Motor and Perceptual Impairments in Acute Stroke Patients: Effects on Self-Care Ability

Birgitta Bernspång, OT, Kjell Asplund, MD, Sture Eriksson, MD, and Axel R. Fugl-Meyer, MD

The relative importance of motor, perceptual, and some cognitive functions for self-care ability was analyzed in a representative sample of 109 subjects within 2 weeks of acute stroke. Forty-nine patients (45%) were dependent or partly dependent in self-care. Profound motor dysfunction was present in 39%, low-order perceptual deficits in 10%, high-order perceptual deficits in 60%, and disorientation in time and space in 13% of the patients. There was a significant covariation between motor function and self-care ability and between low-order perception and orientation function. Low-order and high-order perception covaried only weakly. Discriminant analyses showed that the actual level of self-care proficiency could be correctly predicted in 70% of the cases by the 4 indexes of motor function, low-order perception, high-order perception, and orientation. The dominating predictor was motor function, and the next highest was high-order perception. When a program for early training is designed with the aim to alleviate long-term self-care disability after stroke, correct assessment of motor and perceptual functions in the individual stroke patient is essential.

There is now considerable evidence that early mobilization and activation of patients with stroke is of benefit for their long-term functional outcome. However, most studies have been performed on patients selected for qualified rehabilitation weeks or months after the cerebrovascular accident. In such patients, some major determinants for not attaining a high level of self-care have been identified: age, severe motor impairment, perceptual deficit, incontinence, difficulties in psychological adjustment, and lack of family involvement.

All members of the stroke team have essential roles in the early activation and retraining of the stroke patient. One of the major tasks of the occupational therapist is to diagnose and classify impairments within the spheres of mobility, sensing, and cerebral integration. This is a prerequisite when designing a treatment program.

According to ecological perceptual psychology, perception should be regarded as a quality of sensing. Using multifactorial analysis, we have found previously that each of 12 different items used to describe visual perception could be assigned to one of two factors. One factor characterizes low-order perception; the other composite factor mainly describes high-order, meaningful perceptual functions. There is little overlap between the two factors.

In the present investigation, the effects of impairment of motor control, perception, and cognition on the ability to manage self-care in the first 2 weeks after stroke have been studied in a carefully characterized patient sample. Particular emphasis has been placed on perceptual deficits at low- and high-order levels. This investigation is part of a prospective 5-year study of impairment, disability, and handicap after stroke.

Subjects and Methods

Every patient admitted to the Stroke Unit of Umeå University Hospital during a 3-year period was considered for the study. The 6-bed stroke unit admits patients with acute cerebrovascular disease, except subarachnoid hemorrhage, directly from the emergency room. The hospital is the only one in the district treating patients with acute stroke. The method for patient allocation yields a sample that is representative for all those admitted for acute stroke in the hospital catchment area with respect to age and sex, severity of neurologic deficits on admission, and prevalence of concomitant disorders. All patients in the stroke unit are subjected to a structured program for evaluation, nursing, medical treatment, and early activation. Diagnostic procedures include a computed tomography (CT) scan of each patient.

Inclusion and Exclusion of Patients

Figure 1 is a flow chart of excluded and included patients. Initially, 267 patients were considered for the study. Mean ± SD age was 72 ± 10 years, and mean length of stay in the stroke unit was 21 days. As this investigation was designed to be part of a 5-year follow-up of patients with manifest stroke, subjects with transient ischemic attack (TIA) or brain lesions on CT scan unaccompanied by persisting signs or symptoms were excluded. Patients who died within 1 month and...
2 patients transferred to other hospital departments were also excluded from the study. Motor and perceptual assessments require patient cooperation; therefore, a number of individuals could not be assessed because they had aphasia or were confused. Patients who had already participated in the study were not included again if they were readmitted to the stroke unit. In 12 patients who originally entered the study, data were incomplete, and these patients were excluded from the final data analysis (Figure 1).

The present report includes the remaining 109 patients. Their mean ± SD age was 69 ± 10 years, and mean stay in the stroke unit was 18 days. In Tables 1 and 2, some essential characteristics of the total stroke population and the 109 patients that comprise the present study are compared. As a result of the eligibility criteria, impaired consciousness on admission to the stroke unit was less common in patients included in the study than in the entire stroke population, fewer died, and a larger proportion was able to return home (Table 1). Cerebrovascular diagnoses were distributed differently in the 2 groups (Table 2). Of the study patients, 66 (60%) had a left hemisphere and 41 (38%) had a right hemisphere lesion based on clinical signs and findings on CT scan, whereas 2 (2%) had bilateral symptoms and no brain lesion on CT scan.

