REHABILITATION MANUAL 6

RECOVERY EVALUATING SYSTEM FOR STROKE REHABILITATION

RYUICHI NAKAMURA
Editor

NATIONAL REHABILITATION CENTER
FOR THE DISABLED
JAPAN

(WHO COLLABORATING CENTRE)

MARCH, 1999

Rehabilitation Manual 6
Recovery Evaluating System for Stroke Rehabilitation

March 31, 1999

Editor : Ryuichi Nakamura

4-1 Namiki, Tokorozawa City, Saitama Prefecture 359-8555, Japan
Tel. 81-42-995-3100
Fax. 81-42-995-3102
E-mail : whoclbc@rehab. go. jp

FOREWORD

In 1995, National Rehabilitation Center for the Disabled (NRCD) was designated as World Health Organization (WHO) Collaborating Centre for Disability Prevention and Rehabilitation. Since 1996, we have been publishing "Rehabilitation Manual" to provide information concerning rehabilitation of people with disabilities. In publishing this manual, our intention is to describe and present a systematic framework of rehabilitation in Japan. This manual would be useful to solve problems which may exist in various countries and regions, or as reference material for review to assist future development in this field.

Those of us at NRCD would be delighted if this work generated insights for further discussion and practice.

The contents planned for this publication extend over all dimensions of rehabilitation, including the service frameworks, administrative policies, laws, technologies, and method for developing and educating specialists for respective disabilities.

We wish this manual contribute to development and promotion of rehabilitation of disabled persons by active exchange of opinions and communication between rehabilitation specialists.

We invite any type of criticism, opinions, and/or general inquiries from the readers.

March, 1999

Yasuhiro HATSUYAMA

President
National Rehabilitation Center
for the Disabled, Japan

Head
WHO Collaborating Centre

PREFACE

This manual is an abridged edition of Assessment and Prediction of Functional State in Stroke, 2nd ed. Ishiyaku Publishers Inc, Tokyo, 1997.

In spring 1981, we started research works on the prediction of functional status of stroke patients at set times after starting medical rehabilitation. The details of model, clinical data and statistical analyses related to the prediction of functional status were reported in the first edition of above mentioned book published in 1991.

Recovery Evaluating System-version 4 (RES-4) is presented in this manual as clinical management tools that organize patient care activities and interventions of an interdisciplinary rehabilitation team, and is also used as information sources given to the patient and his/her family. RES-4 have been used in several rehabilitation hospitals for more than 10 years with confidence.

We hope that physicians and rehabilitation staffs working for stroke inpatients will utilize this manual (RES-4) as convenient clinical management tools.

Ryuichi NAKAMURA
Editor

CONTRIBUTORS

Naoyuki KAKUTA
National Rehabilitaion Center for the Disabled
Takako MIWA
National Rehabilitation Center for the Disabled
Sanae MORIYAMA
National Rehabilitation Center for the Disabled
Masanori NAGAOKA
National Rehabilitation Center for the Disabled
Hiroshi NAGASAKI
Tohoku Bunka-Gakuen University
Ryuichi NAKAMURA
National Rehabilitation Center for the Disabled
Yoshiko TOBIMATSU
Tohoku University School of Medicine

CONTENTS

1 Introduction

Physical disability of stroke patients is one of the main targets of medical rehabilitation. According to the national survey on persons with the certification of physical disabilities in Japan, 1996, physically disabled persons of 18 years old and over were more than 2.9 million, and cerebrovascular disease was the most frequent cause (12%) of their disabilities.

For stroke rehabilitation, accurate prediction of the functional recovery at an early stage after the onset is of practical importance. It helps the patients and their families make appropriate plans of their life in near future, and health care professionals set realistic goals of the medical rehabilitation. Studies on predictors of functional outcome of stroke patients were previously reviewed by Jongbloed (1986), in which a prior stroke, older age, urinary and bowel incontinence, and visuo-spatial deficits were adverse prognostic indicators of function, and functional admission score had a positive correlation with discharge functional status. However, as suggested by Hewer (1987), if we are able to assess the effectiveness of various types of intervention and therapy, then we must know what the natural course of the disease and the functional status is likely to be. Information about the natural course of the disease has long been formed as the basis for assessing therapy in medicine. Jongbloed (1986) claims that future studies on the prediction of function after stroke should measure function at set times post-stroke. Partridge et al.(1987), monitoring the recovery of 368 hemiparetic stroke patients over 8 weeks, reported that recovery from physical disability followed a predictable pattern and that it would be possible to develop profiles by which an individual's progress could be compared. Reding et al.(1988), examining Barthel Index of 95 patients admitted to a stroke rehabilitation unit at 2-week intervals, proposed the use of life table analysis. They argued that the analysis provided a statistical basis to predict times at which patients were expected to reach a criterion of the predetermined Barthel Index score. Univariate and multivariate methods have been used to determine the predictors of long-term disability after stroke. Multivariate analysis to obtain the possible predictors of functional outcome is a popular technique. Several equations to obtain a predicted score of some measures such as Barthel Index at 6 months after stroke (Wade et al. 1983) and functional independence at 6 weeks (Prescott et al. 1982) have already been proposed.

In stroke rehabilitation, especially for inpatients, it is impossible to obtain a natural course of functional recovery, since the recovery process is influenced by the therapy provided and the rehabilitative environment. When the same variables are used to predict functional outcome in two different hospitals, equations for the prediction would be different in each one. Rather, such equations would be valuable for practical use in rehabilitation programming of the patients, and also for the evaluation of new intervention and/or therapy. An ongoing program may be altered during rehabilitation when a discrepancy between the prediction and the outcome is evident, hence optimizing the whole process of rehabilitation. The prediction of patients' functional status provides health care professionals with a tool for objective evaluation of their rehabilitation techniques. It is also important for the management of stroke patients to evaluate efficiency and cost performance of the medical rehabilitation on a scientific basis. Common data base systems maintained in microcomputers are becoming standard tools to handle hospital and/or patient data, and now it has been routine for computer technologies to support rehabilitation management (Sulton et al. 1987).

2 Data Base Model

Prediction of the functional recovery of stroke patients, however, has often been dependent on experiences and skills of each rehabilitation professional. Since physical disability is a multivariate phenomenon such that activities in daily life of stroke patients may be determined by the integration of their physical and mental functions, and be also influenced by premorbid social and family functioning of the patients, the assessment to characterize impairments and disabilities of a given patient should be as comprehensive as possible. Recovery of one impaired function such as walking capacity will be dependent on the modification of other physical and psychological functions. For this reason the data base storing comprehensive information of patients is necessary both for functional assessment and recovery evaluation in stroke rehabilitation. Functional recovery or outcome, both assessed by measures of impairments and disabilities, can be predicted by applying an appropriate multivariate statistical analysis to the data base.

Figure 1 shows a data base model following International Classification of Impairments, Disabilities, and Handicaps (WHO 1980), on which our data base for stroke rehabilitation has been constructed (Nakamura et al. 1990, 1991). Functional status and its recovery are assumed to be related to neurological diagnosis, symptoms and signs. Functional status at admission may be characterized by use of various measures covering physical and psychological impairments and disabilities of the patient. The functional recovery process, hence outcome of rehabilitation at set times, can be followed by using the same measures. Demographic characteristics of the patients may also affect their functional status and recovery.

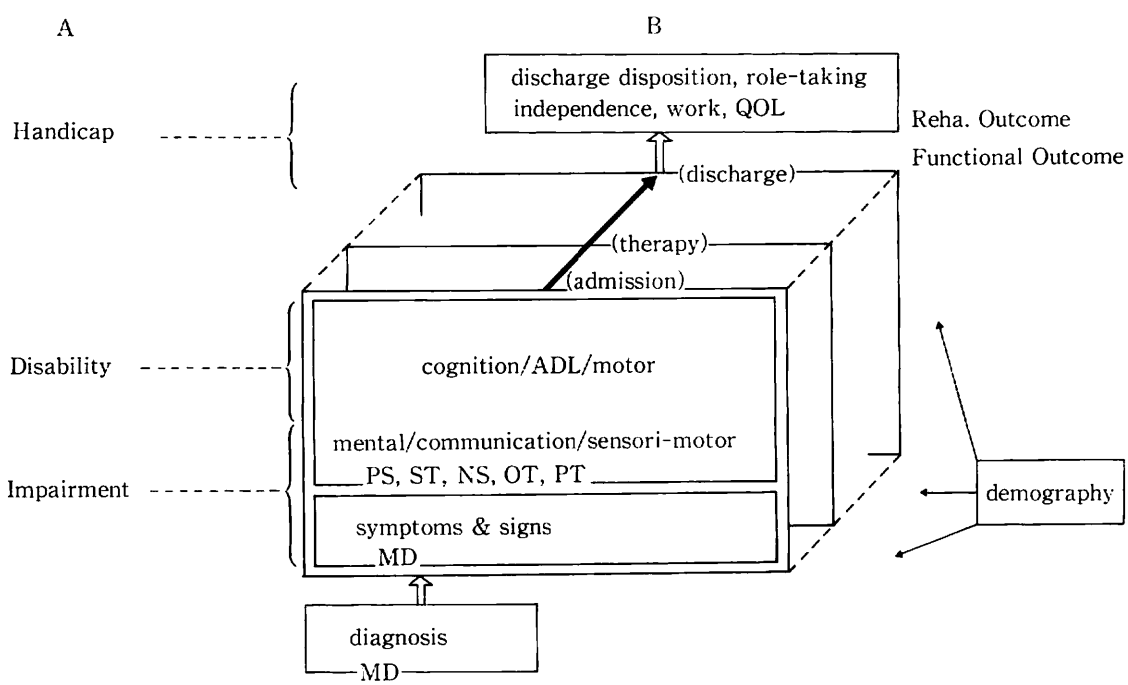


Figure 1 ICIDH Model (A) and Data Base Model (B)

3 Development of Recovery Evaluating System (RES)

During the past 10 years, we have stored information of more than 1,000 stroke inpatients in the data base administering appropriate measures and batteries for the assessment. Multiple regression equations to predict functional recovery were obtained from the data base and statistical analyses. The functional status of each patient at 4, 8, and 12 weeks (for the convenience, referred to as one, 2, and 3 months in the case presentation) after admission has been predicted at the start of his/her rehabilitative training by putting the data related to impairments, disabilities and demographic variables of the patient to those equations. In this way the Recovery Evaluating System (RES) for stroke rehabilitation has been developed in Institute of Rehabilitation Medicine and Narugo-Branch Hospital, Tohoku University School of Medicine, Miyagi, Japan.

The first version of the RES, referred to as RES-1, started to work in 1984. RES-1 was a research-oriented system founded on the data base collecting impairments, disabilities and demographic variables as comprehensive as possible.

In order to establish the system for practical use in general rehabilitation hospitals, revision of the RES was repeated (RES-2 and RES-3), decreasing the number of variables necessary for the assessment. RES-3 has been used in several rehabilitation hospitals other than Narugo-Branch Hospital. Finally, the data base and the recovery evaluating system with the least variables to be collected, RES-4, was constructed on the basis of personal computer system for general use in stroke rehabilitation (Nakamura et al. 1997).

4 The Prediction of Functional Recovery

1) Data for multiple regression analysis

The data stored in the RES of three rehabilitation hospitals, that is, Narugo-Branch, Amakusa and Nozomi hospitals, were used for RES-4 to obtain the predictive equations of functional status. The number of patients were 1,022 (358 in Narugo-Branch, 409 in Amakusa and 255 in Nozomi hospital). They had admitted in those hospitals from February 1990 to March 1994. Patients with full score of Barthel Index at admission were discarded, and the data of 852 patients were subjected to the analysis. Neurological diagnosis, symptoms and sings, and demographic variables of the patients are given in Table 1 and 2.

