Scand J Rehab Med 27: 211–217, 1995

DESCRIPTION AND VALIDATION OF A TEST OF MOTOR FUNCTION AND ACTIVITIES IN STROKE PATIENTS THE SØDRING MOTOR EVALUATION OF STROKE PATIENTS

Karen Margrethe Sødring, RPT,[1] Erik Bautz-Holter, MD, PhD,[1] Anne Elisabeth Ljunggren, RPT, PhD[2] and Torgeir Bruun Wyller, MD[1]

From the [1] University Section, Department of Geriatric Medicine and [2] Research Forum, Ullevål University Hospital, Oslo, Norway

ABSTRACT. A new method (The Sødring Motor Evaluation of Stroke Patients) has been developed for physiotherapists to evaluate motor function and activities in stroke patients. Its main characteristics are the assessment of motor activity without assisting the patient, and the use of a rating which reflects quantity as well as quality in motor performance. A hospitalised group of stroke patients ($n = 93$) was assessed three times after the acute event, by means of SMES. The data were analysed regarding construct validity as well as concurrent validity against another assessment method. Factor analyses showed a reasonably stable three-factor pattern ("arm", "gross motor function", and "leg") which explained 84, 89 and 90%, respectively, of the variance at the three study points, with Factor 1 ("arm") as the dominant factor. The ordinality of the rating scale was assessed by means of linear regression analysis and found to be acceptable. The correlation coefficients were high between comparable parts of the new and the reference methods.

Key words: cerebrovascular disorders, rehabilitation, physical therapy, assessment, motor activity, reproducibility of results.

The Sødring Motor Evaluation of Stroke patients (SMES) comprises movements of the trunk and of the arm and leg at the paretic side, as well as balance and gait. The method is based on the concept of motor control, which is an important aspect in the physiotherapeutic approach to stroke rehabilitation. The rating, which reflects quantity as well as quality in motor performance, makes it relevant as a tool for physiotherapists in clinical work. The method is also supposed to possess some basic clinimetric criteria, which could make it eligible as an instrument for research. The evaluation of the patient's ability to perform unassisted seems to be the least biased way to assess motor capacity. Furthermore, the rating with a scale from 1 to 5 might be suitable to detect small yet clinically important changes in the patient's condition.

Several tests have been developed for the assessment of motor activity (1, 4–6, 10, 11). The common denominator of the relevant assessment instruments frequently mentioned is the registration of motor activity at different levels. All of them use numerical scoring systems which rate the quantity of the patient's performance.

The aim of this paper was to describe the SMES, examine its empirical structure regarding construct validity, and validate the scoring on the scale against a reference method (concurrent validity).

THE SØDRING MOTOR EVALUATION OF STROKE PATIENTS

The chart consists of 3 sections: arm, leg and gross function (trunk movements, balance and gait). There are 13 items for the function of the arm, including activities of the hand; one item for getting into sitting position; two items for sitting balance; and four items for the leg. The function of the arm is more complex than that of the leg, and therefore comprises more items. Activities including trunk movements, standing balance and gait are assessed with 12 items. A manual gives more detailed information about the testing procedure (15). The assessment is carried out in 5–25 minutes, depending on the condition of the patient and the experience of the evaluator.

Scaling

The scaling registers the quantity of active unassisted movement, and the quality with which the active movement is performed, as soon as the patient can move against gravity. Clinical observations were operationalised by describing all scores for each variable. From this interpretation, certain typologies crystallised. These were marked numerically as categories of quantity and quality during movement. Standardisation of all items and of the scoring system is part of this process. The test items range from simple movement patterns to more complex ones, and from test positions using a broad supporting base to test positions with a narrow base. In this way the demand for motor control increases. The sequence of the items is intended to be cumulative. In the arm tests this is further secured in a step-wise evaluation, first registering the control of the shoulder alone; then shoulder and elbow; and finally, the shoulder, elbow and hand as a unit.

All scores range from 1 to 5, the scores 3–4–5 representing increasing levels of motor control.

Arm and leg

1 cannot move actively.
2 can move actively, but not against gravity.
3 can move actively against gravity, but the performance is abnormal (moves in primitive synergies/ in mass movement pattern, with compensatory use of other parts of the body).
4 can move selectively, but the performance lacks full control (incoordinated, lacks full range of movement, retarded).
5 can move normally.

