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Comparing contents of functional outcome measures in stroke rehabilitation using the International Classification of Functioning, Disability and Health

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Abstract

Purpose To examine the content of outcome measures that are frequently used in stroke rehabilitation and focus on activities and participation, by linking them to the International Classification of Functioning, Disability and Health (ICF).

Method Constructs of the following instruments were linked to the ICF: Barthel Index, Berg Balance Scale, Chedoke McMaster Stroke Assessment Scale, Euroqol-5D, Functional Independence Measure, Frenchay Activities Index, Nottingham Health Profile, Rankin Scale, Rivermead Motor Assessment, Rivermead Mobility Index, Stroke Adapted Sickness Impact Profile 30, Medical Outcomes Study Short Form 36, Stroke Impact Scale, Stroke Specific Quality of Life Scale and Timed Up and Go test.

Results It proved possible to link most constructs to the ICF. Most constructs fitted into the activities and participation component, with mobility being the category most frequently covered in the instruments. Although instruments were selected on the basis of their focus on activities and participation, 27% of the constructs addressed categories of body functions. Approximately 10% of the constructs could not be linked.

Conclusions The ICF is a useful tool to examine and compare contents of instruments in stroke rehabilitation. This content comparison should enable clinicians and researchers to choose the measure that best matches the area of their interest.

Introduction

Stroke is a major public health concern, being among the most common causes of death and disability in industrialized societies[1]. Many survivors are facing the long-term consequences of stroke, which are usually complex and heterogeneous, and can result in problems across multiple domains of functioning. Given the long-term consequences of stroke, the focus on functional outcome measurement for assessment, intervention management and outcome evaluation in stroke rehabilitation is well justified.

In recent years there has been a growing awareness that stroke assessment must extend beyond the traditional outcome of mortality and neurological symptoms to include physical, psychological and social functioning[2]. This biopsychosocial approach is increasingly being applied in health care and research, especially in rehabilitation medicine. Accordingly, in the last decades, numerous measures have been developed to assess functional outcome in stroke. An overview of functional outcome measures was recently published by Salter et al[3,4], who evaluated the psychometric and administrative properties.

The International Classification of Functioning, Disability and Health (ICF)[5], published by the World Health Organization in 2001, also uses this biopsychosocial approach[6]. The ICF is a globally agreed framework and classification system, which provides a unified and standardized language to describe the components of health. It describes health from three different perspectives: the perspective of the body (the body component), that of the individual and that of society (the activities and participation component). The ICF also covers environmental and personal factors which interact with all health components.

Functional outcome measures are primarily concerned with measuring an individual's ability to perform activities required in daily life[7], which is conceptually related to the activities and participation component of the ICF. The term activities as used in the ICF is defined as the execution of a task or action by an individual, and participation is defined as involvement in a life situation[5].

Functional outcome measures and the ICF are concurrently applied in stroke rehabilitation medicine. This simultaneous use necessitates a further understanding of their relationship and compatibility[8]. Using the ICF, it is possible to identify and compare the concepts contained in different outcome measures. Geyh et al.[9] have used this method to identify the concepts of outcome measures in stroke trials and demonstrated the wide variety of concepts in this field. Unfortunately, their review did not include any information on the content of the individual outcome measures, as they did not report which specific ICF categories were represented in each of the measures.

Selecting an outcome measure, whether for clinical practice or for research purposes, requires information on the specific content at item level. Unfortunately, the selection

process is often primarily driven by measures that are readily at hand[10] or is guided only by the evaluation of the psychometric properties. In our opinion, more emphasis should be placed on the question whether an instrument is appropriate[11], i.e. which specific constructs should be measured and which instruments match these constructs? The ICF provides an instrument to evaluate the content of a measure in a systematic way.
The objective of this study was to explore the relationship between the ICF model and outcome measures that are frequently used in stroke rehabilitation and focus on activities and participation. The specific aims were to examine and compare the contents of these measures by linking them to the ICF.