The functional status of the patients were assessed by using the following measures : the Motor Age Test (Table 3), of which score was shown as MOA ; the Manual Function Test (Table 4, Figure 2) for the affected side, AMFS ; the Barthel Index (Table 5), BI ; the Hasegawa's Dementia Scale-Revised (Table 6), HDS-R ; and the Standard Language Test of Aphasia (Table 7), SLTA. Those

Table 1 Characteristics of the patients in RES-4 (Categorical item)

Variable	Category	Number of subjects
Sex	male : female	519 : 333
Time from onset to admission*	0 : 1 : 2 : 3 : 4 : 5	100 : 239 : 196 : 248 : 55 : 14
Operation	− : +	628 : 224
Coma (acute phase)	− : +	641 : 211
Attack number	1 : 2 : ≥ 3	704 : 125 : 22
Diagnosis	Cerebral hemorrhage	351
	Cerebral infarct	429
	Subarachnoid hemorrhage	55
	Others	7
Hypoarousal state	alert : others	761 : 91
Visual field defect	− : +	754 : 98
Ocular movement disorder	− : +	763 : 89
Nystagmus	− : +	824 : 28
Aphasia	− : +	579 : 273
Spasticity	− : +	195 : 657
Exaggerated tendon reflex	− : +	55 : 797
Pathological reflex	− : +	67 : 785
Palsy side	− : L : R : Both	21 : 348 : 421 : 62
Sensory disturbance	− : +	198 : 654
Ataxia	− : +	744 : 108
Involuntary movement	− : +	808 : 44
Bladder and bowel disturbance	− : +	696 : 156
Cognitive disorders	− : +	427 : 425
Diabetes mellitus	− : +	698 : 154
Hypertension	− : +	392 : 460
Heart disease	− : +	689 : 163
Joint contracture	− : +	602 : 250

* 0=1—30 days ; 1=31—60 days ; 2=61—90 days ; 3=91—180 days ; 4=181—365 days ; 5 ≥ 366 days

Table 2 Demographic data of the patients in RES-4 (Numerical item)

Variables	Means (S. D.)
Age (years)	61.4 (11.1)
Time from onset to admission (days)	92.8 (85.5)
Education (years)	9.6 (3.0)
Family members (number)	3.7 (1.7)
Duration of coma (days)	1.5 (5.4)

Table 3 Motor Age Test (Lower Extremity)

Motor Age Test was devised as the Motor Age Examination which would yield a score comparable to the intelligence quotient by Johnson et al. (1951).

Directions : Encircle score of all test items performed satisfactorily ; cross out score of items failed. Add encircled score.

MOTOR AGE EXAMINATION

LOWER EXTREMITY :

If failure of test situation due to arm abnormality indicate :

		Score
4 mos	Sits. back support. tailor or long. on mat.	2
	Head balance almost mastered	2
7 mos	Sits 1 min. floor, no support, tailor or long.	3
10 mos	Rolls. both ways, complete revolutions.	1
	Stands holding on to furniture.	1
	Creeps any fashion. prone or hands-and-knees or all fours.	1
12 mos	Creeps reciprocally, hands-and-knees or all fours.	1
	Pulls up on furniture to standing.	1
15 mos	Walks with stop-start ability (4 of 6 tries).	3
18 mos	Runs stiffly	1
	Up and down standard stairs with rail. any fashion.	1
	Seats self in suitably-sized chair with arms. away from wall.	1
21 mos	Walks downstairs, holding tech.* by 1 hand.	1.5
	Walks upstairs, holding rail (1 or 2 hands).	1.5
24 mos	Run 15 m without falling.	1.5
	Walks downstairs, holding rail (1 or 2 hands).	1.5
30 mos	Jumps, both feet in place.	6
36 mos	Stairs, up and down, alternating feet, no rail or hand.	3
	Jumps from bottom step landing on both feet simultaneously without falling.	3
42 mos	Stands on one foot, 2 sec. (Score if successful on either foot).	6
48 mos	Running broad jump, 30 cm.	3
	Standing broad jump, 15 cm.	3
54 mos	Hop forward on one foot. (Score if successful on either foot).	6
60 mos	Skip with alternate feet.	2
	Stand on one feet 8 sec. (Score if successful on either foot).	2
	Walk 3 m line 2.5 cm wide, no faults.	2
72 mos	Jump from 30 cm, landing only on toes.	6
	Stand on alternate feet. eyes closed.	6
	TOTALS :	

*tech. : holding one hand of examiner

(Johnson et al. 1951, modified)

Table 4 Manual Function Test

Manual Function Test (MFT) was developed in an attempt to assess the impaired motor function of the affected upper extremity of stroke patients, and to make statisitical analyses of recovery processes possible during medical rehabilitation (Moriyama 1987). Details of the validity and the reliability of MFT were already reported (Nakamura et al. 1991). MFT is composed of 32 subtests. MFT kit (SOT-5000) is offered from Sakai Iryo Co.

When the examination is completed, the number of subtests scored as success [1] are added up. The maximum score of MFT is 32. The total score thus obtained, Manual Function Score (MFS), is multiplied by 3.125, making the maximum total score as 100.

RES : Name : Date : (Examiner)

Subtest		Item	Left	Right	Comment
Arm motions	FE	0° ~44°			
		45° ~89°			
		90° ~134°			
		135°~			
	LE	0° ~44°			
		45° ~89°			
		90° ~134°			
		135°~			
	PO	Move the arm slightly			
		Elevate the hand above the xiphosternal plane			
		Touch the head with fingers			
		Touch the occipit with the palm			
	PD	Move the arm slightly			
		Touch the buttock with fingers			
		Touch the spine with fingers			
		Touch the spine with the palm			
GR		Keep the ball in the palm			
		Release and drop the ball			
		Grasp and carry the ball			
PI		Pinch and pick up the pencil			
		Pinch and pick up the coin			
		Pinch and pick up the needle			
CC		One to two cubes within 5 sec			
		Three to four			
		Five to six			
		Seven to eight			
PP		One to three pegs within 30 sec			
		Four to six			
		Seven to nine			
		10 to 12			
		13 to 15			
		More than 16			
Total score (32)					success=1, failure=0
MFS (100)					

Specifications for subtest items

FE : forward elevation of the shoulder.

LE : lateral elevation of the shoulder.

PO : touch the occipit with the palm.

PD : touch the dorsum with the palm.

GR : grasp, carry and release function of the hand are assessed using a ball of the base-ball game (diameter : 7 cm).

PI : ability to pinch and to pick up three objects differed in size and shape with the thumb and fingers is assessed.

CC : integrated function of the arm, i. e., reach, grasp, carry and release, is assessed.

PP : integrated function of the arm including the finger dexterity is assessed using a peg-board.

(Nakamura et al. 1992, modified)

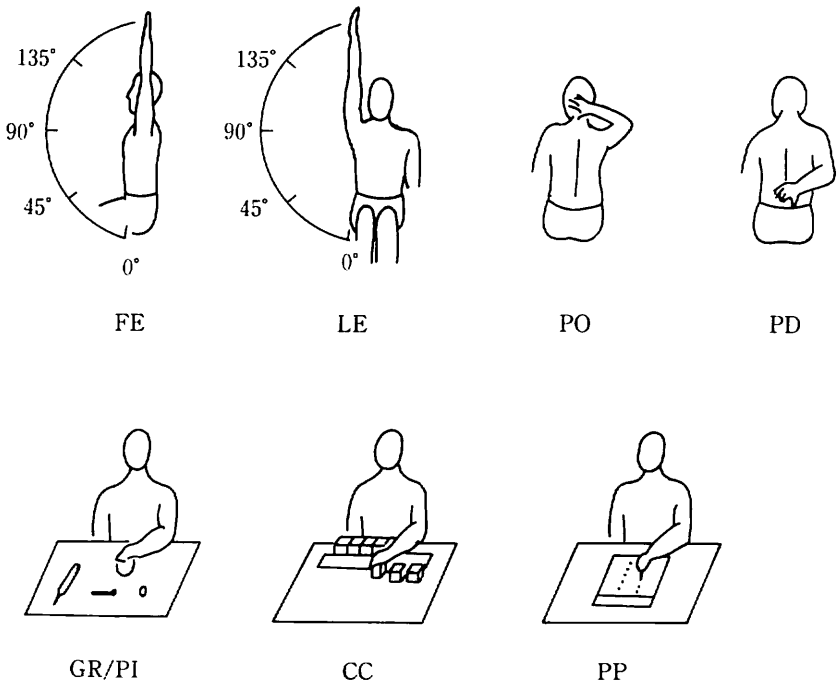


Figure 2 Schemata of eight tasks of Manual Function Test

FE : forward elevation of the shoulder, LE : lateral elevation of the shoulder, PO : touch the occipit with the palm, PD : touch the dorsum with the palm, GR : grasping, PI : pinch, CC : carrying a cube and PP : peg-board.

(Nakamura et al. 1992)

five measures were administered to the patients at admission, and approximately at 4, 8, and 12 weeks after admission, respectively. The measurements were performed by physical therapists, occupational therapists, nurses, clinical psychologists and speech therapists. The means of each measure are shown in Table 8.

2) Statistical methods

A stepwise multiple regression analysis was applied to the dependent variables ; MOA, AMFS, BI, HDS-R and SLTA, each at 4, 8, and 12 weeks after the start of training. The independent variables for the regression analysis were 27 items from neurological diagnosis, symptoms and signs, and demographic variables (Table 9). Those independent variables were assessed for each patient at his/her admission usually within one week. The functional status of the patient assessed at admission was also used as an independent variable to predict the functional status and its gain ; for instance, MOA at admission (MOA0) was an independent variable for its prediction at 4, 8, and 12 weeks after the training (MOA1, MOA2, and MOA3). In this way, the multiple regression analysis was performed so as to predict patients' functional status during rehabilitation process by using data obtained at his/her admission.

Table 5 Barthel Index

	With Help	Independent
1. Feeding (If food needs to be cut up=help)	5	10
2. Moving from wheelchair to bed and return (includes sitting up in bed)	5-10	15
3. Personal toilet (wash face, comb hair, shave, clean teeth)	0	5
4. Getting on and off toilet (handling clothes, wipe, flush)	5	10
5. Bathing self	0	5
6. Walking on level surface (or, if unable to walk, propel wheelchair)	10	15
(* score only if unable to walk)	0*	5*
7. Ascend and descend stairs	5	10
8. Dressing (includes tying shoes, fastening fasteners)	5	10
9. Controlling bowels	5	10
10. Controlling bladder	5	10

A patient scoring 100 BI is continent, feeds himself, dresses himself, gets up out of bed and chairs, bathes himself, walks at least a block, and can ascend and descend stairs. This does not mean that he is able to live alone : he may not be able to cook, keep house, and meet the public, but he is able to get along without attendant care. (Mahoney et al. 1965)

Table 6 Hasegawa's Dementia Scale-Revised

Date : Examiner :

Sex : male/female Educational years : ys Test-room :
Diagnosis : Comment :

1	How old are you?		0 1
2	What is the date today?	year	0 1
		month	0 1
		day	0 1
	What day of the week is it today?	day of the week	0 1
3	Where are you now? (can answer without any hints ; 2 points. can chose correct answer, home, a hospital, or nursing home, from the hint given 5 sec after ; 1 point)		0 1 2
4	Please repeat the three words I will tell you now. Please memories those three words. You will be asked later in this examination. (check a series applied) 1 : a) cherry b) cat c) train 2 : a) plum b) dog c) car		0 1 0 1 0 1
5	Starting from 100, subtract 7, and subtracting 7……	(93) (86)	0 1 0 1
6	Please count back the number I am telling. (6-8-2), (3-5-2-9)	2-8-6 9-2-5-3	0 1 0 1
7	Please tell me the words I told before. (can answer without hints ; score 2. can answer following the hint given ; score 1) a) plant b) animal c) vehicle		a : 0 1 2 b : 0 1 2 c : 0 1 2
8	Now I show you five things on the table. Please tell the name of these things after I hide them. (mutually not related things such as watch, key, cigarette, coin)		0 1 2 3 4 5
9	Please tell the name of vegetables as many as you know. (write the name answered in the right column. stop examination after 10 sec silence)		0 1 2 3 4 5
		total score :	

Hasegawa's dementia scale (HDS) was devised by Hasegawa et al. (1974), and presently revised one (HDS-R) has been used (Kato et al. 1991). HDS-R is a simple screening test for dementia. The score below 20 is regarded as suspected dementia. (Kato et al. 1991)

Table 7 Standard Lanquage Test of Aphasia

Standard Language Test of Aphasia (SLTA) was developed in order to standardize the examination and diagnosis of aphasia in 1974, and the revised manual and kit were offered from Shinko-Igaku Publishing Co. The test items are categorized into five groups, that is, Auditory comprehension, Speech, Visual comprehension, Writing and Arithmetic ; and consist in 187 questions. The rating with six grades, from one to six, is used.

