Finding An
Effective Treatment

**NeuroCom®
International, Inc.**

Five Years Post Stroke

A 70 year-old male with a five-year history of left medullary stroke was referred to the balance center by his family practitioner because of increased complaints of difficulty walking and further restriction of his daily life activities. These new complaints followed a brief hospitalization for a gastrointestinal problem.

His initial history and rehabilitation evaluation at the balance center revealed a number of problems consistent with his history of stroke.

- **Medical History**: Left medullary CVA (chronic)
- **Previous Work-up/Test Results**: MRI was negative for a new CNS event
- **Physical Examination**: Strength grossly within functional limits
- **Observational Tests**: Berg Balance Scale: 54/56 (within normal limits for age), Gait speed: 100 cm/sec (within normal limits for age) with deviations including right leg circumduction, unequal stride length
- **Other**: Lower back and buttock pain

Initial Impressions: Neither the physical examination nor the observational balance or gait function tests identified a specific cause which could account for the patient's increasing difficulties with daily activities. Hence, this evaluation provided no specific guidance as to the most effective treatment plan.
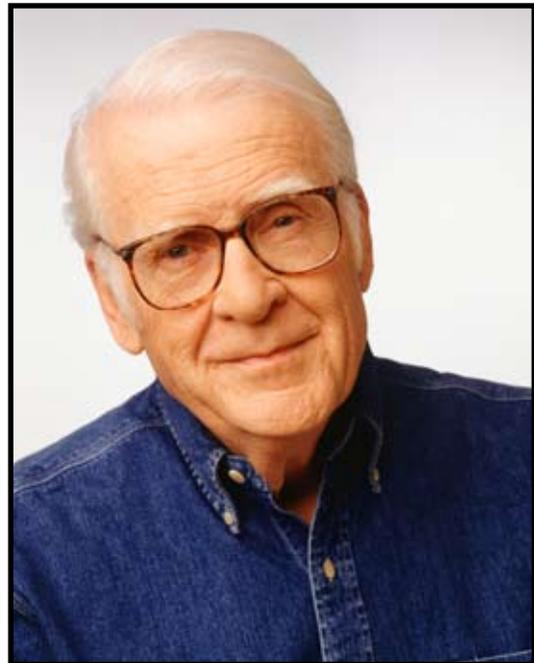
OUTCOMES

Objective assessment identifies specific system impairments and the interaction of those impairments (both acute and chronic) which allows for the classification of neurologically impaired patients into separate treatment categories. In this way, medical management and rehabilitation plans were designed to focus on changeable impairments, and to establish baseline measurements to evaluate patient progress through the rehabilitation process.

Inside Inside You'll Find ...

- An evidence–based clinical management approach which directs and documents appropriate functional prognosis, treatment planning, and outcome.
- A look beyond the medical diagnosis to a functional outcome.

Balance Center Impairment Evaluation

Because the initial clinical examination and observational tests did not point to a clear diagnostic hypothesis beyond the prior left CVA, further evaluation to answer the following questions was necessary to identify specific problems and thereby focus the treatment plan.

1. To what extent has generalized deconditioning associated with the hospitalization contributed to reduced mobility function?
2. Can declines in mobility function be attributed to losses in lower extremity strength and range of motion and concomitant worsening of the patient's right-leg motor deficit?
3. Are there identifiable central nervous system pathologies in addition to the CVA contributing to the patient's mobility deficits?
4. Are there specific balance system pathologies contributing to the patient's declining mobility function? Are the impairments changeable?
   - o Vestibular system
   - o Proprioception
   - o Central adaptive control
   - o Coordination of balance movements
5. Which site-of-lesion tests are indicated, if any?   o VNG/ENG   o EMG
6. Which impairment tests are indicated?   o CDP   o Gait Analysis

The absence of a clear diagnostic hypothesis creates a common clinical dilemma: which tests will contribute to the management of the patient? The commonly used, but usually inefficient, approach is a battery of diagnostic tests which focus on sensory, motor, and related CNS functions from the viewpoint of documenting a disease process and/or a structural lesion. A growing body of clinical evidence indicates that initial objective testing focused on impairments rather than on localizing pathologies may reduce the need for a wider range of tests.