Methods

Outcome measures. We examined outcome measures frequently used in stroke rehabilitation in the area of activities and participation[3,4]. The following 15 functional outcome measures were assessed: Barthel Index (BI)[12], Berg Balance Scale (BBS)[13,14], Chedoke McMaster Stroke Assessment Scale (CMSA)[15,16], Euroqol-5D (EQ5D)[17], Functional Independence Measure (FIM)[18], Frenchay Activities Index (FAI)[19], Nottingham Health Profile (NHP)[20,21], Rankin Scale (RS)[22], Rivermead Motor Assessment (RMA)[23,24], Rivermead Mobility Index (RMI)[25], Stroke Adapted Sickness Impact Profile 30 (SASIP30)[26,27], Medical Outcomes Study Short Form 36 (SF36)[28,29], Stroke Impact Scale (SIS)[30], Stroke Specific Quality of Life Scale (SSQOL)[31] and Timed Up and Go test (TUG)[32]. Salter et al.[3,4] evaluated the psychometric and administrative properties of these 15 instruments.
Linking to ICF. The ICF[5] has two parts, each containing two components. The first part deals with functioning and disability and includes the body functions (b) and body structures (s) component and the activities and participation (d) component. The second part covers contextual factors and includes the environmental factors (e) component and the personal factors component. Each component includes several categories, which are the units of the ICF classification. The personal factors component is only broadly described, as categories have not yet been defined. In the ICF classification, the letters b, s, d and e, which refer to the components, are followed by a numeric code starting with the first-level category, i.e. the chapter number (1 digit), followed by the second (2 digits), third (1 digit) and sometimes fourth (1 digit) levels. The component letter with the suffix consisting of 1, 3, 4 or 5 digits corresponds with the code of the categories. An example selected from the activities and participation component (d) would result in a code with d4 'mobility' at the first level, d420 'transferring oneself' at the second level, and d4200 'transferring oneself while sitting' at the third level.

Linking rules have been developed which allow a reliable linking of items of outcome measures to the ICF[33]. We tried to link each item in the various measures to the most appropriate ICF category. If an item encompassed different constructs, the information in each construct was individually linked. For example, in item 36 of the NHP 'I'm in pain when going up and down stairs or steps', the constructs 'pain' and 'going up and down stairs of steps' were linked to separate ICF categories. If an item could not be linked, this item was assigned an nd (not defined) code.

First, each measure was linked independently by three health professionals working in rehabilitation research. One of them (VS) linked all the 15 measures, one (IvdP) linked eight measures and one (MK) linked the other seven measures. Second, for each measure, the linked categories were compared. In case of consensus the item was linked to the ICF category. In case of disagreement a discussion followed, led by the third person (MK or IvdP) who initially did not link that measure. This person finally decided to which ICF category the item was linked. For the purpose of the present paper, ICF codes of the first- and second-level categories were reported.

Results

It proved possible to link all instruments to the ICF, except for the RS, none of whose constructs could be linked (table 1). These were therefore all coded nd. Six instruments, EQ 5D, NHP, SASIP30, SF36, SSQL and SIS, contained some constructs that could not be linked. The 15 instruments included a total of 364 items, which contained 471 constructs. Of these constructs, 298 (63%) belonged to the activities and participation component (d), for which most constructs, 166, were linked to the first-level category of mobility (d4); followed by 32 constructs linked to self-care (d5). The first-level categories with the fewest links were general tasks and demands (d2) and learning and applying knowledge (d1), with 4 and 6 links, respectively.

Of all linked constructs, 128 (27%) belonged to body functions (b). All first-level ICF categories for body functions were linked, except for one (b4: functions of the cardiovascular, haematological, immunological and respiratory systems). The largest number of constructs (68) were linked to mental functions (b1), followed by 38 constructs linked to neuromusculoskeletal and movement-related functions (b7). Of body structures (s), the only first-level category linked to any constructs was that of structures related to movement (s7).