Walking on a surface and walking on stairs

1 Ambulates with the help of one person and technical aid (walks on stairs with one person and support on the bannister).
2 Walks with technical aid and/or a brace (walks with support on the bannister, always leading with the same foot).
3 Walks without technical aid or brace, but with poor/abnormal performance (walks with one foot after the other in normal sequence, but with heavy support on the bannister).
4 Walks in an almost normal way, but with lack of full control (walks on stairs in a normal sequence with one foot after the other, but with lack of full control).
5 Walks in a normal way (walks up and down stairs in a normal way).

Activities and balance reactions are assessed on a 1–5 point scale with 3 scores:

Activities

1 Cannot perform the activity.
3 Can perform with great difficulty.
5 Can perform safely.

Balance reactions (BR)

1 BR not present.
3 BR present, but timing and range of movement inadequate.
5 BR normal.

In our experience it has proved difficult to assess the quality of activities, including trunk movements and balance, on a 5-level scale. Movement patterns in man are manifold, and a variety of movement patterns can be accepted as normal. In order to obtain acceptable reliability, these activities are assessed with the use of only 3 levels where the numerical scores basically represent the same as they do for arm and leg. The score 3 (abnormal) is here replaced by "can perform with great difficulty", and 5 (normal) by "can perform safely". Correspondingly, for balance reactions 3 means "present, but inadequate in range and timing", and 5 "normal".

The code on the 5-level scale is different when assessing walking on a flat surface and on stairs. Most stroke patients are able to walk with the support of a crutch or a cane, possibly with a brace to stabilise the foot. Acknowledging this fact, we have in these four items departed from the purpose of the assessment, which is to reveal the motor resources in the patient's body, to study instead how technical aids become of practical importance in patients with extensive loss of function.

MATERIAL AND METHODS

Ullevål University Hospital serves as a general hospital for 175,000 people in the city of Oslo. All patients ($n = 270$) with a suspected acute stroke, admitted to the hospital during the period from September 1st 1992 to February 28th 1993, were considered for inclusion. The criteria for this were verified stroke, WHO's definition, subarachnoid haemorrhage not included (7), with onset less than 14 days before admission. Not only first strokes were included, as the method aims at being applicable also for patients with more than one stroke. A total of 99 patients did not meet the criteria. A further 18 died, 8 were discharged from hospital before the first assessment, 6 were unwilling to participate, and 46 were unable to participate because of a serious or unstable medical condition. Consequently, 93 persons gave informed consent and entered the study. Their mean age was 75 years (range 55–92), and there were 45 (48%) women; 41 has a right hemisphere lesion, 50 a lesion in the left hemisphere, and 2 had

Table I. *Factor analysis based on principal component, before Varimax rotation*

	Assessment point 1 ($n = 93$)			Assessment point 2 ($n = 87$)			Assessment point 3 ($n = 76$)		
Factor	Eigenvalue	Variance explained (%)	Cronbach's alpha*	Eigenvalue	Variance explained (%)	Cronbach's alpha*	Eigenvalue	Variance explained (%)	Cronbach's alpha*
1	24.0	70	0.98	26.2	77	0.99	27.2	80	0.99
2	3.0	9	0.97	2.8	8	0.98	2.6	8	0.99
3	1.6	5	0.94	1.3	4	0.97	1.2	2	0.98

* Cronbach's alpha based on items kept after rotation.

brain-stem stroke. Intracerebral haemorrhage was diagnosed in 7 cases, 79 suffered from cerebral infarction and 7 had an unspecified stroke. In 54 cases (59%) the symptoms of stroke commenced on the same day as the admission, in 20 (22%) the day before, and in 19 (20%) earlier.

The patients were assessed three times. The first assessment was performed 2–10 days after admission. At assessment point 2 (6–8 days after the first assessment) the number of participants was reduced to 87 due to 2 deaths, one patient suffering from a new stroke, and 3 patients not being available for assessment for non-medical reasons. At assessment point 3 (3 months ± 1 week after admission) the number of participants was further reduced to 76, owing to 8 additional deaths and another 3 patients not being available for assessment for non-medical reasons. The Sødring Motor Evaluation of Stroke Patients was employed at all assessment points.