BALANCE IMPAIRMENT TESTING:
Computerized Dynamic Posturography (CDP) is an objective series of tests that isolate and quantify impairments to individual sensory inputs, motor control outputs, and central integrative functions that collectively maintain balance. The full CDP test battery is comprised of three protocols: Sensory Organization Test (SOT), Motor Control Test (MCT) and Adaptation Test (ADT). CDP also includes additional performance tests: Limits of Stability (LOS) and Rhythmic Weight Shift (RWS) that objectively assess a patient's ability to voluntarily control the body position over the base of support. This case shows how this combination of protocols focus both the diagnostic process and the subsequent treatment design.

The **Sensory Organization Test (SOT)** quantifies the patient's ability to make effective use of vestibular, visual, and somatosensory information as well as ability to select the appropriate sense or senses under conflict conditions. The SOT results (Figure 1) indicate that the patient is not effectively using information from the vestibular system. However, the patient's overall sensory balance control (Composite Score) is within acceptable age matched performance ranges, with normal utilization of visual and somatosensory inputs.
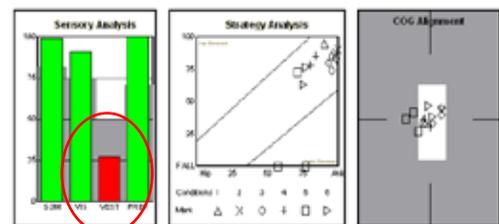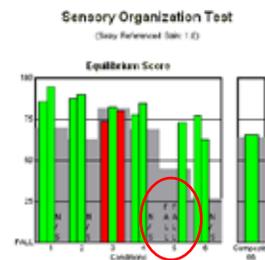

Figure 1: The patient is unable to effectively use vestibular cues for balance, and center of gravity position and control are ineffective under these conditions.

The **Motor Control Test (MCT)** quantifies the timing, strength, and coordination of the patient's automatic postural responses to external perturbations. The MCT results shown in Figure 2 indicate that motor reactions in the right leg are both delayed and weak, while reactions of the left leg are within normal limits. These results are consistent with the history of left CVA and indicate a motor impairment that is most likely unchangeable.
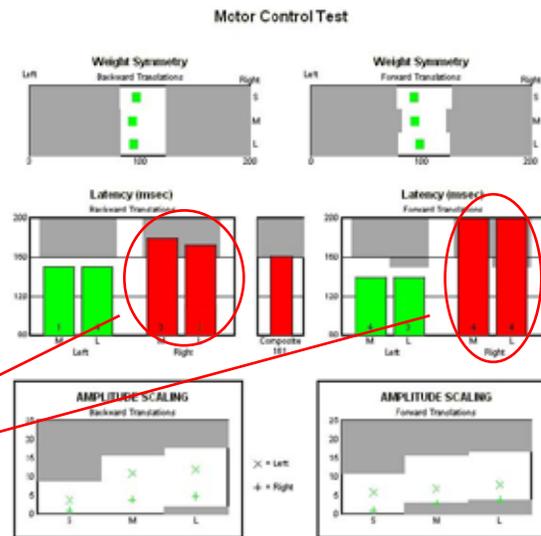
The patient's automatic motor responses are ineffective (increased latency) and weak (decreased amplitude) on the right.

Figure 2.

The **Limits of Stability Test (LOS)** test quantifies the patient's ability to voluntarily control movements of the center of gravity (COG) over the base of support. Voluntary COG control is essential to normal gait, as well as to transfer activities such as sitting, standing, and reaching. The LOS results indicate that the patient's ability to control COG movement to the back right of center is significantly impaired, while movements in the remaining directions are performed within low normal ranges (at 40%-50% LOS).
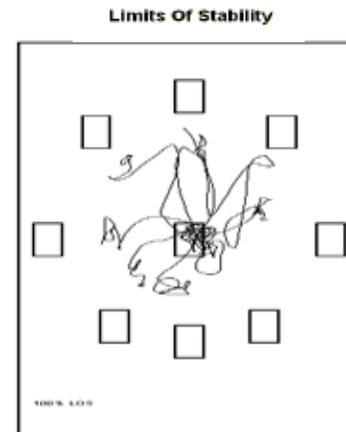

Figure 3.