I. Auditory comprehension
1. Recognition of words/pointing
2. Recognition of sentences/pointing
3. Moving objects/oral commands
4. Recongnition of Kana/pointing

II. Speech
5. Naming objects drawn in picture
6. Repetition of verbal words
7. Explanation of activities in picture
8. Explanation of a comic strip
9. Repetition of verbal sentences
10. Enumeration of animal names
11. Oral reading of Kanji words
12. Oral reading of Kana letters
13. Oral reading of Kana words
14. Oral reading of sentences

III. Visual comprehension
15. Recongnition of Kanji words/pointing
16. Recognition of Kana words/pointing
17. Recognition of sentences/pointing
18. Moving objects/written commands

IV. Writing
19. Writing Kanji words/picture objects
20. Writing Kana words/picture objects
21. Writing sentences of a comic strip
22. Dictation of Kana
23. Dictation of Kanji words
24. Dictation of Kana words
25. Dictation of sentences

V. Arithmetic
26. Simple tests of four fundamental rules

(Japanese Association of Aphasia 1997, modified)

Table 8 Functional status at set times

Functional measure	MOA	AMFS	BI	HDS-R	SLTA
Score range	0—72	0—100	0—100	0—30	0—100
at admission	18.7±14.1 (852)	27.0±30.0 (852)	53.8±29.2 (852)	16.8±9.0 (852)	34.8±27.9 (284)
4 weeks	24.3±16.8 (765)	33.2±31.9 (767)	68.8±28.7 (767)	18.5±9.0 (767)	39.0±27.2 (233)
8 weeks	26.6±17.3 (676)	33.8±31.6 (677)	74.1±28.4 (676)	18.9±9.1 (677)	40.8±28.0 (200)
12 weeks	25.5±15.5 (482)	31.3±29.3 (482)	75.2±27.5 (482)	19.4±8.9 (481)	43.0±28.6 (142)

Mean±S. D. ( )=n

Table 9 The variables used in RES-4

Variables	Abbreviations	Code
Motor Age Test	MOA	0-72
Manual Function Test (affected side)	AMFS	0-100
Barthel Index	BI	0-100
Hasegawa's Dementia Scale-Revised	HDS-R	0-30
Standard Language Test of Aphasia	SLTA	0-100 (mean of five categories)
Age	AGE	(years)
Sex	SEX	Male=0, Female=1
Time from onset to admission	TOA	*
Operation (brain-surgery)	OPE	0, 1
Coma (acute phase)	COMA	0, 1
Attack number	ATTACK	1, 2, 3**
Diagnosis		
Cerebral hemorrhage	ICH	0, 1
Cerebral infarct	CI	0, 1
Subarachnoid hemorrhage	SAH	0, 1
Hypoarousal state	HYPOAR	alert=0, others=1
Visual field defect	VF	0, 1
Ocular movement disorder	OCULAR	0, 1
Nystagmus	NYSTAG	0, 1
Aphasia	APHASIA	0, 1
Spasticity	SPASTIC	0, 1
Exaggerated tendon reflex	DTR	0, 1
Pathological reflex	REFLEX	0, 1
Palsy	PALSY	0, 1
Sensory disturbance	SENSORY	0, 1
Ataxia	ATAXIA	0, 1
Involuntary movement	INVOL	0, 1
Bladder and bowel disturbance	RECTO	0, 1
Cognitive disorders	COGNT	0, 1
Diabetes mellitus	DM	0, 1
Hypertension	HT	0, 1
Heart disease	CD	0, 1
Joint contracture	CONTR	0, 1

if not denoted, 0=absent and 1=present.

* 0-30 days TOA=0 ; 31-60 days TOA=1 ; 61-90 days TOA=2 ; 91-180 days TOA=3 ; 181-365 days TOA=4 ; ≥ 366 days TOA=5

** patients with attacks more than three times belong to 3.

3) The prediction of functional status at set times

Table 10 presents the results of regression analysis. MOA1, MOA2 and MOA3 are the predicted MOAs at 4, 8, and 12 weeks (one, 2, and 3 months) after the training, and so forth. In the column of each dependent variable, significant standardized partial regression coefficients (β) are written for predictor variables. The number of patients (n) used in the regression analysis, the results of F-test (F, p), and multiple regression coefficient (R, R^2) are also shown.

Table 10 indicates that the functional status at admission is the most influential predictor of its recovery for all variables with standardized partial regression coefficients more than 0.5. Advanced age of patients and the delay of admission from stroke onset are negative predictors for the recovery in motor and mental function, and Barthel Index (BI) of stroke patients. Also bladder and bowel disturbance (RECTO), and cognitive disturbance (COGNT) supress the gain of BI in every set times. Symptoms and signs such as disorders of ocular movements (OCULAR), hypoarousal state (HYPOAR), RECTO, and COGNT, reflecting the severity and diversity of neurological disorders, negatively affect the recovery of physical as well as mental functions after stroke.

The contribution ratio of the regression equation (R^2) is more than 0.8 for almost all functions, and set times of recovery, suggesting that the accuracy of prediction of RES-4 is satisfactory for its practical use in stroke rehabilitation. Since the regression equation in RES-4 were obtained from the data of three hospitals at different localities and with different rehabilitation facilities, RES-4 could be utilized in general for inpatient stroke rehabilitation.

4) Equations for predicting functional status used in RES-4

Table 11 presents the regression equations for predicting functional status and recovery in RES-4 for MOA, AMFS, BI, HDS-R and SLTA at the three set times. It is easy for RES-4 to revise those equations applying multiple regression analysis for specific use of another hospital when sufficient data of stroke patients in that hospital are accumulated in RES-4. Then, the accuracy of prediction will be improved.

5) Manual calculation for the prediction

When a personal computer system of RES-4 is not available, the prediction of any functional status can be performed by manually calculating the equations for your cases.

An example of the calculation is given below as for BI of a patient (see Case 2 in Case Reports). The examination of this patient at her admission shows ; BI0=55, AGE=50, TOA=2 (60—90 days), CI=0, APHASIA=0, DTR=1, RECTO=0, COGNT=0, CONTR=0 and OCULAR=1. Substituting those data to the equation for prediction of BI1 (Table 11), BI at 4 weeks after the training is calculated as follows :

$$\begin{aligned} BI1 &= 50.507 + 0.699 \times (BI0=55) - 0.258 \times (AGE=50) - 2.597 \times (TOA=2) + 2.74 \times (CI=0) \\ &+ 2.858 \times (APHASIA=0) + 4.372 \times (DTR=1) - 10.593 \times (RECTO=0) - 3.266 \times (COGNT=0) \\ &- 3.89 \times (CONTR=0) - 3.931 \times (OCULAR=1) = 71 \end{aligned}$$

The same procedure can be applied to the prediction of BI2 and BI3, and also of other measures. The results of calculation will be the same as those shown in Figure 8.

Table 10 Standardized regression coefficients of step-wise analysis for MOA, AMFS, BI, HDS-R, and SLTA at 4, 8, and 12weeks after the training.

variable	MOA1	MOA2	MOA3	AMFS1	AMFS2	AMFS3	BI1	BI2	BI3	HDS-R1	HDS-R2	HDS-R3	SLTA1	SLTA2	SLTA3
MOA0	0.858	0.775	0.717	–	–	–	–	–	–	–	–	–	–	–	–
AMFS0	–	–	–	0.922	0.873	0.835	–	–	–	–	–	–	–	–	–
BI0	–	–	–	–	–	–	0.713	0.604	0.567	–	–	–	–	–	–
HDS-R0	–	–	–	–	–	–	–	–	–	0.940	0.916	0.914	–	–	–
SLTA0	–	–	–	–	–	–	–	–	–	–	–	–	0.951	0.883	0.878
AGE	−0.077	−0.132	−0.138	−0.041	−0.083	−0.124	−0.098	−0.129	−0.150	−0.039	−0.070	−0.071		−0.061	−0.106
TOA	−0.121	−0.172	−0.221	−0.076	−0.111	−0.142	−0.107	−0.145	−0.192	−0.035	−0.056	−0.050	−0.136	−0.185	−0.185
COMA				−0.029	−0.034	−0.043			−0.064	0.026		0.045			
SEX															
ICH				−0.027	−0.047	−0.070									
CI							0.048								
SAH															
ATTACK			−0.066						−0.066		−0.033			−0.053	
OPE							−0.047								
HYPOAR	−0.039										−0.028	−0.038			
VF				−0.023											
OCULAR							−0.043	−0.050	−0.102	−0.040	−0.041	−0.049			
NYSTAG															
APHASIA					−0.041	−0.052	0.047	0.063							
SPASTIC		0.040	0.150												
DTR							0.036	0.062	0.112	0.024					
REFLEX		−0.049				−0.078								0.060	
PALSY															
SENSORY									0.102						
ATAXIA														0.117	
INVOL										0.037	0.032		0.039		
RECTO	−0.060	−0.098	−0.107				−0.142	−0.180	−0.137						
COGNT				−0.035	−0.046	−0.071	−0.057	−0.084	−0.061						
DM															
HT															
CD															
CONTR							−0.062	−0.045							
n	764	675	481	766	676	481	766	675	481	766	676	480	219	186	132
F	857.189	426.201	224.676	1176.630	588.585	291.372	340.383	191.116	98.365	1110.639	772.485	493.327	1010.280	225.168	325.433
p	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001	p<0.001
R	0.922	0.890	0.838	0.957	0.928	0.901	0.905	0.861	0.823	0.955	0.943	0.929	0.966	0.940	0.940
R^2 (%)	85.0	79.3	70.3	91.6	86.0	81.2	81.8	74.2	67.7	91.1	89.0	86.2	93.4	88.3	88.4

n : number of patients

Table 11 Equations for the prediction of functional status used in RES-4

at 4 weeks (one month)

MOA1 = 16.414 + 1.032 × MOA0 − 0.119 × AGE − 1,734 × TOA − 2.604 × RECTO − 2.094 × HYPOAR
(n = 764, R = 0.922, R^2 = 0.850)

AMFS1 = 21.072 + 0.986 × AMFS0 − 0.119 × AGE − 2.06 × TOA − 2.171 × COMA − 2.231 × COGNT − 1.75 × ICH − 2.274 × VF
(n = 766, R = 0.957, R^2 = 0.916)

BI1 = 50.507 + 0.699 × BI0 − 0.258 × AGE − 2.597 × TOA + 2.74 × CI + 2.858 × APHASIA + 4.372 × DTR − 10.593 × RECTO − 3.266 × COGNT − 3.89 × CONTR − 3.931 × OCULAR
(n = 766, R = 0.905, R^2 = 0.818)

HDS-R1 = 6.428 + 0.775 × HDS-R0 − 0.032 × AGE − 0.264 × TOA + 0.541 × COMA + 0.917 × DTR + 1.524 × INVOL − 1.163 × OCULAR
(n = 766, R = 0.955, R^2 = 0.911)

SLTA1 = 13.429 + 0.997 × SLTA0 − 3.321 × TOA + 7.067 × INVOL
(n = 219, R = 0.966, R^2 = 0.934)

at 8 weeks (2 months)

MOA2 = 29.003 + 1.004 × MOA0 − 0.206 × AGE − 2.548 × TOA + 1.694 × SPASTIC − 3.364 × REFLEX − 4.325 × RECTO)
(n = 675, R = 0.89, R^2 = 0.793)

