to the treatment goal, preparation, facilitated movements, gait-specific activities, and functional activities.

**A. Preparation.** Normalization of tone using proximal mobilization of the trunk, shoulder girdle, or pelvis.[12,14] Realignment of joints and muscles using specific rotatory mobilization of muscle. This refers to the use of a linear stretch in the direction of the muscle fibers while maintaining stability through improved alignment of the appropriate joints.[a]

1. Circular trunk mobilizations
2. Shoulder girdle mobilizations
3. Inhibitory mobilizations of any specific muscle (see definition above)

**B. Facilitated movements.** Performance of normal movement patterns of the trunk, pelvis, and limbs with the therapist guiding the movements while providing proximal stability to allow for selective movement in the limbs.[15] Facilitated movements were subgrouped according to body segments: proximal (trunk, pelvis, hip), distal (knee, ankle, foot), and upper limb.

**Proximal**

4. Weight transfer to unaffected side (sitting)
5. Weight transfer to affected side (sitting)
6. Anterior/posterior pelvic tilt (sitting)
7. Lateral pelvic tilt (sitting)
8. Moving the trunk over the affected arm with weight bearing on the arm (sitting)
9. Reaching to the unaffected side (sitting/standing)
10. Weight transfer in stride standing (standing)
11. Prone standing (in standing, the patient's upper body is supported on a treatment bed placed at waist height in front)
12. Weight transfer in step position (standing)
13. Anterior/posterior pelvic tilt (standing)
14. Reaching to the unaffected side (standing)
15. Reaching across the body with the unaffected limb to the affected side (standing)
16. Knee flexion/extension with unaffected foot on a step (standing)
17. Bridging (supine)
18. Holding different positions with the affected lower limb (supine)
19. Selective movement of the hip (supine/side lying) (basic movement patterns of the hip; this refers to the ability to move the hip independently from the knee or foot)

**Distal (leg)**

20. Selective movement of the knee (supine)
21. Selective movement of the foot (supine)
22. Placing the lower limb (supine) (the response of the lower limb to being moved by the therapist)

**The arm**

23. Selective movement of the upper limb (supine)
24. Reaching to the affected side with the affected upper limb (sitting/standing)
25. Holding the upper limb (supine)
26. Placing the upper limb (supine) (the response of the upper limb to being moved by the therapist)

**C. Gait-specific activities.** Working on the different phases of gait or walking with the assistance of the therapist.

**Stance phase re-education**

27. Stepping with the unaffected lower limb forward
28. Stepping with the unaffected lower limb backward
29. Stepping with the unaffected lower limb sideways
30. Stepping with the unaffected lower limb on and off a step

**Swing phase re-education**

31. Stepping with the affected lower limb

**Walking**

32. Walking around a plinth (side stepping or using the treatment bed for support on the unaffected side)
33. Walking

**D. Functional activities**

34. Standing up from sitting
35. Stair climbing

[a] Mary Lynch, British Bobath Tutors' Association; personal communication; March 2000.