Assessment Methods

All evaluations were made within 2 weeks of stroke onset.

Self-care ability. The ability to manage self-care was assessed in the morning by an occupational therapist according to the principles described by Fugl-Meyer and Jääskö. Twenty items relating to dressing, grooming, and eating were scored from 0 (totally dependent) to 3 (independent without aids), giving a maximum score of 60 points. On the basis of the total self-care score, patients were classified as dependent (score 0–39), partly dependent (score 40–59) or independent (score 60) (Table 3).

Motor function. A physiotherapist assessed the patients’ degree of volitional motor control according to the principles described by Twitchell. The results are expressed by a 100-point scale, with 0 equivalent to flaccid paralysis and 100 to normal function. Scores ≤ 84 points designate hemiplegia, 85–95 hemiparesis, and 96–99 slight motor impairment with dyscoordination.

Visual perception. The occupational therapist assessed the patients’ visual perception with a brief bedside test of 16 items (Table 3). This test is described in Table 2. Cerebrovascular Diagnosis at Discharge From Stroke Unit

<table>
<thead>
<tr>
<th>Cerebrovascular diagnosis</th>
<th>Total population (N = 267)</th>
<th>Study group (n = 109)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Nonembolic infarction</td>
<td>44</td>
<td>55</td>
</tr>
<tr>
<td>Embolic infarction</td>
<td>28</td>
<td>19</td>
</tr>
<tr>
<td>Transient ischemic attack</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Ill-defined cerebrovascular disease</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Diagnostic procedures and criteria described in detail in Ref. 1.

n, number of patients; values in percent.
Table 3. Items Used to Assess 109 Study Patients Within 2 Weeks After Stroke

**Self-Care**
- Grooming
  - Wash upper half of body
  - Wash lower half of body
  - Climb in and out of bathtub
  - Shower and dry oneself
  - Brush teeth, use tube of toothpaste
  - Comb hair
  - Cut nails
  - Manage in bathroom
- Dressing
  - Put on and take off shirt without buttons
  - Put on and take off blouse/nightie
  - Put on and take off socks
  - Put on and take off shoes
  - Put on and take off coat
  - Put outdoor clothes on and off a clothes hanger
  - Put on skirt and/or long trousers
  - Pick up small objects from the floor
- Eating
  - Eat prepared food
  - Drink from glass or cup
  - Butter slice of bread
- **Visual Perception**
  - Size estimation
  - Identification
  - Recognition
  - Form estimation
  - Identification
  - Recognition
  - Color estimation
  - Identification
  - Recognition
  - Point to body parts
  - Spatial relations
  - Identification
  - Recognition
  - Block design
  - Figure-ground; embedded figures
  - Draw a clock
  - Draw a person
  - Copy geometric figures
  - Complete a goblet
  - Object constancy

**Orientation in time and space**
- How long have you stayed here? (week, month, half-year)
- What time of the day is it? (morning, afternoon, evening)
- What time is it?
- Where are you? (institution)
- Where are you? (town)

The items were presented with alternatives to give the right answer, the score was 1, and total inability to answer was scored as 0. Thus, the cumulative maximum score was 10 points.

Statistical Evaluations

In the statistical evaluations, discriminant analysis was used to study to what extent a given set of functional variables (describing locomotor, perceptual, and cognitive functions) could predict self-care ability. The independent variables were dichotomized as follows: 1) motor function — hemiplegia/hemiparesis vs. slight motor impairment/normal function, 2) low-order and high-order visual perception — < maximum vs. maximum score, and 3) orientation in time and space — < maximum vs. maximum score.

To correlate the different functional variables, Pearson's correlation coefficients were calculated. In these calculations, motor, perceptual, and cognitive variables were dichotomized as above, whereas self-care ability was subdivided into dependent, partly dependent, and independent groups as described above. SPSS software was used for the calculations.

Results

Twenty-six of the 109 patients (24%) were dependent in self-care and 23 (21%) partly dependent; the remaining 60 (55%) had normal self-care proficiency. Hemiplegia or hemiparesis was present in 42 of the 109 patients (39%). The remaining 67 (61%) had no or only slight motor impairment (≥96 points on the 100-point motor scale).