The **Rhythmic Weight Shift (RWS)** test quantifies the patient's ability to coordinate the amplitude and timing of rhythmic COG movements over the support base. The RWS results show coordination of movements substantially impaired in the forward-backward direction, while coordination in the lateral direction is in the low normal range.
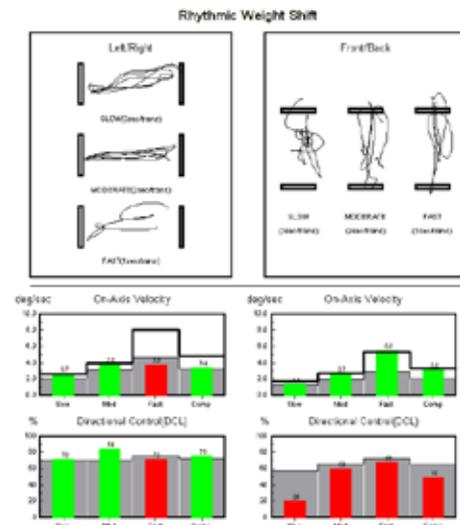

Figure 4.

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Impression

The MCT and LOS tests documented motor impairments while moving automatically and voluntarily to the right of center that are consistent with the patient's history of a left CVA. These impairments included delayed and weak automatic responses in the right leg and reduced voluntary movement distances. The RWS test indicated poorly coordinated forward-backward movements, further factors contributing to poor gait control.

The SOT results document significant impairment in the patient's ability to effectively use vestibular inputs for balance, an impairment that has no direct physiological relationship to the medullary stroke. CDP is a test of impairment rather than pathology. The SOT results alone cannot determine whether the vestibular impairment results from recently acquired vestibular system pathology or a change in compensation from a pre-existing vestibular deficit following hospitalization and inactivity.

The normal functioning of automatic and volitional movements to the left, and the normal use of somatosensory and visual inputs during the CDP evaluation suggests that focused sensory and motor impairments are the primary contributors to the patient's decreased ability to perform daily life activities. Generalized deconditioning is less likely to be the cause. The **combination** of impairments is causing more severe impact of daily life activities than any single impairment alone. The vestibular impairment and the voluntary motor control impairments may be amenable to rehabilitation. If function can be improved in these two areas, the patient is likely to benefit substantially in daily life activity, even with the automatic motor control impairments which are permanent consequences of the stroke.

In deciding on the next course of action relative to the vestibular impairment, two options were considered:
- Perform a complete evaluation of the patient's vestibular system including ENG/VNG to determine if the patient has an unstable and/or progressive vestibular pathology amenable to medical treatment.
- Proceed with a treatment plan focused on the impairments identified by the clinical examination and the CDP results and closely monitor progress. This approach is based on the assumption that vestibular pathology, if it exists, is likely to be stable and the functional improvements should be measurable within 30-60 days.

Recommendation

Neither the symptoms described in the history nor the findings of the clinical examination were consistent with recently acquired vestibular pathology. The working hypothesis was that the vestibular impairment represented a decline in compensation from a pre-existing condition following the patient's hospitalization. According to this hypothesis, the vestibular impairment is the result of stable pathology that will respond favorably to rehabilitation therapy.

Treatment Plan

The decision was made to customize a treatment plan that focused on specific sensory and motor impairments and on the functional limitations described in the history and identified by the clinical examination:
- **Ineffective Use of Vestibular Inputs and Poor Voluntary Motor Control:** The patient performed weight shifting exercises while standing on compliant support surfaces and within moving or absent visual surrounds. The degree of challenge to the vestibular system was systematically increased over the course of therapy by initially destabilizing the support surface or the visual surround, combining the two challenges, and then progressively increasing the degree of instability provided by both.
- **Gait and Movement Coordination (Function):** The patient practiced walking on a treadmill over a range of speeds. To increase the challenge and to combine motor and sensory training tasks, the patient walked on the treadmill while moving the head from side to side at increasing speeds and with eyes closed.
- **Health and Wellness:** The patient participated in a Yoga class.

Overview

Physical Exam/ History →

Unremarkable for acute change in central or peripheral nervous system. Gait dysfunction.

Diagnostic Hypotheses →

Gait dysfunction secondary to chronic CVA with hemiparesis deconditioning, weakness.