AMFS2 = 35.279 + 0.971 × AMFS0 − 0.238 × AGE − 3.017 × TOA − 2.477 × COMA − 2.741 × APHASIA − 2.901 × COGNT − 2.993 × ICH
(n = 676, R = 0.928, R^2 = 0.86)

BI2 = 68.068 + 0.597 × BI0 − 0.331 × AGE − 3.527 × TOA − 3.036 × OPE + 3.796 × APHASIA + 7.909 × DTR − 13.168 × RECTO − 4.762 × COGNT − 2.762 × CONTR − 4.601 × OCULAR
(n = 675, R = 0.861, R^2 = 0.742)

HDS-R2 = 11.142 + 0.759 × HDS-R0 − 0.057 × AGE − 0.431 × TOA − 0.693 × ATTACK + 1.331 × INVOL − 1.222 × OCULAR − 0.822 × HYPOAR
(n = 676, R = 0.943, R^2 = 0.89)

SLTA2 = 26.359 + 0.975 × SLTA0 − 0.154 × AGE − 4.621 × TOA − 3.727 × ATTACK + 7.403 × REFLEX + 14.524 × ATAXIA
(n = 186, R = 0.94, R^2 = 0.883)

at 12 weeks (3 months)

MOA3 = 31.562 + 1.014 × MOA0 − 0.913 × AGE − 2.983 × TOA − 2.355 × ATTACK − 4.214 × RECTO
(n = 481, R = 0.838, R^2 = 0.703)

AMFS3 = 45.154 + 0.981 × AMFS0 − 0.327 × AGE − 3.616 × TOA − 2.77 × COMA − 3.24 × APHASIA − 4.173 × COGNT − 4.165 × ICH
(n = 481, R = 0.901, R^2 = 0.812)

BI3 = 70.986 + 0.573 × BI0 − 0.372 × AGE − 4.587 × TOA − 3.908 × COMA − 4.182 × ATTACK + 13.92 × DTR − 9.603 × RECTO − 3.334 × COGNT − 9.026 × OCULAR + 7.129 × SENSORY
(n = 481, R = 0.823, R^2 = 0.677)

HDS-R3 = 11.116 + 0.735 × HDS-R0 − 0.057 × AGE − 0.384 × TOA + 0.872 × COMA − 1.388 × OCULAR − 1.103 × HYPOAR
(n = 480, R = 0.929, R^2 = 0.862)

SLTA3 = 39.875 + 0.982 × SLTA0 − 0.279 × AGE − 4.886 × TOA
(n = 132, R = 0.94, R^2 = 0.884)

5 Utilization of RES-4 for Rehabilitation Goal Setting and Management of Rehabilitation Process

RES-4 is now working in the hospital, National Rehabilitation Center for the Disabled, Japan. Computer software for RES-4 (Windows 95) is available from Sakai Iryo Co, Tokyo, Japan (Nakamura 1995).

1) Data collection and input

After medical examinations and demonstration of neurological impairments of the admitted patient to rehabilitation staffs, the physician in charge orders the staffs including nurses in the rehabilitation unit to assess the functional status of the patient. Usually the results of those assessments will be gathered within 2 weeks after admission, and be recorded on RES-4 worksheet (Figure 3). Then, following the instruction manual attached to RES-4 (Windows 95), the demographic and medical data, and scores of each measure are loaded into the computer.

Scores of each measure at 4, 8, and 12 weeks should be entered at the set times in order to make comparison of the predicted and the measured scores.

2) Presentation of the functional status at admission, and 4, 8, and 12 weeks after the start of training

The computer installed with RES-4 software prints out the demographic data and others at admission, and the predicted functional status at 4, 8, and 12 weeks after the training (Figure 4). Now the staffs in charge of the patient recognize the rehabilitation outcome and the functional status. Each therapist makes effort to enhance the patient's functional status as high as possible.

3) Presentation of the in-between report

When the scores of all measures are entered into the computer at a set time, the computer prints the in-between report (Figure 5). The report is utilized in the in-between case conference. Based on the report, the reconsideration of rehabilitation goal and/or plan will be discussed.

The processes above mentioned could be easily proceeded by the manual calculation.

4) Data saving

The demographic data and the predicted scores are saved as text file after the transfer of data from the inpatient table to the discharged patient table in RES-4 software.

RES-4 work sheet

ID No. _____ Name _____

Date of onset _____ Age _____ years Sex (male • female)

Paresis (left • right • bilateral • none) Diagnosis (ICH • CI • SAH)

Comment _____

Medical

OPE	(+ • − • ns)	COMA	(+ • − • ns)	ATTACK	(1 • 2 • ≥ 3 • ns)
HYPOAR	(+ • − • ns)	VF	(+ • − • ns)	OCULAR	(+ • − • ns)
NYSTAG	(+ • − • ns)	APHASIA	(+ • − • ns)	SPASTIC	(+ • − • ns)
DTR	(+ • − • ns)	REFLEX	(+ • − • ns)	PALSY	(+ • − • ns)
SENSORY	(+ • − • ns)	ATAXIA	(+ • − • ns)	INVOL	(+ • − • ns)
RECTO	(+ • − • ns)	COGNT	(+ • − • ns)	DM	(+ • − • ns)
HT	(+ • − • ns)	CD	(+ • − • ns)	CONTR	(+ • − • ns)

Functional

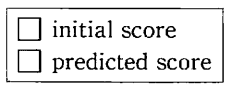
	Admission	4 wks	8 wks	12 wks	16 wks	20 wks	24 wks
Date							
MOA							
MFS-L							
MFS-R							
BI							
HDS-R							
SLTA							

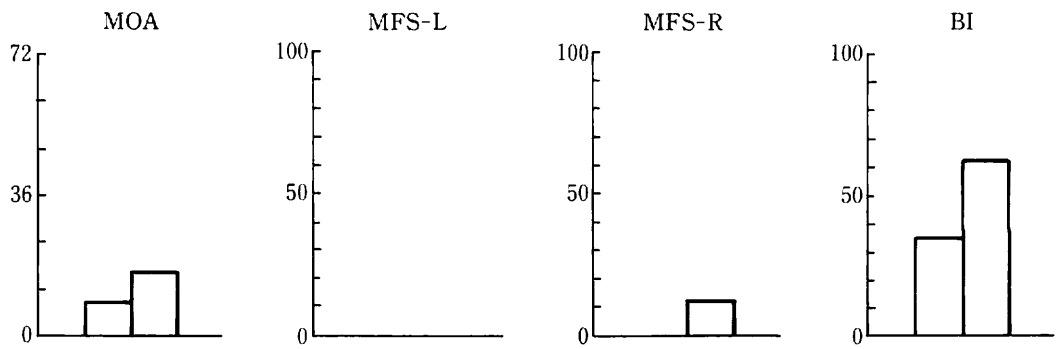
Figure 3 RES-4 work sheet

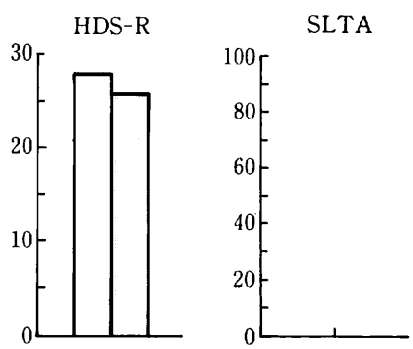
IDNo. 94063901
Name ××××

Item	Data	Paretic side	right
Date of onset	1995/10/22	HYPOAR	−
Date of initial assess	1995/12/27	VF	−
TOA	66	OCULAR	−
AGE	79	NYSTAG	−
SEX	female	APHASIA	−
OPE	−	SPASTIC	−
COMA	−	DTR	+
ATTACK	1	REFLEX	+
ICH	−	PALSY	+
CI	+	SENSORY	−
SAH	−	ATAXIA	−
RECTO	−	INVOL	−
COGNT	−	HT	−
DM	−	CD	−

Predicted score at 12 weeks





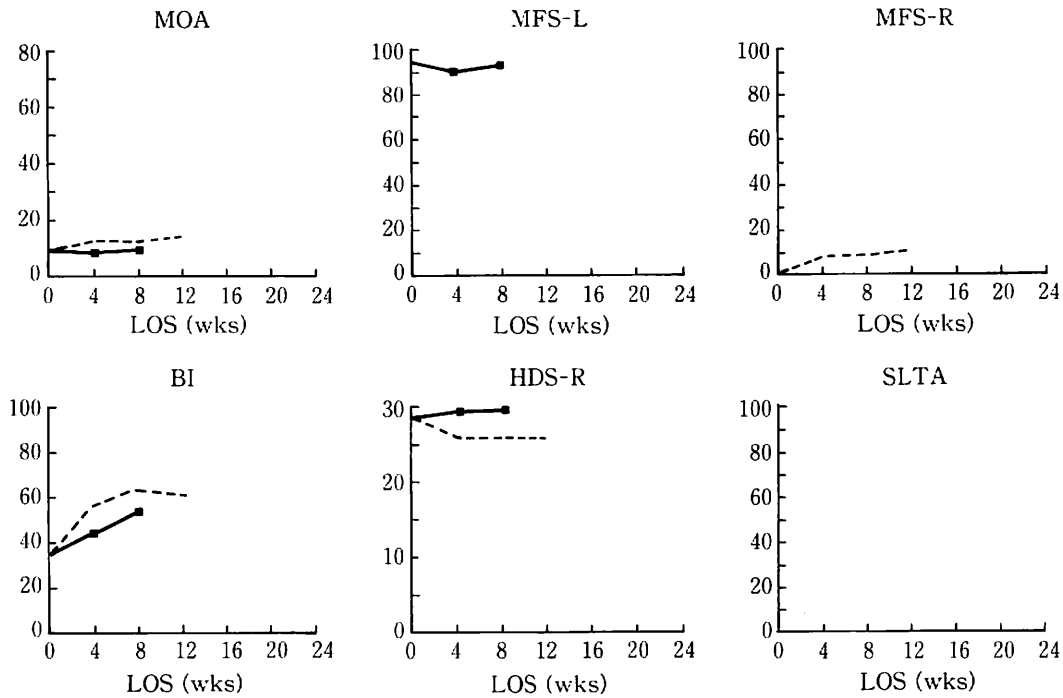


		m. s.*	p. s.**		
		at admission	4 wks	8 wks	12 wks
1	MOA	9	13	13	17
2	MFS-L	−	−	−	−
3	MFS-R	0	8	10	12
4	BI	35	57	64	62
5	MDS-R	28	26	26	26
6	SLTA	−	−	−	−

*m. s. : measured score
**p. s. : predicted score

Figure 4 Assessment Chart at Admission

IDNo. 94063901
Name ××××



LOS (wks)	MOA		MFS-L		MFS-R		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	9	9	–	94	0	0	1995/12/27
4 wks	13	9	–	91	8	0	1996/01/24
8 wks	13	10	–	94	10	0	1996/02/21
12 wks	17	–	–	–	12	–	1996/03/20
16 wks	–	–	–	–	–	–	1996/04/17
20 wks	–	–	–	–	–	–	1996/05/15
24 wks	–	–	–	–	–	–	1996/06/12

LOS (wks)	BI		HDS-R		SLTA		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	35	35	28	28	–	–	1995/12/27
4 wks	57	45	26	29	–	–	1996/01/24
8 wks	64	55	26	30	–	–	1996/02/21
12 wks	62	–	26	–	–	–	1996/03/20
16 wks	–	–	–	–	–	–	1996/04/17
20 wks	–	–	–	–	–	–	1996/05/15
24 wks	–	–	–	–	–	–	1996/06/12

Figure 5 Assessment Chart at In-between Meeting

6 Practical Use of RES-4 : Rehabilitation Planning and Goal Setting

The information related to a stroke patient, including demographic variables, the medical data and the prediction of functional status at set times, should be shared by every staffs in charge of the patient. Accordingly, discussions on rehabilitation planning and goal setting proceed orderly among the staffs in the case conference and/or the staff meeting.