All instruments, except the RS, covered mobility (d4). The BBS, RMI (except for one construct) and TUG were completely focussed on mobility. The SSQL addressed all domains of activity and participation. The SASIP30, SIS and SF36 also covered a wide

range of categories from the activity and participation component, including 8, 8 and 7 of the 9 first-level categories, respectively. Eight instruments (BI, CMSA, FIM, NHP, RS, RMA, RMI and SASIP30) included environmental factors of the products and technology category (e1) and of the support and relationships category (e3). The BBS and SSQL only included the support and relationships category (e3), while the TUG only included products and technology (e1).

Table 1. Links between first-level ICF categories of body functions, body structures and activities and participation on the one hand and outcome measures frequently used in stroke rehabilitation on the other.

ICF Category	BI	BBS	CMSA	EQ5D	FIM
Body functions					
b1 Mental functions				1	1
b2 Sensory functions and pain			1	1	
b3 Voice and speech functions					
b5 Functions of the digestive, metabolic and endocrine systems	1				1
b6 Genito-urinary and reproductive functions	1				1
b7 Neuromusculoskeletal and movement-related functions			15		
Body structures					
s7 Structures related to movement			1		
Activities and Participation					
d1 Learning and applying knowledge					1
d2 General tasks and demands					
d3 Communication					2
d4 Mobility	4	14	25	1	7
d5 Self-Care	5			2	7
d6 Domestic life				1	
d7 Interpersonal interactions and relationships					1
d8 Major life areas				2	
d9 Community, social and civic life				1	
Not definable				3	
Total	11	14	42	12	21

ICF= International Classification of Functioning, Disability and Health; BI = Barthel Index; BBS = Berg Balance Scale; CMSA = Chedoke McMaster Stroke Assessment Scale, EQ5D = Euroqol-5D; FIM = Functional Independence Measure; FAI = Frenchay Activities Index; NHP= Nottingham Health Profile; RS = Rankin Scale; RMA = Rivermead Motor Assessment;

Within the first-level category of mobility (d4), the second-level categories most frequently included in the instruments were changing basic body position (d410) and walking (d450) (table 2b). Within the self-care category (d5), dressing (d540) and washing oneself (d510) were the second-level categories most frequently covered by the instruments. The most frequently linked category of mental functions (b1) was that of emotional functions (b152). The most frequently linked second-level category of neuromusculoskeletal and movement-related functions (b7) was control of voluntary movements (b760) (table 2a).

FAI	NHP	RHS	RMA	RMI	SASIP30	SF36	SSQL	SIS	TUG	Total
	19				4	13	15	15		68
	8					2	2			14
					1		1			2
								1		3
								1		3
			18		1			4		38
										1
					2		1	2		6
					1	2	1			4
					2		6	7		17
3	12		35	18	7	12	10	15	3	166
	1			1	2	2	7	5		32
8	1				4	1	2	4		21
	4				4		2	3		14
1	1					8	1	3		16
5	3				1	4	4	4		22
	9	5			3	16	6	2		44
17	58	5	53	19	32	60	58	66	3	471

RMI = Rivermead Mobility Index; SASIP30 = Stroke Adapted Sickness Impact Profile 30; SF36 = Medical Outcomes Study Short Form 36; SSQL = Stroke Specific Quality of Life Scale; SIS = Stroke Impact Scale and TUG = Timed Up and Go test.

Table 2a. Links between second-level ICF categories of body functions and body structures on the one hand and outcome measures frequently used in stroke rehabilitation on the other.