Evaluation of concurrent validity can be performed when a method with relevant criteria exists. Regarding evaluation of motor control there is no agreement as to what should be considered a methodological "golden standard". The BL Motor Assessment, developed by Birgitta Lindmark (11), was chosen as the reference method owing to its documented high reliability and validity (11, 12), and because its two parts concerning motor function and activities (A + B and C + D) are comparable to the SMES. The BL Motor Assessment has been modified after Fugl-Meyer et al. (6) and comprises active movements, rapid changes in movement (part A + B), gross mobility, walking, balance (part C + D), sensation (part E), joint pain (part F) and joint motion (part G). Both the paretic and the non-paretic sides are assessed. The scoring on each item is ordinal with four levels. The method has been evaluated concerning content validity, concurrent/convergent validity, and predictive validity (12). We have later been informed that these analyses included arm and leg (parts A + B) only, not gross motor function, walking and balance (parts C + D). Consequently, only the arm and leg items of the SMES could be validated against the BL Motor Assessment, which was employed at the first and the third assessment points.

Statistical analyses were performed, using the BMDP statistical software (2).

RESULTS

Construct validity

Unidimensionality: The data from the three assessment points were separately subjected to factor analysis. Due to the high number of items, all with three or five scoring levels, a non-parametric factor analysis was not feasible. Parametric factor analysis, based upon principal components and using the BMDP 4M program, identified three factors with eigenvalues above 1.0. Together, they explained 84%, 89% and 90% of the variance at study points 1, 2 and 3, respectively. The factors were named "arm", "gross motor function", and "leg". Of these, "arm" explained 70, 77 and 80% of the variance (Table I).

Spector (14) stated that a minimum value of about 0.30 to 0.35 is required to consider that an item loads on any factor. We decided to use 0.50 as a cut-off value (Table II). The factor loadings were generally high, with the exception of two items, nos 33 and 34, which loaded over the cut-off value at one test point only. The factor structure of the data from all three assessment points was quite similar, except for two items (nos. 8 and 18) which loaded only on "arm" at test points 1 and 2, and only on "leg" at point 3. Items 5, 6 and 7 loaded on both "arm" and "leg" factors at test points 1 and 2.

The squared multiple correlation of each item with all other items had a range of 0.86–1.00 at study point 1, 0.81–0.99 at study point 2, and 0.96–1.00 at study point 3. The values of communality were also high (range 0.65–0.94; of which 27 out of 35 items had a communality value higher than 0.80), indicating a strong relation between the resulting factors and the items. Cronbach's alpha-coefficient was high for all three factors at all study points, ranging from 0.94 to 0.99 (Table I). This evidences a high internal consistency in the factors. Detailed results from the factor analyses may be obtained from the authors.

Ordinality: the scoring on the items of the SMES is ordinal with either three or five levels, depending on the function assessed. The summation of the scorings on items belonging to one particular factor to a sum score which describes the factor adequately requires the ordinal scaling to function well on each item. This

Table II. *Factor loadings obtained after Varimax rotation*

Hyphens indicate factor loadings below 0.50.
Factor loadings higher than 0.50, but still not included in our proposed factor structure, are placed within brackets.