The followings are methods of management of stroke rehabilitation based on RES-4 in the hospital, National Rehabilitation Center for the Disabled.

1) From the admission to the initial case conference

Within a few days after admission, the physician in charge introduces the patient to rehabilitation staffs, and presents the medical history, diagnosis, complications, neurological impairments and so on. The physician orders functional assessments to the staffs with a written request. Also he performs medical check on cardio-respiratory (CR) system as soon as possible, and indicates the staffs CR-fitness of the patient. Usually the level of CR-fitness is expressed as the upper limit of heart rate (bts/min) during physical exercises or training.

The initial case conference will be carried on the next week. The staffs should complete the functional assessments ordered by the physician, and report them before the meeting. Then a medical secretary prepares the written data related to the patient with the print-out of RES-4 (Figure 4).

At the meeting, rehabilitation goal such as the return to previous work and home, and rehabilitation planning will be determined after the discussions, utilizing the data of RES-4.

The rehabilitation goal and plan should be informed to the patient and his/her family by the physician as soon as possible. At first they often do not agree the proposed goal and/or plan, since they can not grasp the situation clearly. Application of educational model in rehabilitation medicine (Anderson, 1978), and detailed and repeated explanations of functional status based on predictions of RES-4 will bring about the satisfactory results.

2) In-between case conference

The case conference will be held approximately every 4 weeks. Figure 5 presents the report of RES-4 for an in-between case conference. Both the measured scores and the predicted ones are shown as solid and dotted lines in the upper part of the report, and the scores in the lower part. When there is moderate discrepancy between the measured and the predicted scores, for instance, more than 10 in BI, its causes should be explored and examined thoroughly. Is it urgent to modify the program of each therapy? Sometimes the change of rehabilitation goal is necessary. If a re-attack of stroke happens during medical rehabilitation, the whole process might be done over again.

Before the discharge the final assessment will be performed by all staffs. Then the physician reports the summary including rehabilitation outcome.

7 Case Reports

Case 1 (Figure 6, 7)

A 44-years-old right-handed male. Owner of a restaurant.

Diagnosis : Cerebral infarction.

Impairments : Aphasia and right hemiplegia.

Present illness : When graduated from a university, he planned to get job in a city bank. However, he left the bank after taking an orientation course. Then, he has run a small restaurant with his wife for 20 years. On 27 March 1995, he drank quite a lot. When he got up in the next afternoon, he noticed weakness of the right hand and foot, and could not talk. He admitted to a hospital. Computed tomography (CT) revealed low density area in the border zone of middle and posterior cerebral arteries, and in the deep white matter of left cerebral hemisphere. Consciousness was clear all through his illness. Ten days later he started to eat meals and sat on a wheelchair. Early in May, he could walk few steps with a T-cane. He admitted to the rehabilitation unit of our hospital on 23 May 1995.

Present status : Height 165 cm, body weight 71 kg, and blood pressure 128/82 mmHg. Right hemiplegia and aphasia were recognized. Aphasia consisted of difficulty to find words and to write, and mild disturbance of comprehension of spoken language. A psychologist, examining WAIS-R, reported that verbal IQ was 86, performance IQ 89 and total IQ 86. HDS-R was 23. There was no other problem of cognitive function. Brunnstrom's recovery stage of the right extremities were 4/6 in the arm, 5/6 in the hand and 5/6 in the lower extremity. There were increased deep tendon reflexes and positive Babinski sign on the right side. The right shoulder stiffened with moderate limitation of range of motion.

Laboratory data : Hyperlipidemia (total amount of cholesterol 262 mg/d*l*, triglyceride 446 mg/d*l*). ECG and chest X-ray showed no abnormal findings.

Functional assessment at admission : SLTA was 60 (hearing 80, talking 62, reading 77, writing 27, calculation 45) and his aphasia was considered as atypical, probably recovery phase of conduction aphasia. MFS was 75 on the right and 100 on the left side. MOA was 56. He could walk with a T-cane and the maximum walking speed for 10 m distance was 101.7 m/min. BI was 65 at the day of admission, and became 85 after 2 weeks. He needed assistance for taking a bath and was unable to climb up and down stairs. Otherwise, he could do his daily activities without help. Cardio-respiratory (CR) fitness examined with a bicycle ergometer reduced slightly.

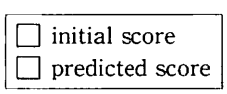
Problems : Hyperlipidemia was a risk factor to the cardiovascular system. The decreased CR-fitness and the aphasia were main impairments for returning to his job, limiting his physical and social activities.

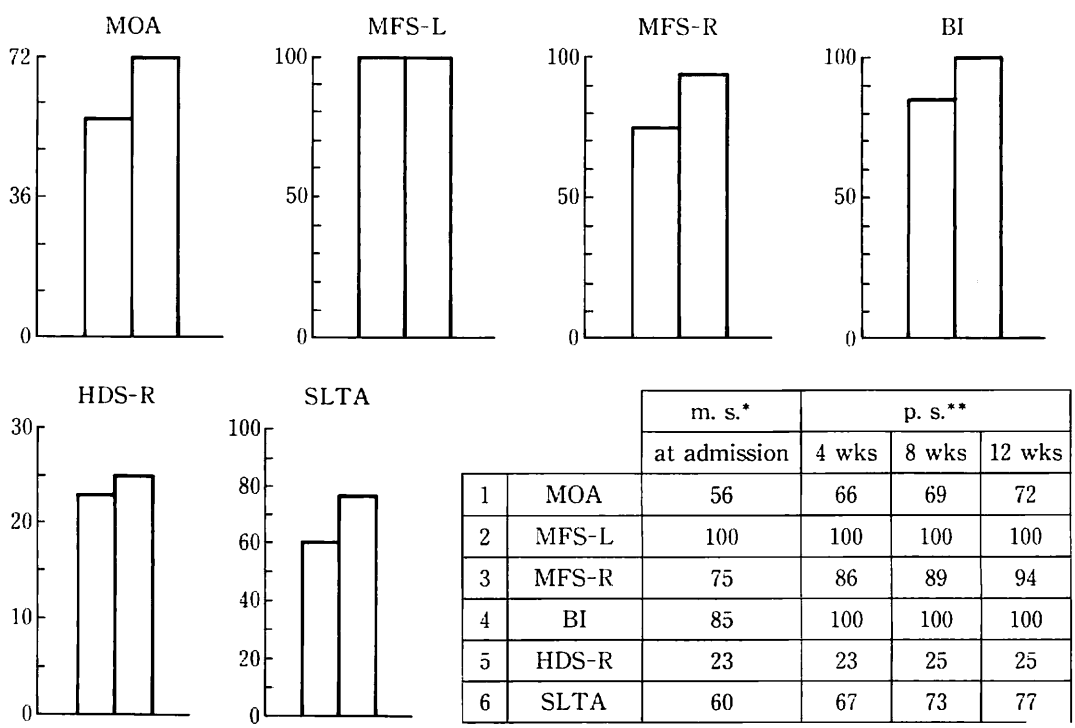
Plan and tentative goal : Diet therapy and physical exercise were prescribed for the hyperlipidemia. According to RES-4, the impaired language function and motor function of both the upper and lower extremity would recover moderately at least for 3 months after starting functional training. Speech therapy consisted of speaking, comprehension of written language and calculation. The speech

IDNo. 95097604
Name ××××

Item	Data	Paretic side	right
Date of onset	1995/03/28	HYPOAR	−
Date of initial assess	1995/06/07	VF	−
TOA	71	OCULAR	−
AGE	44	NYSTAG	−
SEX	male	APHASIA	+
OPE	−	SPASTIC	+
COMA	−	DTR	+
ATTACK	1	REFLEX	+
ICH	−	PALSY	−
CI	+	SENSORY	+
SAH	−	ATAXIA	−
RECTO	−	INVOL	−
COGNT	−	HT	+
DM	−	CD	−
		CONTR	−

Predicted score at 12 weeks



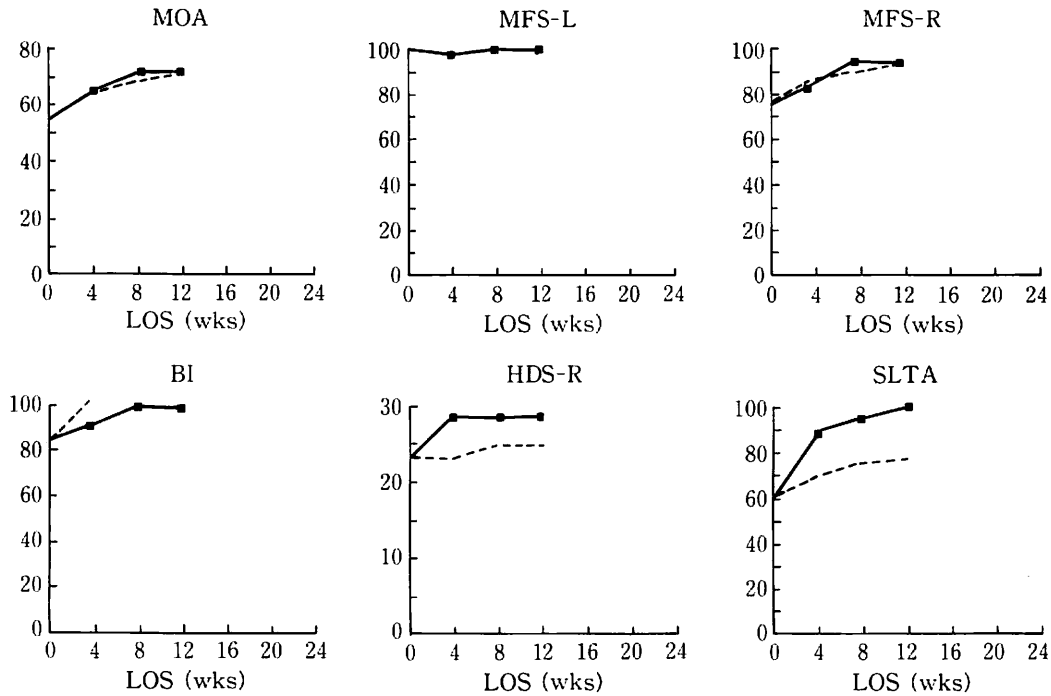


		m. s.*	p. s.**		
		at admission	4 wks	8 wks	12 wks
1	MOA	56	66	69	72
2	MFS-L	100	100	100	100
3	MFS-R	75	86	89	94
4	BI	85	100	100	100
5	HDS-R	23	23	25	25
6	SLTA	60	67	73	77

*m. s. : measured score
**p. s. : predicted score

Figure 6 Assessment Chart at Admission (Case 1)

IDNo. 95097604
Name ××××



LOS (wks)	MOA		MFS-L		MFS-R		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	56	56	100	100	75	75	1995/06/07
4 wks	66	66	100	97	86	84	1995/07/05
8 wks	69	72	100	100	89	94	1995/08/02
12 wks	72	72	100	100	94	94	1995/08/30
16 wks	–	–	–	–	–	–	1995/09/27
20 wks	–	–	–	–	–	–	1995/10/25
24 wks	–	–	–	–	–	–	1995/11/22

LOS (wks)	BI		HDS-R		SLTA		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	85	85	23	23	60	60	1995/06/07
4 wks	100	90	23	28	67	89	1995/07/05
8 wks	100	100	25	28	73	95	1995/08/02
12 wks	100	100	25	28	77	99	1995/08/30
16 wks	–	–	–	–	–	–	1995/09/27
20 wks	–	–	–	–	–	–	1995/10/25
24 wks	–	–	–	–	–	–	1995/11/22

Figure 7 Final Report (Case 1)

therapist in charge reported that the improved language function would help him communicate in daily life, but not in the communications with guests of his restaurant. The aims of physical therapy were to walk without T-cane and to improve CR-fitness.