ICF Category	BI	BBS	CMSA	EQ5D	FIM
Mental functions					
b114 Orientation functions					
b126 Temperament and personality functions					
b130 Energy and drive functions					
b134 Sleep functions					
b140 Attention functions					
b144 Memory functions					1
b152 Emotional functions				1	
b160 Thought functions					
b167 Mental functions of language					
Sensory functions and pain					
b210 Seeing functions					
b280 Sensation of pain			1	1	
Voice and speech functions					
b330 Fluency and rhythm of speech functions					
Functions of the digestive, metabolic and endocrine systems					
b525 Defecation functions	1				1
Genito-urinary and reproductive functions					
b620 Urination functions	1				1
Neuromusculoskeletal and movement-related functions					
b710 Mobility of joint functions			1		
b730 Muscle power functions					
b750 Motor reflex functions			1		
b760 Control of voluntary movements			13		
Structures related to movement					
s720 Structure of the shoulder region			1		

ICF= International Classification of Functioning, Disability and Health; BI = Barthel Index; BBS = Berg Balance Scale; CMSA = Chedoke McMaster Stroke Assessment Scale, EQ5D = Euroqol-5D; FIM = Functional Independence Measure; FAI = Frenchay Activities Index; NHP= Nottingham Health Profile; RS = Rankin Scale; RMA = Rivermead Motor Assessment;

FAI	NHP	RHS	RMA	RMI	SASIP30	SF36	SSQL	SIS	TUG	Total
								1		1
	1				1		4			6
	2					3	2			7
	6									6
							1	1		2
							2	3		6
	10				3	10	5	9		38
								1		1
							1			1
							2			2
	8					2				12
					1		1			2
								1		3
								1		3
										1
								4		4
										1
			18		1					32
										1

RMI = Rivermead Mobility Index; SASIP30 = Stroke Adapted Sickness Impact Profile 30; SF36 = Medical Outcomes Study Short Form 36; SSQL = Stroke Specific Quality of Life Scale; SIS = Stroke Impact Scale and TUG = Timed Up and Go test.

Table 2b. Links between second-level ICF categories of activities and participation on the one hand and outcome measures frequently used in stroke rehabilitation on the other.

ICF Category	BI	BBS	CMSA	EQ5D	FIM
Learning and applying knowledge					
d110 Watching					
d160 Focusing attention					
d163 Thinking					
d172 Calculating					
d175 Solving problems					1
General tasks and demands					
d230 Carrying out daily routine					
d240 Handling stress and other psychological demands					
Communication					
d310 Communicating receiving spoken language					
d329 Communicating receiving other spec/unspec.					1
d330 Speaking					
d345 Writing messages					
d349 Communication - producing other spec/unspec.					1
d350 Conversation					
d360 Using communication devices and techniques					
d369 Conversation and use of communication devices and techniques, other spec/unspec.					
Mobility					
d410 Changing basic body position		7	11		1
d415 Maintaining a body position		6	3		
d420 Transferring oneself	1	1	2		1
d429 Changing and maintaining body positions, other spec/unspec.					2
d430 Lifting and carrying objects					
d440 Fine hand use					
d445 Hand and arm use			1		
d449 Carrying, moving and handling objects, other spec/unspec.					
d450 Walking	1		6	1	1
d455 Moving around	1		2		1
d460 Moving around in different locations					
d465 Moving around using equipment	1				1

FAI	NHP	RHS	RMA	RMI	SASIP30	SF36	SSQL	SIS	TUG	Total
							1			1
					1					1
					1					1
								1		1
								1		2
						2	1			3
					1					1
								1		1
										1
					1		3	3		7
							1			1
										1
					1			1		2
							2	1		3
								1		1
	2		7	4		2	2	1	2	39
	3		3	3			1	2		21
			3							8
				1	2			2		7
			1	1		2		1		5
			8				1	3		12
	1		5			1	2	1		11
			1			1				2
1	4		3	5	1	3	2	3	1	32
	2		4	3	1	3	1	2		20
					1					1
					1		1			4