In Table 4, the results of testing for visual perception and orientation in time and space are shown. Deficits in high-order perception were present in more than half of the patients, whereas only a small minority had submaximum scores in low-order perception and orientation.

Low-order perception was correlated with orientation in time and space (r = 0.60) (Table 5); this correlation was of the same magnitude as that between motor function and self-care ability (r = 0.64). Other correlations between the functional variables were considerably weaker. It was particularly worthy of note that the correlation between low-order and high-order perception was rather weak (r = 0.23).

Two discriminant analyses, using self-care ability as the dependent variable, were performed (Table 6). The first analysis (Group 1 membership) included motor function, and low-order and high-order perception. In the second discriminant analysis (Group II membership), the same 3 independent variables were used, and orientation in time and space was added. The two analyses gave identical proportions of predicted levels of self-care ability. Both groups of independent variables correctly classified self-care ability in 70% of the patients. All but 2 of the 26 dependent patients and the...
Table 5. Pearson Correlation Coefficients Between Motor Function, Low-Order Visual Perception, High-Order Visual Perception, Self-Care Ability, and Orientation in Time and Space

<table>
<thead>
<tr>
<th></th>
<th>Low-order perception</th>
<th>High-order perception</th>
<th>Self-care ability</th>
<th>Orientation in time and space</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor function</td>
<td>0.05</td>
<td>—</td>
<td>—</td>
<td>0.09</td>
</tr>
<tr>
<td>Low-order perception</td>
<td>0.08</td>
<td>0.23</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>High-order perception</td>
<td>0.64</td>
<td>0.16</td>
<td>0.23</td>
<td>—</td>
</tr>
<tr>
<td>Self-care ability</td>
<td>—</td>
<td>—</td>
<td>0.16</td>
<td>—</td>
</tr>
<tr>
<td>Orientation in time and space</td>
<td>0.09</td>
<td>0.60</td>
<td>0.33</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Motor function, hemiplegia/hemiparesis vs. slight discoordination/normal; self-care ability, dependent vs. partly dependent vs. independent; orientation in time and space, impaired vs. normal.

great majority (49 of 60) of the independent patients were correctly classified. On the other hand, correct classification was obtained in only 3 of the 23 patients who were partly dependent.

Table 6 also shows that motor function was that variable with the highest predictive power for self-care ability; high-order perception also contributed. The low predictive power of low-order perception in the Group I discriminant analysis (0.17) was further reduced when orientation in time and space was taken into account.

Discussion

These results show that motor function, if appropriately measured, is by far the most important determinant of self-care ability during the first 2 weeks after stroke. In addition, complex perceptual qualities (here assessed as high-order perception) predict the level of self-care ability.

This prospective study is unique in that the patients were recruited from an unselected stroke population. The stroke unit admits patients who are representative of all those admitted for acute stroke within a strictly defined geographic area. However, it is not possible to assess perception in all patients early after stroke. In accordance with the eligibility criteria of the present study, the study group had a lower prevalence of death-related prognostic factors on admission than an unselected stroke population.

The theoretical basis for the method used to measure motor function is the sequential development of motor function during ontogeny. It has previously been demonstrated that, in practice, the method measures this sequence of development, i.e., it is internally valid. The present finding that motor impairment assessed in this manner strongly predicts self-care ability after stroke confirms previous observations.

Visual perception showed only weak correlation with motor function. High-order perception also added to motor function to predict self-care ability early after stroke. Hence, perception and motor function should be assessed separately in stroke patients.

It has been suggested that perception, i.e., the ability to extract information from the environment, has been "picked up over an enormous history of evolutionary internalization." According to this concept, the organism "resonates" to incoming information. In the present study, items supposed to reflect low-order and high-order perception respectively showed only low covariation and had a distinctly different impact on self-care ability early after stroke. This supports the contention that the broad categorization into low-order and high-order perception is indeed clinically meaningful. Thus, there appear to be different levels of resonance with more or less specialized modes of perception. At a lower level of resonance, color, form, etc., are perceived. Higher levels of perception involve more complex qualities, which include a spatial component. Intact perception at this higher level is necessary to organize the layout of the environment. Therefore, deficits in high-order perception adversely affect self-care ability after stroke, as demonstrated by the present results.

Low-order perception and orientation in time and space had similar, low predictive power for self-care ability. This suggests that poor sensing of the very simple stimuli used to test low-order perception reflects disorientation. It seems that some degree of cognition is necessary to sense simple stimuli that appear meaningless.