Medical Work–Up →

MRI: Normal
No acute pathology

Medical Diagnosis →

- Latent effects of stroke
- Deconditioning
- Gait ataxia

Impairment Work–Up →

Tests to isolate impairments:

Computerized Dynamic Posturography
      Sensory Organization Test
      Motor Control Test
Voluntary Motor Control testing
      Limits of Stability
      Rhythmic Weight Shift

Impairment Diagnosis →

Sensory and motor balance problem secondary to hemiparesis, hospitalization (vestibular decompensation) vs. aging.

Functional Outcome →

- 21 day re-assessment identified resolution of the sensory balance problem and significant improvements in voluntary motor control, translating to improved functional independence and safety.

- Data provided documented evidence of status to assist in rehabilitation discharge planning and in modification of the treatment for the outpatient treatment phase.

Influence of CDP/computerized tests on medical decision making?

1. CDP showed that the patient lacked adequate vestibular compensation.
2. CDP directed the management approach in general and the rehabilitation approach specifically, narrowing the treatment modalities required.
3. CDP provided an objective benchmark for the decision to safely perform ADLs.

Functional Outcome

- **The Sensory Organization Test (SOT):** The patient's ability to make effective use of vestibular inputs improved to well within the normal range following therapy. (See Figure 5.)
- **The Motor Control Test (MCT):** Automatic responses in the right leg continued to be abnormally prolonged and weak, indicating no changes in these impairments.
- **The Limits of Stability (LOS)** and **Rhythmic Weight Shift (RWS)** Tests: The patient's ability to coordinate forward-backward movements was significantly improved. (See Figures 6 and 7.)
- Independent community level ambulation without a device, no patient complaints of significant balance control problems. Patient attempted to return to golf.
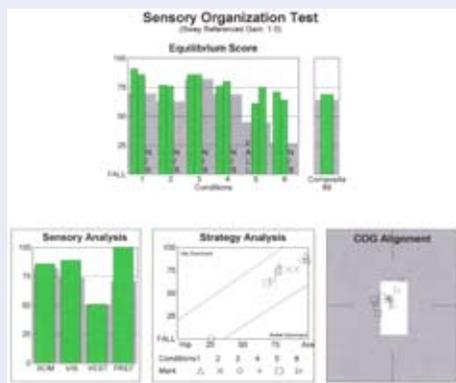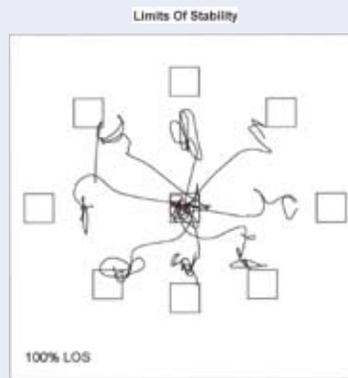

Figure 5: Post-treatment.
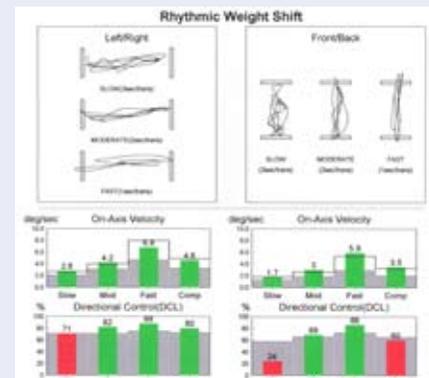
Figure 6: Post-treatment.

Figure 7: Post-treatment.

Summary

How did the impairment information provided by CDP contribute to the treatment plan and the outcome?

- **Medical History:** did not explain the patient's recent functional declines
- **Physical Examination:** did not explain the patient's recent functional declines
- **CDP Information:** a combination of motor control deficits consistent with the patient's history of medullary stroke and the compounding effect of a vestibular impairment were consistent with the patient's significant functional problems in daily life mobility tasks. These findings provided a specific focus for rehabilitation. Improvements in the patient's ability to effectively use vestibular inputs and to coordinate rhythmic movements provided measures of progress that were both objective and consistent with the patient's reported improvements in daily life activities.

Computerized balance control testing, including CDP, provided:

- CDP information provided a sub–classification of this patient post–stroke that identified the specific impairments limiting this patient's function.
- This sub–classification provided a basis for a focused rehabilitation program limited to the impairments identified.
- CDP information provided a basis for determination of functional prognosis, as well as the means to determine if that outcome was achieved.