ICF Category	BI	BBS	CMSA	EQ5D	FIM
d469 Walking and moving, other spec/unspec.					
d470 Using transportation					
d475 Driving					
Self-care					
d510 Washing oneself	1			1	2
d520 Caring for body parts	1				1
d530 Toileting	1				1
d540 Dressing	1			1	2
d550 Eating	1				1
Domestic life					
d620 Acquisition of foods and services					
d630 Preparing meals					
d640 Doing housework					
d650 Caring for household objects					
d660 Assisting others					
d699 Domestic life, unspecified				1	
Interpersonal interactions and relationships					
d710 Basic interpersonal interactions					
d720 Complex interpersonal interactions					
d729 General interpersonal interactions, other spec/unspec.					1
d750 Informal social relationships					
d760 Family relationships					
d770 Intimate relationships					
Major life areas					
d839 Education, other spec/unspec.				1	
d850 Remunerative employment					
d859 Work and employment, other spec/unspec.				1	
d860 Basic economic transactions					
d865 Complex economic transactions					
Community, social and civic life					
d920 Recreation and leisure				1	
d930 Religion and spirituality					
d999 Community, social and civic life, unspecified					

ICF= International Classification of Functioning, Disability and Health; BI = Barthel Index; BBS = Berg Balance Scale; CMSA = Chedoke McMaster Stroke Assessment Scale, EQ5D = Euroqol-5D; FIM = Functional Independence Measure; FAI = Frenchay Activities Index; NHP= Nottingham Health Profile; RS = Rankin Scale;

FAI	NHP	RHS	RMA	RMI	SASIP30	SF36	SSQL	SIS	TUG	Total
				1	1					2
1										1
1										1
				1		1	1	1		8
								1		3
							1	1		4
	1				2	1	4	1		13
							1	1		4
1					1			1		3
1							1			2
4					2			1		7
2					1					3
								1		1
	1					1	1	1		5
					1			1		2
	1				1					2
	1				2					4
	1						1	1		3
								1		1
	1						1			2
										1
1	1									2
						8	1	1		11
								1		1
								1		1
4	3				1	4	3	3		19
1								1		2
							1			1

RMA = Rivermead Motor Assessment; RMI = Rivermead Mobility Index; SASIP30 = Stroke Adapted Sickness Impact Profile 30; SF36 = Medical Outcomes Study Short Form 36; SSQL = Stroke Specific Quality of Life Scale; SIS = Stroke Impact Scale and TUG = Timed Up and Go test; other spec/unspec. = other specified and unspecified.

Discussion

Most constructs of the functional outcome measures were covered by the ICF model, except those of the RS. Most linked constructs fitted into the activities and participation component, with mobility being the category most frequently covered in the instruments, followed by self-care. Although the outcome measures had been selected on the basis of their focus on activities and participation, 27% of the constructs addressed the body functions categories. Approximately 10% of the constructs could not be linked to the ICF.

The ICF turned out to be a useful framework and classification system to categorize health components, as it proved possible to relate many constructs in the functional outcome measures to the ICF categories. Linking the constructs of the instruments to the ICF has resulted in a clear view of the major differences and similarities. Other studies[9,34,35] have also reported positive experiences with the linkage of instruments to the ICF. However, we also encountered specific difficulties in assigning ICF codes to the constructs of outcome measures. One of the difficulties is illustrated by the finding that more constructs than we expected could not be linked to the ICF. Most of the constructs that could not be linked referred to a concept that was too general, for example the construct 'physical health' in item 4 of the SF36 or 'personal life' in item 3 of the Family roles subscale of the SSQL. None of the RS constructs could be linked, as they were all too generally formulated, for instance as 'lifestyle' or 'symptoms'. The RS, which is widely used in stroke research, should only be viewed as a global functional health index[36] and is therefore, in our opinion, of limited value in rehabilitation. A few other constructs, though more specifically described, could not be linked either, for example 'I am confined to bed' in item 1 of the EQ5D or 'I had to stop and rest during the day' in item 2 of the Energy subscale of the SSQL.