In stroke patients, a multitude of clinical problems have been ascribed to perceptual deficits. These include neglect, impaired spatial organization, right–left disorientation, dyspraxia, and the defense mechanism denial. Anosognosia, which is a general term involving both neglect and denial, has previously been reported to be present in 37–44% of unselected stroke patients during the acute phase of the disease. In the present study, a higher prevalence (57%) of perceptual

Table 6. Discriminant Analyses of Actual vs. Predicted Memberships for Level of Self-Care Ability in 109 Patients

<table>
<thead>
<tr>
<th>Actual membership</th>
<th>Predicted Group I membership</th>
<th>Predicted Group II membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Predicted dependent</td>
<td>Partly independent</td>
</tr>
<tr>
<td>Dependent</td>
<td>26</td>
<td>92</td>
</tr>
<tr>
<td>Partly dependent</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>Independent</td>
<td>60</td>
<td>15</td>
</tr>
</tbody>
</table>

Standardized canonical discriminant function coefficients: Group I, motor function 0.96, high-order perception 0.28, low-order perception 0.17; Group II, motor function 0.96, high-order perception 0.24, orientation in time and space 0.16, low-order perception 0.09. Actual membership as number of patients; predicted membership as %.
deficits was found. Yet perception was tested as a more specific and restricted function than anosognosia, and only patients with moderate impairment of higher cerebral integration were included (patients with severe aphasia and/or cognitive impairment were excluded). It appears that deficits in perception can be demonstrated in the majority of stroke patients, provided an appropriate testing procedure is used.

The relative importance of different functional deficits during the various phases of cerebrovascular disease probably has direct implications for rehabilitation. In the individual patient, detailed mapping of motor function and perception are important when designing a rehabilitation program. It has been demonstrated that perceptual treatment programs can accelerate the recovery of perceptual function after brain damage.\(^{27,28}\) The impact of training could be on specific perceptual domains such as visual analysis and organization\(^ {29,30}\) and on behavioral anomalies, e.g., denial and distorted body reference.\(^ {31}\)

It previously has been shown that comprehensive programs for early reactivation and functional training after stroke improve long-term functional outcome and reduce the need for long-term institutional care.\(^ {13,14}\) It is not clear exactly which constituents of such a composite treatment program are of major importance for improved outcome. The present demonstration that locomotor dysfunction and high-order perception together determine much of the self-care ability emphasizes that training of these functions is particularly important in the first weeks after stroke.

Appendix 1. Scoring for Perception

For items A, B, C, and E both recognition and identification are assessed (Table 3). Items H, I, J, and K all assess paper-and-pencil performance.

A. Size estimation. Three wooden cylinders are placed on a table in front of the patient who is asked to recognize, when presented with 2 duplicates, the correct length of the cylinders. The patient is then asked to identify the cylinders in order of length.

B. Form recognition. The patient is asked to identify 3 flat wooden figures of different shapes (triangle, square, and circle) without using her/his hands and to recognize 2 duplicates.

C. Color recognition. The patient is asked to identify 4 cards of different colors (blue, green, yellow, and red) and to recognize 2 duplicates.

D. Body parts. The patient is asked to point to or by other means to correctly identify left and right knees and both third fingers after the command "Show me your . . . ."

E. Spatial relations. The patient is shown 3 different cards each depicting a man with a ball in his hand, the hand being in different positions. The patient is first asked to identify the positions, then to identify (by comparison) 2 different duplicates.

F. Block design. The patient is given 6 cubes (3 blue, 1 red, 1 green, and 1 yellow) and asked to construct a simple L-shaped block design consisting of three cubes based on a design shown to her/him in a picture. She/he is told to use the minimum number of cubes necessary for the construction.

G. Figure–ground relations. The patient is shown a picture in which the upper part shows an embedded picture composed of 3 drawn objects, and the lower part displays 6 drawn objects. The patient is asked to identify the 3 objects which are also present in the upper picture (adapted from Ayres).

H. Draw a clock. The patient is asked to draw a clock in a predrawn circle.

I. Draw a person. The patient is asked to draw a frontal view of a person.

J. Copy figures. The patient is asked to copy 6 different geometric figures.

K. Complete a goblet. The patient is asked to complete the left and right sides of a predrawn half-goblet after seeing the complete picture.

L. Object constancy. The patient is asked to identify well-known everyday objects photographed from an unusual angle.

The total score for perceptual function ranges from 0 to 32.

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