Item #	Description	Assessment point 1 ($n = 93$)			Assessment point 2 ($n = 87$)			Assessment point 3 ($n = 76$)		
		Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Supine										
1	Flex hip/knee	–	–	0.83	–	–	0.80	[0.52]	–	0.74
2	Place feet on plinth	–	–	0.77	–	–	0.80	[0.52]	–	0.76
3	Dorsiflex ankle, leg straight	–	–	0.87	–	–	0.88	[0.62]	–	0.64
4	Bridging	[0.53]	–	0.66	–	–	0.80	[0.67]	–	0.56
5	Hand towards opposite shoulder	0.54	–	[0.70]*	0.58	–	[0.72]*	0.76	–	[0.51]*
6	Lift straight arm up/down	0.61	–	[0.63]*	0.61	–	[0.69]*	0.78	–	–
7	Arm up: flex/ext. elbow	0.69	–	[0.50]*	0.63	–	[0.63]*	0.84	–	–
8	From supine to sitting	0.71	–	–	0.70	–	–	–	–	[0.81]*
Sitting										
9	Hand towards shoulder	0.81	–	–	0.83	–	–	0.80	–	–
10	Support on straight arm	0.83	–	–	0.83	–	–	0.79	–	–
11	Lift straight arm up/down	0.83	–	–	0.82	–	–	0.80	–	–
12	Stretch arm forward	0.86	–	–	0.82	–	–	0.81	–	–
13	As #10; flex/ext. elbow	0.86	–	–	0.79	–	–	0.82	–	–
14	Flex./ext. of fingers	0.86	–	–	0.83	–	–	0.85	–	–
15	Opposition of fingers	0.88	–	–	0.85	–	–	0.83	–	–
16	*Nondominant hand*: Bring fork to mouth *Dominant hand:* Bring spoon to mouth	0.82	–	–	0.87	–	–	0.84	–	–
17	*Nondominant hand*: Hold meaty object with fork *Dominant hand*: Cut meaty object	0.80	–	–	0.84	–	–	0.83	–	–
18	Tip to affected side	0.72	–	–	0.72	–	–	0.45*	–	[0.64]
19	Tip to sound side	0.73	–	–	0.64	[0.52]	–	0.66	[0.60]	–
Standing										
20	Protective ext. of hands forward	0.66	[0.51]	–	0.82	–	–	0.76	–	–
Sitting										
21	From sitting to standing	[0.54]	0.62	–	[0.64]	0.59	–	–	0.66	[0.56]
22	Step forward with sound leg	–	0.72	–	[0.53]	0.70	–	–	0.77	–
23	Step forward with affected leg	–	0.74	–	[0.55]	0.68	–	–	0.78	–
24	Walk 10 m forward	–	0.80	–	–	0.75	–	–	0.80	–
25	Walk 2 m backwards	–	0.82	–	–	0.79	–	–	0.80	–
26	Walk 10 steps upstairs	–	0.84	–	–	0.86	–	–	0.86	–
27	Walk 10 steps downstairs	–	0.87	–	–	0.87	–	–	0.88	–
Standing										
28	Tip backwards	[0.56]	0.55	–	[0.59]	0.62	–	–	0.76	–
29	Tip, stand on sound leg	–	0.81	–	–	0.78	–	–	0.84	–
30	Tip, stand on affected leg	–	0.82	–	–	0.84	–	–	0.88	–
31	Standing to lying on floor	–	0.84	–	–	0.84	–	–	0.76	–
32	Lying on floor to standing	–	0.78	–	–	0.76	–	–	0.89	–
Prone										
33	Flex knee to 90°	[0.58]*	[0.44]*	[0.44]*	[0.66]*	–	[0.54]*	[0.45]*	[0.65]*	[0.47]*
34	Roll from supine to prone	[0.65]*	[0.44]*	–	[0.71]*	[0.43]*	[0.42]*	[0.49]*	[0.61]*	[0.42]*

*See comments in the text.

Table III. *Examples of regression coefficients from linear regression analyses performed after recoding of the polychotomous variables into dummy variables (n = 93)*

Item #	Regression coefficients Score = 1	Score = 2	Score = 3	Score = 4	Score = 5
Examples of well-functioning variables; 3-step scale					
8	0		24		49
19	0		18		35
28	0		16		31
Examples of acceptably functioning variables; 5-step scale					
9	0	9	23	41	53
11	0	10	25	45	55
23	0	11	18	25	44
Examples of mal-functioning variables; 5-step scale					
14	0	12	12	38	52
16	0	0	50	49	55
The same variables as above, after recoding through merging the scores 1 and 2, and the scores 4 and 5					
14	0		6		47
16	0		50		53

was examined by means of linear regression analyses. The scoring on each item, with N scoring levels, was described by means of N–1 dummy variables, using the lowest scoring level as the reference. The dummy variables were then introduced as explanatory variables for the sum score on the factor to which the item was allocated (3, 8). Given that it functioned well, the ordinal scaling of an item would then result in a relatively monotonous increase in the regression coefficients for the dummy variables describing each scoring level. In general, these regression analyses demonstrated good ordinality for the items scored on a three-level scale, while items scored on a five-level scale tended to have a less convincing, yet acceptable ordinality. The items concerning the hand functioned badly in this aspect (Table III).

Concurrent validity

Concurrent validity was analysed by means of Spearman's rank correlation coefficients. There was a high correlation between corresponding subsets of the SMES and the BL at both assessment points (Table IV). The correlation coefficients refer to the sum score within the respective factors. At assessment point 1, however, the data from 11 patients showed weak correlations between the arm scores of the two tests (Fig. 1): these patients had a high BL score and a low score on the SMES.

DISCUSSION

Construct validity

The following questions are essential when assessing construct validity and the justification for the summation of scores: *i)* Do the items reflect a unidimensional phenomenon of motor function? *ii)* Is the scaling of each item actually ordinal, with an increase in all scores from 1 to 5?