A remarkable finding was the substantial number of links to the body functions categories, although the outcome measures examined had been selected by Salter et al.[37] based on their focus on activities and participation. In the NHP, which has the most links to body functions of all instruments (47%), two different types of links to body functions can be distinguished. On the one hand, there are items that solely cover a body function, for example item 9 of part I, 'I feel lonely'. On the other hand, there are items that refer to a connection between a body function and a category of activities and participation, for example item 8 of part I, 'I find it painful to change position'. The latter type of item, combining body functions and activities/participation, can also be found in the RMA, where most items refer to a certain physical movement in the mobility category, sometimes in combination with the quality of movement at the level

of body functions. Even though many measures include items of body functions as well as of activities and participation[37], we still conclude that the instruments we examined measure functional outcome. We conclude this, firstly, because none of instruments had more than half of their constructs linked to body functions, and secondly, because some items addressing body functions connected these to activities and participation. However, it is important to realize that when the scores of items measuring body functions and the scores of activities and participation items are added to form one overall score, interpretation of the final result and the real meaning of the finding may be questionable[38,39].

The SASIP30, SF36, SSQL and SIS are examples of measures which enable the user to get a comprehensive picture of health outcome in post-stroke patients[30]. They cover the largest range of ICF categories within the activities and participation component. However, apart from activities and participation, they also include categories of body functions. If an instrument is required that solely measures activities and participation, four instruments can be considered, viz the BBS, FAI, RMI and TUG. Of these four measures, only the FAI yields a wider view of patients' functioning, addressing work, household and social life. The BBS, RMI and TUG only cover a narrow spectrum within the activities and participation component, and are suitable for specific questions regarding mobility. The RMI, for example, was developed with the intention to focus on disability, not impairment, and to span a wide range of reduction in mobility[25]. Evaluating the linked constructs of the RMI allows both intentions to be clearly recognized: a broad range of mobility categories are covered, and there are no linkages to the categories of body functions.

Mobility is the most frequently represented category, with 35% of all the linkages. This emphasis on mobility is understandable, as it has for a long time been a major goal in rehabilitation medicine. However, work, recreation and relationships are becoming more and more important issues in this field. Unfortunately, the present instruments still pay relatively little attention to these topics, resulting in little outcome assessment in this area[40]. Development of measures in these areas is required.

The importance of our findings for rehabilitation practice is that they provide a comprehensive and helpful overview of the content of frequently used functional outcome measures, both for clinicians and researchers. Previously published overviews[3,4,37,41,42] have described primarily the psychometric properties of validity and reliability, whereas Wade[11] already emphasized that information on the concepts contained in the instruments is of great importance. The intention of the present paper is not to give any specific recommendations as to which instrument to use, as this decision depends on the question that needs to be answered. Selection of an outcome

measure should start by exactly describing the specific concepts that need to be measured. After these have been clearly described, potential measures matching these concepts must be identified. Tables 1 and 2 could be helpful for this purpose: the required concepts are shown on the left hand side of both tables, where the ICF categories are presented. It can therefore be seen at a glance which instruments cover these concepts, and the outcome measures most frequently used in stroke rehabilitation can easily be compared.

In conclusion, examining and comparing the content of functional outcome measures in stroke rehabilitation using the ICF was found to be a useful approach. Clinicians and researchers who need to select an outcome measure need to be aware of the constructs covered by an instrument and the areas that it does not cover at all. The content comparison presented in this paper should enable clinicians and researchers in stroke rehabilitation to choose the appropriate measure that best matches the area of their interest.