After one and a half months, his body weight decreased from 71 kg to 66 kg. Since hyperlipidemia was not improved, the drug, pravastatin sodium, was prescribed. Recovery of the language function was good in both aspects of speaking and comprehension. The function of paralyzed right arm improved well and reached a plateau after 2 months. Walking capacity improved so well that rehabilitation sport was ordered for further improvement of CR-fitness. Finally, he took a course for retraining of driving a car.

Final assessment : SLTA was 99, which was better than the predicted score, 77. He could manage his restaurant and talk with guests. The right MFS was 94 as same as the predicted score, enabling him to cook small dishes. MOA was 72 as same as the predicted score. The maximum walking speed for 10 m distance was 171.4 m/min, and the distance of 3 minutes' walk was 262 m.

Outcome : He went back his home and previous work 5.1 months after the onset of cerebral infarction, with the stay for 3.3 months in our rehabilitation unit.

Comments : The patient showed functional improvement as predicted. MOA reached at the maximum of the scale 2 months later, also MFS attained a plateau at 2 months, and the language function continued to improve until 3 months. Compared to the average, he stayed rather long because of retraining for the driving. Driving a car was indispensable task for him to return the previous work.

Case 2 (Figure 8, 9)

A 50-years-old female. Housewife and assistant of her husband's company.

Diagnosis : Cerebral hemorrhage.

Complication : Hypertension.

Impairments : Left-sided hemiparesis and sensory disturbances, unilateral spatial inattention, and the left low vision.

Past history : Since she suffered from retinal bleeding on the left eye at the age of 46 years, its visual acuity decreased and was uncorrectable.

Present illness : During these 5 years, she underwent medical treatment for hypertension. On 1 January 1995, she suddenly had nausea and dizziness. She was transferred to an emergency hospital and diagnosed as left hemiparesis due to cerebral hemorrhage in the right thalamus. For a couple of days, her consciousness was moderately disturbed. Immediately the nasal feeding started, and 10 days later did ROM exercise at the bed-side. Then, eating and sitting on a wheel chair, exercises for standing and gait were followed. She admitted to the rehabilitation unit of our hospital on 15 March 1995.

Present status : Slightly obese (height 156 cm, body weight 55 kg), blood pressure was 102/67 mmHg under medications, and pulse rate 85/min and regular. Consciousness was clear. The left sight was 0.02. HDS-R was full score (30/30). Although results of line bisection test and a test of cross out lines were within normal range, she often forgot to put on the left brake of her wheel chair while riding on it, suggesting the presence of inattention. Brunnstrom's recovery stage of the left side was 1/6 for the arm, 1/6 for the fingers and 3/6 for the lower extremity. Superficial and deep sensations of the left side were moderately affected. There was moderate limitation of ROM of the left hip joint.

Laboratory findings : Except for abnormal values indicating hyperlipidemia (total cholesterol amount 248 mg/d*l*, triglyceride 225 mg/d*l*), there were no abnormal findings in blood and urine. The findings of chest X-ray and ECG were normal.

Functional assessment at admission : MOA was 11, the maximum walking speed for 10 m distance was 38 m/min with AFO and a T-cane. MFS was 0 for the affected side and 100 for the nonaffected side. Psychological examinations with WAIS-R and HDS-R indicated verbal IQ 87, performance IQ 80 and total IQ 83, and HDS-R 30. During the performance of difficult tasks and/or in urged situations, the left-sided inattention became obvious. BI was 55. The item, transfer, was unsuccessful. She often complained fatigue. Medical check using a bicycle ergometer detected no ischemic changes in ECG up to 40 watts. Self-rating depression scale (SDS) score was 41.

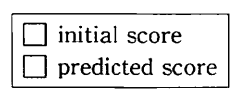
Problems : Considering the time since stroke onset and unilateral inattention, the recovery of functional status would be poor. Even with those negative features, she insisted to return her job as an assistant.

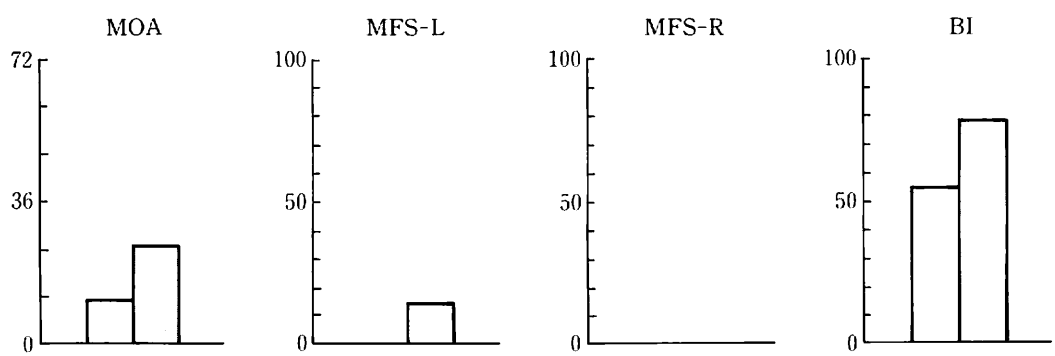
Plan and tentative goal : According to RES-4, the predicted BI3 after starting physical therapy and occupational therapy was 79, indicating that indipendent living at home was practical goal. The predicted MFS3 was 15, that is, at the level of synergic holding a wooden block. The predicted MOA3 was 25. Accordingly, she could walk safely on level surface. Discussions of staffs at the initial case conference were focused on whether the training should aim only for home making activities as a

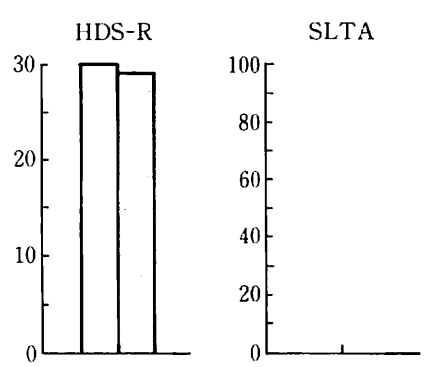
IDNo. 95021001
Name ××××

Item	Data	Paretic side	left
Date of onset	1995/01/01	HYPOAR	−
Date of initial assess	1995/03/29	VF	−
TOA	87	OCULAR	+
AGE	50	NYSTAG	−
SEX	female	APHASIA	−
OPE	−	SPASTIC	+
COMA	+	DTR	+
ATTACK	1	REFLEX	+
ICH	+	PALSY	+
CI	−	SENSORY	+
SAH	−	ATAXIA	−
RECTO	−	INVOL	−
COGNT	−	HT	−
DM	−	CD	−
		CONTR	−

Predicted score at 12 weeks





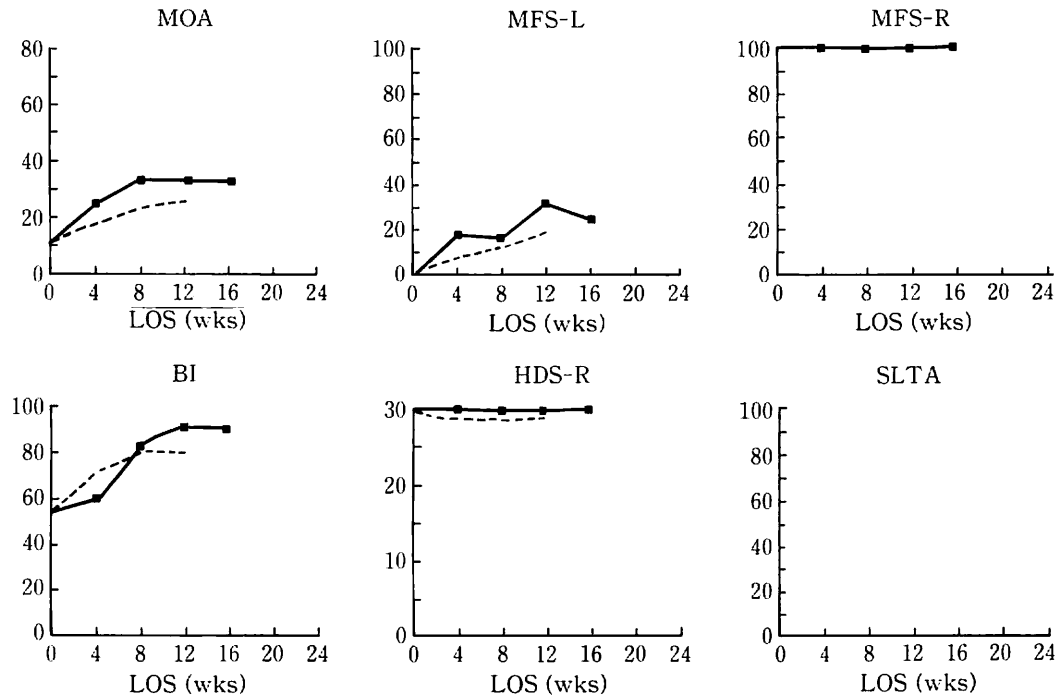


		m. s.*	p. s.**		
		at admission	4 wks	8 wks	12 wks
1	MOA	11	18	23	25
2	MFS-L	0	9	12	15
3	MFS-R	−	−	−	−
4	BI	55	71	81	79
5	HDS-R	30	28	28	29
6	SLTA	−	−	−	−

*m. s. : measured score
**p. s. : predicted score

Figure 8 Assessment Chart at Admission (Case 2)

IDNo. 95021001
Name ××××



LOS (wks)	MOA		MFS-L		MFS-R		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	11	11	0	0	–	100	1995/03/29
4 wks	18	26	9	19	–	100	1995/04/26
8 wks	23	34	12	16	–	100	1995/05/24
12 wks	25	34	15	31	–	100	1995/06/21
16 wks	–	34	–	25	–	100	1995/07/19
20 wks	–	–	–	–	–	–	1995/08/16
24 wks	–	–	–	–	–	–	1995/09/13

LOS (wks)	BI		HDS-R		SLTA		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	55	55	30	30	–	–	1995/03/29
4 wks	71	60	28	30	–	–	1995/04/26
8 wks	81	85	28	30	–	–	1995/05/24
12 wks	79	90	29	30	–	–	1995/06/21
16 wks	–	90	–	30	–	–	1995/07/19
20 wks	–	–	–	–	–	–	1995/08/16
24 wks	–	–	–	–	–	–	1995/09/13

Figure 9 Final Report (Case 2)

housewife or should include the retraining of techniques for driving a car. Some staffs compromised her wants, that is, returning to previous job. However, RES-4 indicated clearly that return to work at the office was not realistic as a goal. As shown by her easy fatigability, she was depressive to some extent. The functional outcome predicted by RES-4 was not informed to her at the beginning of training. Instead, we took the alternative way, showing her regularly the accomplished functional gain and promoting her to be aware of her low potentialities through the training.

Clinical course : Two months later, MOA became 34.5 and she could go up and down stairs under someone's supervision. She walked around the ward. BI was 85. Three months after the training, the retraining of driving a car was ordered instead of cooking activities, complying her wish to return the work. After one month of the training, the instructor reported that she should not drive a car, because of inattention and inadequate judgements. Her self-care skills were tested repeatedly in her living space, including her home and her husband's office. Finally, she and her family decided that she would mainly stay home. Husband and/or daughter would be a care-taker for going to the office. For the adjustment of physical environment, the remodeling of the house was necessary. As for medical problems, hyperlipidemia was treated with diet therapy, and hypertension with nicardipine hydrochloride, enalapril maleate and restriction of salt intake. Before the discharge, she and her daughter received consultation of a dietician.

Final assessment : MOA was 34 and the maximum walking speed for 10 m distance 54.5 m/min with AFO and a T-cane, that is, functional as a community-walker. MFS was 31 and BI 90. Independent living home and occasional visits to the office with assistance of a family member were made sure by repeated stay home overnight.

Outcome : Eight months since the onset, she returned her home after the training for 4 months. Although it took a little longer period, the initially planned goal was attained.

Summary : Clinical course of the functional status coincided with the predicted one. Unilateral spatial inattention was not obvious, and the patient has reached the initial goal, that is, the independent walk on level floor and living home alone in day-time, after 3 months of the training. It took longer period to complete the training, because of the patient's eagerness of returning to work and the additional retraining for the driving. Although the patient did not show anosognosia in the neurological examination, the lack of realistic recognition on her functional capacities would be a kind of unawareness of deficit.