Unidimensionality: Even if all test items are supposed to measure motor function and activities it is not reasonable to assume *a priori* that this can be viewed as a unidimensional phenomenon. A conceivable explanation for this is that the clinical manifestations of stroke frequently show a picture where arm and leg are paretic to a different extent, reflecting the cerebral artery involved in each particular case. A unifactorial result from a factor analysis cannot therefore be expected. In accordance with this, in a

Table IV. *Spearman rank correlation coefficients between the sum scores of corresponding factors of the SMES and the BL scales*

	Assessment point 1	Assessment point 3
Sum of SMES arm items versus sum of BL arm items	0.94	0.94
Sum of SMES leg items versus sum of BL leg items	0.92	0.83

p values for all coefficients are < 0.001.

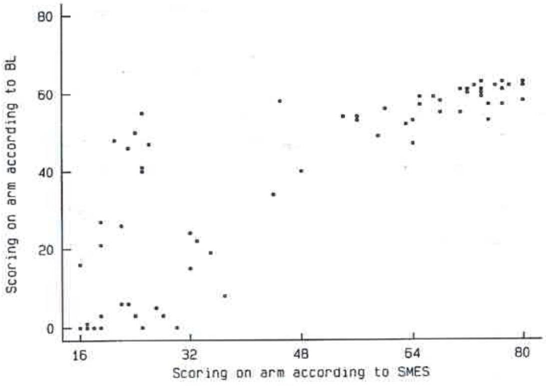

Fig. 1. Correlation between the arm scores of BL and SMES.

study on the construct validity of the BL test the arm and leg variables separated into different factors (11). Exploratory factor analysis can be used to study the dimensionality of a scale and how well the items correlate with one another. It is to be looked upon as an advisory means of enlightening and supporting the clinical judgement (14). The analyses resulted in three clinically explainable factors. The values were relatively consistent throughout the three assessment points. The items which do not demonstrate consistency are items 5, 6 and 7, which loaded on both factor "arm" and factor "leg" at assessment points 1 and 2. At assessment point 3, however, these three items loaded primarily on factor "arm". From a clinical point of view, the "arm" factor is the only one to which these items reasonably belong. As the loadings were evaluated as being sufficiently high in the "arm" factor, we decided to keep the items there. This line of argument also concerns item 4.

Further, the two items which involve both arm and trunk as well as the leg (nos. 8 and 18) loaded strongly on factor "arm" at test points 1 and 2. However, at test point 3, these two items loaded on factor "leg" only. The reason for the above-mentioned inconsistency at the third test point may be that the factor analysis reflects the way the patient moves. During the course of stroke improvement in the lower limb function may cause a changed pattern of movement, i.e. the patient swings his legs out when asked to sit up. Likewise, one would assume that the patients at this time are able to transfer more weight to the affected side, and thus produce better balance reactions in the uninvolved side, which results in more movements with the affected leg. We therefore decided to keep these two items in the assessment chart, despite their changing factor attachment in the course of the disease.

However, two other items (nos. 33 and 34; Table II) displayed unacceptable factor attachment through the test points, and loaded only once in the factor to which they clinically were expected to belong. These two items were considered not to fulfil the necessary requirements and were excluded from the test.

Ordinality: The weighting of each item in the SMES is based on empirical judgement, i.e. all items are weighted equally from 1 to 5. The ordinality proved to be satisfactory regarding the items with a three-level scoring. For the items with five scoring levels, ordinality was acceptable but with less uniformity between the coefficients, sometimes with less convincing differences between scores 1–2 and 4–5 (Table III). By merging these score levels, the ordinality may have been better; on the other hand, this might result in an assessment method less capable of detecting small changes towards improvement or deterioration. Viewed in this light, the 5-level scoring was considered to be justified. The items describing hand functioning (nos. 16 and 17) definitely failed to show a satisfactory ordinality. Consequently, the scaling of these four items was changed to 1-3-5 (Table III), which to some extent improved the ordinality.

The adequacy of summation: Logically speaking, only items measured on the interval level should be added to a sum score. Nevertheless, summation of ordinal data is a common procedure when applying functional assessment instruments, though the scientific justification for summating items is frequently undocumented. There is an ongoing discussion about the requirements for adding ordinal scores (9, 13, 16). A satisfactory degree of unidimensionality exists within each factor, which is a requirement for adding the scores on the items belonging to that factor. Furthermore, the uniformly high loadings on all variables of the factors through all three assessment points indicate that the items belonging to the respective factors may be weighted equally. This, along with the results of the regression analyses of the ordinality of the scoring on each item of the scale, argues for the adequacy of adding items on the level of each factor to sum scores. However, the reservations against adding the three sum scores to a total are much greater. Conclusions regarding the summation to a total sum score will be left until the predictive validity of the evaluation method has been investigated.