References

1. Murray CJ and Lopez AD. Global mortality, disability, and the contribution of risk factors: Global Burden of Disease Study. Lancet 1997;349:1436-42.
2. Doyle PJ. Measuring health outcomes in stroke survivors. Arch Phys Med Rehabil 2002;83:S39-S43.
3. Salter K, Jutai JW, Teasell R, Foley NC, Bitensky J, and Bayley M. Issues for selection of outcome measures in stroke rehabilitation: ICF activity. Disabil Rehabil 2005;27:315-40.
4. Salter K, Jutai JW, Teasell R, Foley NC, Bitensky J, and Bayley M. Issues for selection of outcome measures in stroke rehabilitation: ICF Participation. Disabil Rehabil 2005;27:507-28.
5. WHO International Classification of Functioning, Disability and Health: ICF. Geneva: WHO; 2001.
6. Ustun TB, Chatterji S, Bickenbach J, Kostanjsek N, and Schneider M. The International Classification of Functioning, Disability and Health: a new tool for understanding disability and health. Disabil Rehabil 2003;25:565-71.
7. Cohen ME and Marino RJ. The tools of disability outcomes research functional status measures. Arch Phys Med Rehabil 2000;81:S21-S29.
8. Stucki G, Ewert T, and Cieza A. Value and application of the ICF in rehabilitation medicine. Disabil Rehabil 2003;25:628-34.
9. Geyh S, Kurt T, Brockow T, Cieza A, Ewert T, Omar Z, and Resch KL. Identifying the concepts contained in outcome measures of clinical trials on stroke using the International Classification of Functioning, Disability and Health as a reference. J Rehabil Med 2004;(44 Suppl):56-62.
10. Finch E, Brooks D, Startford PW, and Mayo NE. Physical rehabilitation outcome measures. A guide to enhanced clinical decision-making. second edition. Hamilton, Ontario: BC Decker inc; 2002.
11. Wade DT. Measurement in neurological rehabilitation. New York: Oxford University Press;1992.
12. Mahoney F and Barthel D. Functional evaluation: The Barthel Index. Md Med J 1965;14:61-5.
13. Berg KO, Wood-Dauphinee SL, Williams JI, and Maki B. Measuring balance in the elderly: validation of an instrument. Can J Public Health 1992;83 (Suppl 2):S7-11.
14. Berg K, Wood-Dauphinee S, and Williams JI. The Balance Scale: reliability assessment with elderly residents and patients with an acute stroke. Scand J Rehabil Med 1995;27:27-36.
15. Gowland C, Van Hullenaar S, Torresin W, Moreland J, Vanspall B, Barreca S et al. Chedoke-McMaster Stroke Assessment: development, validation, and administration manual. Hamilton, Ontario: Chedoke Mc Master hospitals and Mc Master University; 1995.
16. Gowland C, Stratford P, Ward M, Moreland J, Torresin W, Van Hullenaar S, Sanford J, Barreca S, Vanspall B, and Plews N. Measuring physical impairment and disability with the Chedoke-McMaster Stroke Assessment. Stroke 1993;24:58-63.
17. The EuroQol Group. EuroQol--a new facility for the measurement of health-related quality of life. Health Policy 1990;16:199-208.