Case 3 (Figure 10, 11)

A 74-years-old male. Physician.

Diagnosis : Brainstem infarction.

Complications : Hypertension and diabetes mellitus.

Impairments : Right hemiparesis and dysarthria.

Present illness : On 4 December 1994, the patient noticed weakness of the right lower extremity and dysarthria. About 3 hours later, he was not able to walk. He was transferred to an emergency hospital and was diagnosed as brainstem infarction. His consciousness was clear. He took an antiplatelet drug for a few days, but it was quitted because of the discovery of an unruptured aneurysm at the bifurcation of IC-ophthalmic artery by carotid angiogram. Physical therapy started 7 days after the admission. Soon he became independent in eating and could walk few steps. He admitted to the rehabilitation unit of our hospital on 19 January 1995.

Present status : Moderate stature, height 170 cm and body weight 63 kg. Blood pressure was 102/54 mmHg, pulse rate 68/min and regular. Neurological examinations showed paralytic dysarthria, right-sided hemiparesis, and truncal ataxia. Slight sensory disturbance on the right side was noticed. Brunnstrom's recovery stage was 5/6 for the arm, 5/6 for the fingers and 5/6 for the lower extremity.

Laboratory findings : Chest X-ray and ECG showed no abnormal findings. Fasting level of blood glucose was 102 mg/d*l* under a diet of 1,600 Cal.

Functional assessment at admission : MOA was 26 and the maximum walking speed for 10 m distance 19.8 m/min. MFS was 69 on the affected and 94 on the non-affected side. BI was 40. According to WAIS-R examination, verbal IQ was 103, performance IQ 110 and total IQ 110. HDS-R was 27.

Plan and tentative goal : RES-4 predicted that MOA3 would be 38 and MFS3 85 after the training. He could walk outside, and use his affected arm for writing and manipulate chopsticks after the physical and occupational therapy for 3 months. The predicted BI3 was 79. Accordingly, he would be partially dependent in some items of ADL.

Clinical course : Gait training with AFO, functional occupational therapy for the affected upper extremity and speech therapy were prescribed. After one month of the training, scores of each measure exceeded the predicted ones. BI was 90. Taking bath, and climbing and descending stairs were still dependent activities.

Final assessment : After 3 months, MOA was 41 and the maximum walking speed for 10 m distance 66.8 m/min. He became a community-walker. MFS was 84. He could use chopsticks and write letters. BI was 95. Taking bath was independent, but ascending and descending stairs were still under someone's supervision. He could control the rate of speech and was freely communicable with others.

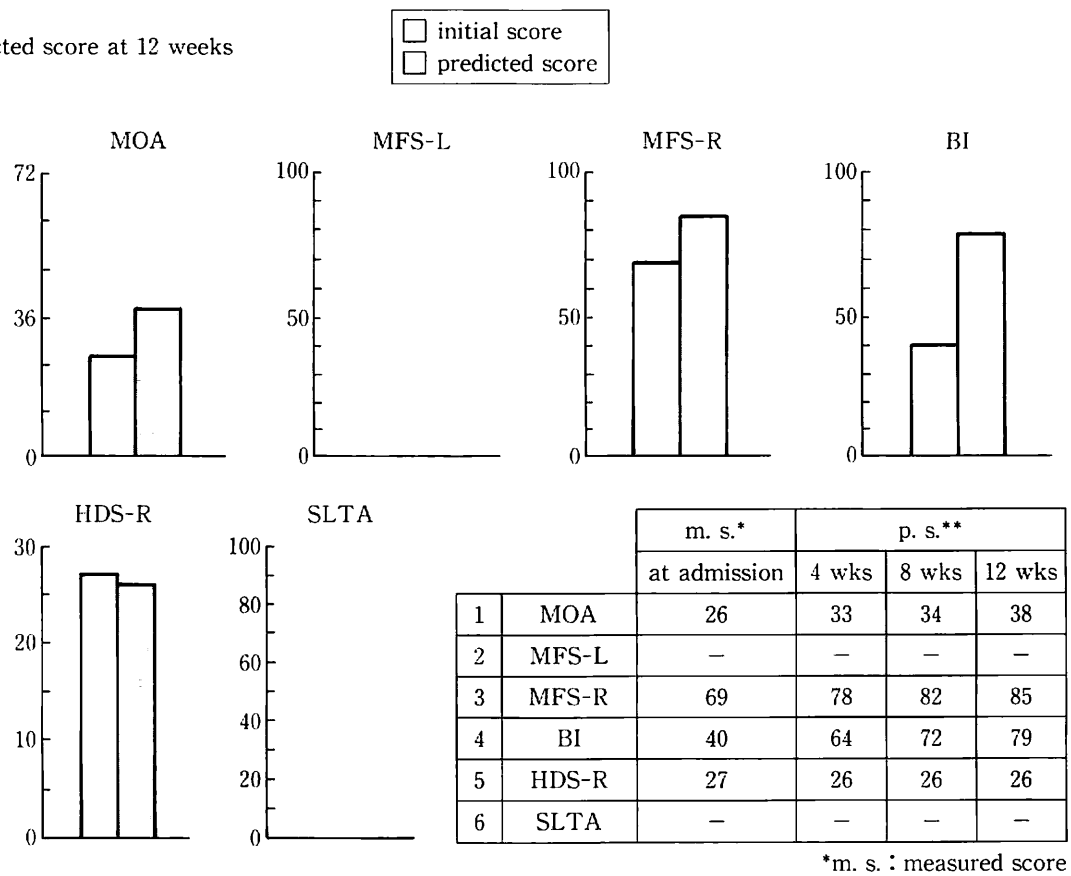
Outcome : Four and a half months after the onset and with 3 months of the training, he discharged home and started partly his previous work, consulting people in his community as a physician.

Summary : His functional gain was more than the predicted one. Decreased arousal level at admission and physical dependency on his wife during the admission in emergency hospital might be related to the seemingly low BI at the initial assessment. Better recovery than the predicted one could be partly due to elevated arousal level. The inexperience of ADL during the early phase after neurological recovery from stroke was another reason for the mismatch between the predicted and the measured BI.

IDNo. 94268603
Name ××××

Item	Data	Paretic side	right
Date of onset	1994/12/04	HYPOAR	−
Date of initial assess	1995/02/01	VF	−
TOA	59	OCULAR	−
AGE	74	NYSTAG	−
SEX	male	APHASIA	−
OPE	−	SPASTIC	−
COMA	−	DTR	+
ATTACK	1	REFLEX	+
ICH	−	PALSY	+
CI	+	SENSORY	+
SAH	−	ATAXIA	+
RECTO	−	INVOL	−
COGNT	−	HT	−
DM	+	CD	−
		CONTR	−

Predicted score at 12 weeks

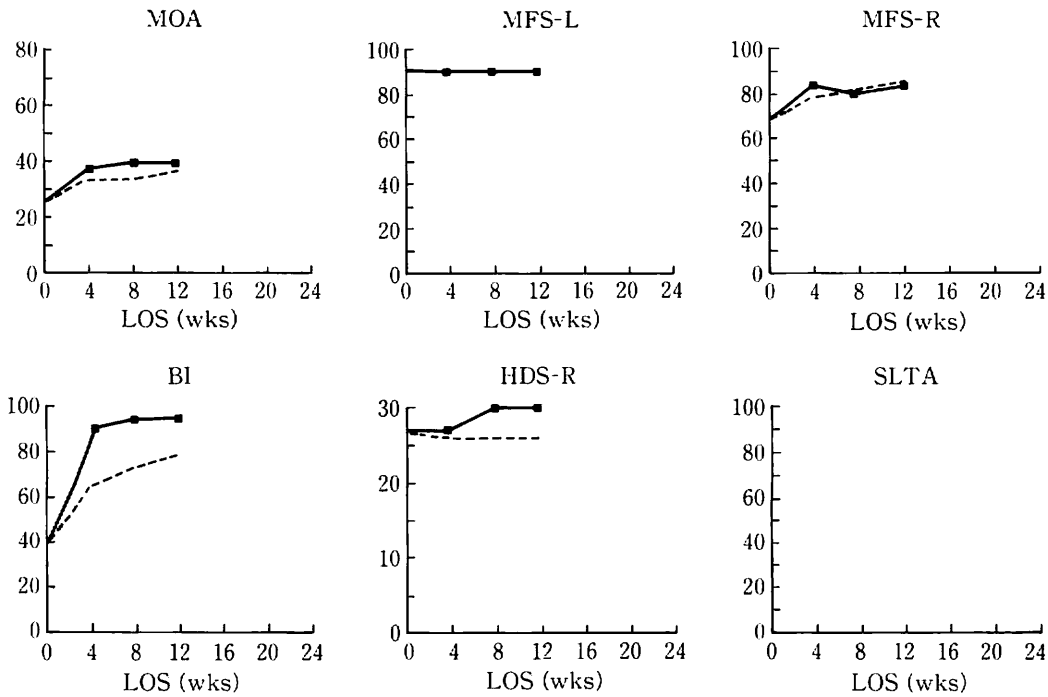


		m. s.*	p. s.**		
		at admission	4 wks	8 wks	12 wks
1	MOA	26	33	34	38
2	MFS-L	−	−	−	−
3	MFS-R	69	78	82	85
4	BI	40	64	72	79
5	HDS-R	27	26	26	26
6	SLTA	−	−	−	−

*m. s. : measured score
**p. s. : predicted score

Figure 10 Assessment Chart at Admission (Case 3)

IDNo. 94268603
Name ××××



LOS (wks)	MOA		MFS-L		MFS-R		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	26	26	–	91	69	69	1995/02/01
4 wks	33	38	–	91	78	84	1995/03/01
8 wks	34	41	–	91	82	81	1995/03/29
12 wks	38	41	–	91	85	84	1995/04/26
16 wks	–	–	–	–	–	–	1995/05/24
20 wks	–	–	–	–	–	–	1995/06/21
24 wks	–	–	–	–	–	–	1995/07/19

LOS (wks)	BI		HDS-R		SLTA		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	40	40	27	27	–	–	1995/02/01
4 wks	64	90	26	27	–	–	1995/03/01
8 wks	72	95	26	30	–	–	1995/03/29
12 wks	79	95	26	30	–	–	1995/04/26
16 wks	–	–	–	–	–	–	1995/05/24
20 wks	–	–	–	–	–	–	1995/06/21
24 wks	–	–	–	–	–	–	1995/07/19

Figure 11 Final Report (Case 3)

Case 4 (Figure 12. 13)

A 56-years-old, right-handed male. Farmer.

Diagnosis : Cerebral infarction.

Complication : Hypertension.

Impairment : Right hemiplegia.

Present illness : He had a history of hypertension for 10 years. On 14 October 1997, he had a sudden onset of the right-sided numbness and weakness. When he admitted to an emergency hospital, MRI showed a small infarction of the left corona radiata. There were also scattered small ischemic foci in the bilateral cerebral white matter and basal ganglia. His consciousness was clear. Within a few days, he started eating. On 31 October, he was transferred to the rehabilitation unit of our hospital.

Present status : Blood pressure was 160/80 mmHg and other general conditions were unremarkable. Neurological examinations revealed clear consciousness, no cognitive disorders and no ataxia. There were right-sided paresis of the face, the arm and the lower extremity, and mild sensory disturbances.

Laboratory findings : There were no remarkable findings in blood and urine. ECG and chest X-ray examinations showed normal findings.

Functional assessment at admission : MOA was 11 and MFS of the affected side 50. According to WAIS-R examination, verbal IQ was 61, performance IQ 88 and total IQ 74. HDS-R was 26. BI was 70. He needed moderate assistance for taking bath and transfer from his bed to a wheel chair. He was unable to walk alone.

Plan and tentative goal : RES-4 indicated that MOA3 would be 27, MFS3 72 and BI3 100 after the training. He could be independent in basic ADL and walking around home. Accordingly, he would participate some works in his kitchen garden as leisure activities.