Concurrent validity

Except for 11 patients, the SMES score reflected the BL score well (Fig. 1). These patients had a high BL score, while they scored low on the SMES. The discrepancy was presumably due to the fundamental difference in the two assessment methods. When assessed by the SMES, where no assistance is supposed to be given, the patients were unable to get into sitting position. Consequently, the test came to a stop after the scoring on the items performed in the lying position. In the BL method, the patients are assisted into the sitting position. This results in a higher sum score, but probably explains the patients' functional capacity to a lesser degree.

As a conclusion, we find that the construct validity of the SMES is clearly acceptable. The concurrent validity of the arm and leg part of the SMES is good, using the BL as the reference method. Further analyses are necessary to investigate the predictive validity of the method as well as its properties as an outcome measure in clinical trials.

ACKNOWLEDGEMENTS

This project was supported by grants from The Norwegian Fund for Post-graduate Training in Physiotherapy and The Royal Norwegian Ministry of Health and Social Affairs.

The authors wish to express their gratitude to Professor Knut Laake for his contribution to the statistical analyses and his constructive criticism during the project.

We also want to thank Professor Ingar Holme for valuable advice regarding the statistical calculations.

REFERENCES

1. Ashburn, A.: A physical assessment for stroke patients. Phys Ther *68:* 109–113, 1982.
2. BMDP Statistical Software. University of California Press, Berkeley, 1990.
3. Braekhus, A., Laake, K. & Engedal, K.: The Mini-Mental State Examination: Identifying the most efficient variables for detecting cognitive impairment in the elderly. J Am Geriatr Soc *40:* 1139–1145, 1992.
4. Carr, J., Shepherd, R. B., Nordholm, L. & Lynne, D.: Investigation of a new motor assessment scale for stroke patients. Phys Ther *65:* 175–180, 1985.
5. Corriveau, H., Guarna, F., Dutil, E., Riley, E., Arsenault, A. B. & Drouin, G.: An evaluation of the hemiplegic subject based on the Bobath approach. Part II. The evaluation protocol. Scand J Rehabil Med *20:* 5–11, 1988.
6. Fugl-Meyer, A. R., Jaskoo, L., Leyman, I., Olsson, S. & Steglind, S.: The post stroke hemiplegic patient. I. A method for evaluation of physical performance. Scand J Rehabil Med *7:* 13–31, 1975.
7. Hatano, S.: Experience from a multicentre stroke register: a preliminary report. Bull WHO *54:* 541–553, 1976.
8. Hosmer, D. W. & Lemeshow, S.: Applied logistic regression. John Wiley & Sons, New York, 1989.
9. Johnston, M. V., Hamilton, B. B., Granger, C. V., Silverstein, B., Kilgore, K., Fisher, W. & Gresham, G. E.: Letters to the editor re ordinal scales. Arch Phys Med Rehabil *70:* 861–867, 1989.
10. Lincoln, N. & Leadbitter, D.: Assessment of motor function in stroke patients. Phys Ther *65:* 48–51, 1979.
11. Lindmark, B. & Hamrin, E.: Evaluation of functional capacity after stroke as a basis for active intervention. Presentation of a modified chart for motor capacity assessment and its reliability. Scand J Rehabil Med *20:* 103–109, 1988.
12. Lindmark, B. & Hamrin, E.: Evaluation of functional capacity after stroke as a basis for active intervention. Validation of a modified chart for motor capacity assessment. Scand J Rehabil Med *20:* 111–115, 1988.
13. Merbitz, C., Morris, J. & Grip, J. C.: Ordinal scales and foundations of misinference. Arch Phys Med Rehabil *70:* 308–312, 1989.
14. Spector, P. E.: Summated rating scale construction: An introduction. Series: Quantitative Applications in the Social Sciences 82, Sara Miller McCune. Sage Publications, London, 1992.
15. Sødring, K. M.: The Sødring Motor Evaluation of Stroke Patients, manual. Clinic for Geriatrics and Rehabilitation Medicine, Ullevål University Hospital, 1994.
16. Wright, B. D. & Linacre, J. M.: Observations are always ordinal; measurements, however must be interval. Arch Phys Med Rehabil *70:* 857–860, 1989.

Address for offprints:

Karen Margrethe Sødring
Senior Physiotherapist,
Clinic for Geriatrics and Rehabilitation Medicine
Ullevål University Hospital,
N-0407 Oslo,
Norway