18. Hamilton BB, Granger CV, Sherwin FS, Zielezny M, and Tashman JS. A uniform national data system for medical rehabilitation. In Fuhrer MJ editor. Rehabilitation outcomes: analysis and measurement. Baltimore: Brooks; 1987:115-50.
19. Holbrook M and Skilbeck CE. An activities index for use with stroke patients. Age Ageing 1983;12:166-70.
20. Hunt SM and McEwen J. The development of a subjective health indicator. Sociol Health Illn 1980;2:231-46.
21. Hunt SM, McKenna SP, McEwen J, Williams J, and Papp E. The Nottingham Health Profile: subjective health status and medical consultations. Soc Sci Med [A] 1981;15:221-9.
22. Van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, and Van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke 1988;19:604-7.
23. Lincoln N and Leadbitter D. Assessment of motor function in stroke patients. Physiotherapy 1979;65:48-51.
24. Adams SA, Pickering RM, Ashburn A, and Lincoln NB. The scalability of the Rivermead Motor Assessment in nonacute stroke patients. Clin Rehabil 1997;11:52-9.
25. Collen FM, Wade DT, Robb GF, and Bradshaw CM. The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment. Int Disabil Stud 1991;13:50-4.
26. Van Straten A, De Haan RJ, Limburg M, Schuling J, Bossuyt P, and Van den Bos GA. A stroke-adapted 30-Item version of the Sickness Impact Profile to assess quality of life (SA-SIP30). Stroke 1997;28:2155-61.
27. Van de Port IGL, Ketelaar M, Schepers VPM, Van den Bos GAM, and Lindeman E. Monitoring the functional health status of stroke patients: the value of the Stroke-Adapted Sickness Impact Profile-30. Disabil Rehabil 2004;26:635-40.
28. Ware JE Jr and Sherbourne CD. The MOS 36-item Short-Form health survey (SF-36): I. Conceptual framework and item selection. Med Care 1992;30:473-83.
29. McHorney CA, Ware JE Jr, and Raczek AE. The MOS 36-Item Short-Form Health Survey (SF-36): II. Psychometric and clinical tests of validity in measuring physical and mental health constructs. Med Care 1993;31:247-63.
30. Duncan PW, Wallace D, Lai SM, Johnson D, Embretson S, and Laster LJ. The Stroke Impact Scale version 2.0. Evaluation of reliability, validity, and sensitivity to change. Stroke 1999;30:2131-40.
31. Williams LS, Weinberger M, Harris LE, Clark DO, and Biller J. Development of a stroke-specific quality of life scale. Stroke 1999;30:1362-9.
32. Podsiadlo D and Richardson S. The Timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39:142-8.
33. Cieza A, Brockow T, Ewert T, Amman E, Kollerits B, Chatterji S, Ustun TB, and Stucki G. Linking health-status measurements to the International Classification of Functioning, Disability and Health. J Rehabil Med 2002;34:205-10.
34. Stamm TA, Cieza A, Machold KP, Smolen JS, and Stucki G. Content comparison of occupation-based instruments in adult rheumatology and musculoskeletal rehabilitation based on the International Classification of Functioning, Disability and Health. Arthritis Rheum 2004;51:917-24.

35. Scheuringer M, Grill E, Boldt C, Mittrach R, Mullner P, and Stucki G. Systematic review of measures and their concepts used in published studies focusing on rehabilitation in the acute hospital and in early post-acute rehabilitation facilities. Disabil Rehabil 2005;27:419-29.
36. De Haan R, Limburg M, Bossuyt P, Van der Meulen JHP, and Aaronson N. The clinical meaning of Rankin 'handicap' grades after stroke. Stroke 1995;26:2027-30.
37. Salter K, Jutai JW, Teasell R, Foley NC, and Bitensky J. Issues for selection of outcome measures in stroke rehabilitation: ICF Body Functions. Disabil Rehabil 2005;27:191-207.
38. Dekker J, Dallmeijer AJ, and Lankhorst GJ. Clinimetrics in rehabilitation medicine: current issues in developing and applying measurement instruments. J Rehabil Med 2005;37:193-201.
39. De Haan RJ, Vermeulen M, Holman R, and Lindeboom R. [Measuring the functional status of patients in clinical trials using modern clinimetric methods]. Ned Tijdschr Geneeskd 2002;146:606-11.
40. Duncan PW, Jorgensen HS, and Wade DT. Outcome measures in acute stroke trials: a systematic review and some recommendations to improve practice. Stroke 2000;31:1429-38.
41. Buck D, Jacoby A, Massey A, and Ford G. Evaluation of measures used to assess quality of life after stroke. Stroke 2000;31:2004-10.
42. De Haan R, Aaronson N, Limburg M, Hewer RL, and Van Crevel H. Measuring quality of life in stroke. Stroke 1993;24:320-7.