Clinical course : Physical therapy and occupational therapy were prescribed as usual. Initially he was eager to recover and to start his previous work as soon as possible, falling into an anxious state. Then, he was afraid of re-attack and became depressive. Within few weeks, he could not get concentrated on the training. Anti-depressants were prescribed. Then, we, physician and staffs, informed him the prediction of functional outcome based on RES-4 repeatedly. He satisfied with those procedures and started to continue the training. After one and a half months, he became an active participant in the physical therapy and occupational therapy room.

Final assessment : After 3 months MOA was 21, lower than the predicted score. MFS was 69, near the predicted MFS. However, at 4 months after the initiation of training, MOA become 27 which coincided with the predicted MOA3. Although he had some difficulties for descending and ascending stairs, he could walk around home freely.

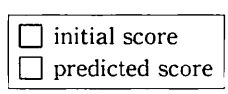
Outcome : After receiving medical rehabilitation for 4 months as inpatient, he returned home and performed basic daily activities as similar as previous life.

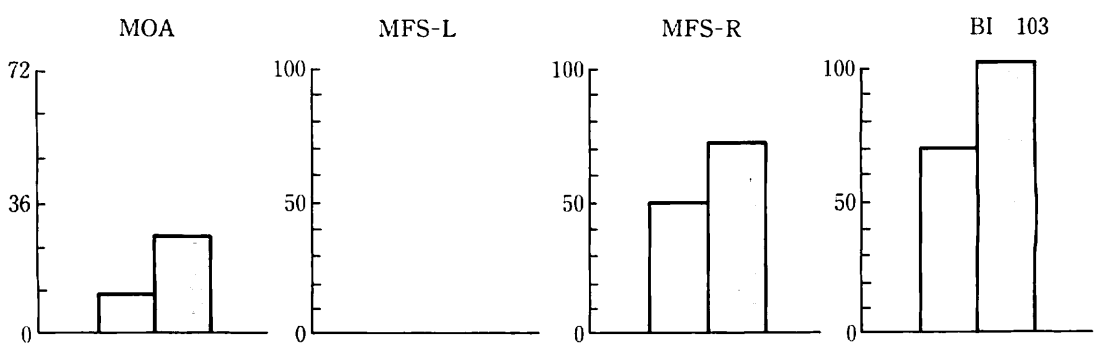
Summary : Although the patient's hemiparesis was mild, he could not concentrate on the training due to anxiety and depression. Explanations of the predicted functional outcome based on RES-4 was beneficial for the patient. After becoming psychologically stable, his recovery process followed the predicted one. In this patient, we were not sure whether anxiety and depression were organic signs of lacuna stroke or psychological reactions to his physical disabilities and the related socio-economic problems.

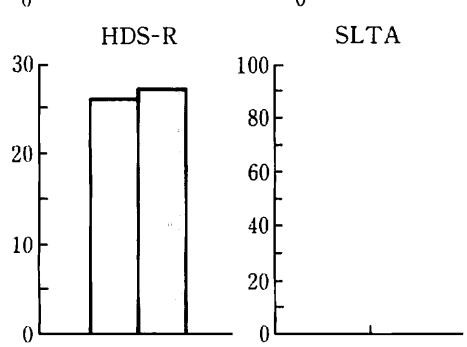
IDNo. 97234702
Name ××××

Item	Data	Paretic side	right
Date of onset	1997/10/24	HYPOAR	−
Date of initial assess	1997/11/12	VF	−
TOA	39	OCULAR	−
AGE	56	NYSTAG	−
SEX	male	APHASIA	−
OPE	−	SPASTIC	+
COMA	−	DTR	+
ATTACK	1	REFLEX	+
ICH	−	PALSY	+
CI	+	SENSORY	+
SAH	−	ATAXIA	−
RECTO	−	INVOL	−
COGNT	−	HT	+
DM	−	CD	−

Predicted score at 12 weeks





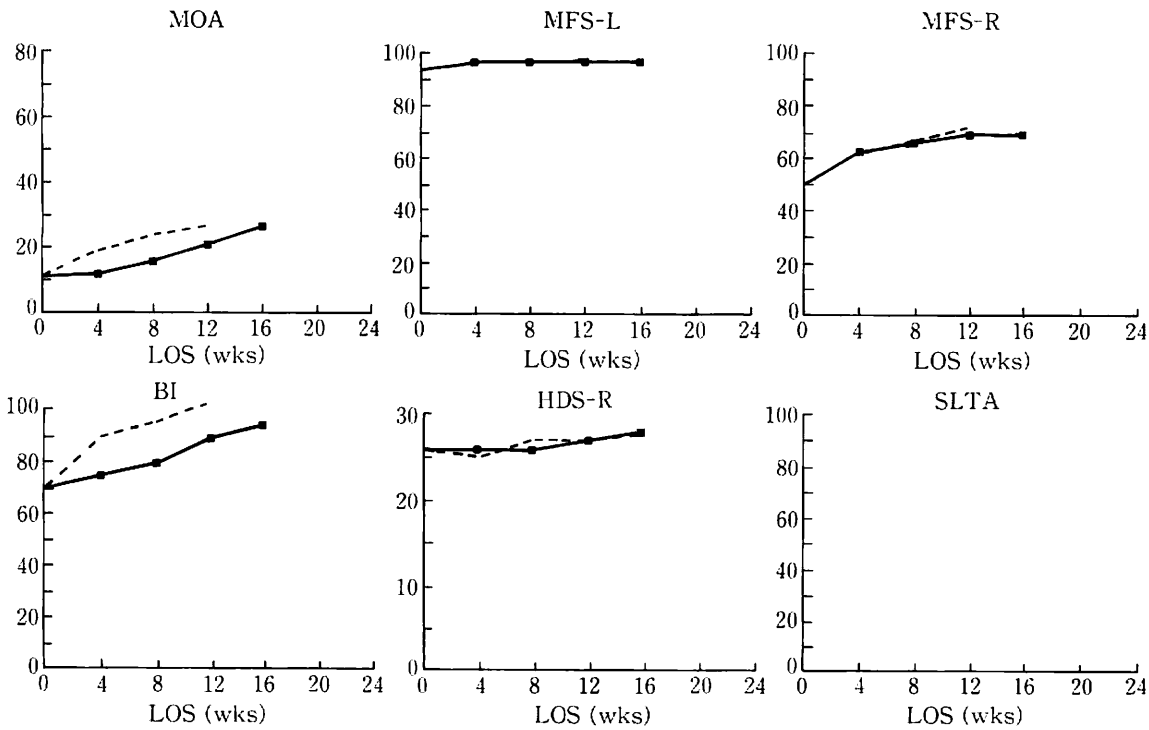


		m. s.*	p. s.**		
		at admission	4 wks	8 wks	12 wks
1	MOA	11	19	24	27
2	MFS-L	−	−	−	−
3	MFS-R	50	62	67	72
4	BI	70	90	96	103
5	HDS-R	26	25	27	27
6	SLTA	−	−	−	−

*m. s. : measured score
**p. s. : predicted score

Figure 12 Assessment Chart at Admission (Case 4)

IDNo. 97234702
Name ××××



LOS (wks)	MOA		MFS-L		MFS-R		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	11	11	–	94	50	50	1997/11/12
4 wks	19	12	–	97	62	62	1997/12/10
8 wks	24	16	–	97	67	66	1998/01/07
12 wks	27	21	–	97	72	69	1998/02/04
16 wks	–	27	–	97	–	69	1998/03/04
20 wks	–	–	–	–	–	–	1998/04/01
24 wks	–	–	–	–	–	–	1998/04/29

LOS (wks)	BI		HDS-R		SLTA		
	p. s.	m. s.	p. s.	m. s.	p. s.	m. s.	date
admission	70	70	26	26	–	–	1997/11/12
4 wks	90	75	25	26	–	–	1997/12/10
8 wks	96	80	27	26	–	–	1998/01/07
12 wks	103	90	27	27	–	–	1998/02/04
16 wks	–	95	–	28	–	–	1998/03/04
20 wks	–	–	–	–	–	–	1998/04/01
24 wks	–	–	–	–	–	–	1998/04/29

Figure 13 Final Report (Case 4)

References

1. Anderson TP : Educational frame of reference ; an additional model for rehabilitation medicine. Arch Phys Med Rehabil 59 : 203-206, 1978.
2. Hasegawa K, Inoue K, Moriya K : A study on dementia scale for the eldery. Seisin-igaku 16 : 965-969, 1974.(in Japanese)
3. Hewer RL : Is neurological disability and handicap measurable? in C Warlow, J Garfield (eds) : More Dilemmas in the Management of the Neurological Patient. Churchill Livingstone, Edinburgh, 1987.
4. Japanese Association of Aphasia (ed) : Standard Language Test of Aphasia ; Manual. Shinko-Igaku Publisher Inc, Tokyo, 1997. (in Japanese)
5. Johnson MK, Zuck FN, Wingate K : The motor age test ; measurement of motor handicaps in children with neuromuscular disorders such as cerebral palsy. J Bone Joint Surg 33-A : 698-707, 1951.
6. Jongbloed L : Prediction of function after stroke ; a critical review. Stroke 17 : 765-776, 1986.
7. Kato S, Shimogaki H, Onodera A et al. : Frame of Hasegawa's Dementia Scale Revised. Ronen Seisin-igaku Zasshi 2 : 1339-1347, 1991.(in Japanese)
8. Kato S, Hasegawa K, Simogaki H et al. : Frame of Hasegawa's Dementia Scale Revised (Supplement). Ronen Shakaikagaku 14 : 91-99, 1992. (in Japanese)
9. Mahoney FI, Barthel DW : Functional evaluation ; the Barthel Index. Maryland St Med J 14 : 61-65, 1965.
10. Moriyama S : Occupational therapy in stroke rehabilitation —with reference to early stage program —. Proc. Joint Japanese-China Stroke Conference. Reimeikyo Rehabil Hosp, 114-124, 1987.
11. Nakamura R (ed) : RES-4 for Windows (SR-1000). Sakai Iryo Co, Tokyo, 1995.(in Japanese)
12. Nakamura R, Moriyama S, Yamada Y, et al. : Recovery of impaired motor function of the upper extremity after stroke. Tohoku J Exp Med 168 : 11-20, 1992.
13. Nakamura R, Nagasaki H, Hosokawa T : Assessment and prediction of the functional state of stroke in early rehabilitation. in JS Chopra, K Jagannathan, IMS Sawhney (eds) : Advances in Neurology. Elsevier, Amsterdam, 1990.
14. Nakamura R, Nagasaki H, Hosokawa T (eds) : Assessment and Prediction of Functional State in Stroke. Ishiyaku Publishers Inc, Tokyo, 1991.(in Japanese)
15. Nakamura R, Nagasaki H, Hosokawa T (eds) : Assessment and Prediction of Functional State in Stroke. 2nd ed, Ishiyaku Publishers Inc, Tokyo, 1997.(in Japanese)
16. Partridge CJ, Johnston M, Edwards S : Recovery from physical disability after stroke ; normal patterns as a basis for evaluation. Lancet i : 373-375, 1987.
17. Prescott RJ, Garraway WM, Akhtar AJ : Predicting functional outcome following acute stroke using a standard clinical examination. Stroke 13 : 641-647, 1987.
18. Reding MJ, Potes E : Rehabilitation outcome following initial unilateral hemispheric stroke ; life table analysis approach. Stroke 19 : 1354-1358, 1988.
19. Sulton LD, Hardisty B, Disterfeldt J, et al. : Computerized data base ; an integrated approach to

monitoring quality of patient care. Arch Phys Med Rehabil 68 : 850-853, 1987.
20. Wade DT, Skilbeck CE, Hewer RL : Predicting Barthel ADL score at 6 month after an acute stroke. Arch Phys Med Rehabil 64 : 24-28, 1983.
21. World Health Organization : International Classification of Impairments, Disabilities, and Handicaps. WHO, Geneva, 1980.