The online version of this article is located at http://www.minervamedica.it
European Journal of Physical and Rehabilitation Medicine 2016 April;52(2):195-202

ORIGINAL ARTICLE

Clinical scales for measuring stroke rehabilitation promote functional recovery by supporting teamwork

Michelangelo BARTOLO [1]*, Chiara ZUCCHELLA [1], Paolo TORTOLA [1], Francesca SPICCIATO [1], Giorgio SANDRINI [2], Francesco PIERELLI [1, 3]

[1]NeuroRehabilitation Unit Neurological Mediterranean Institute NEUROMED IRCCS Pozzilli, Isernia, Italy; [2]Department of Neurological Rehabilitation IRCCS "C. Mondino" Foundation Institute of Neurology, Pavia, Italy; [3]Department of Medico-Surgical Sciences and Biotechnologies "Sapienza" University of Rome, Polo Pontino, Latina, Italy

*Corresponding author: Michelangelo Bartolo, Neurorehabilitation Unit, IRCCS NEUROMED, Via Atinense, 18 – 86077 Pozzilli, Isernia, Italy. E-mail: bartolomichelangelo@gmail.com

ABSTRACT

BACKGROUND: The growing interest in documenting the effectiveness of rehabilitation has led to a progressive increasing focus on clinical tools to measure stroke-survivors disability and recovery. In clinical practice a general agreement on the instruments to be used seems to be lacking and clinical scales are often limited to the assessment of global function.
AIM: The study investigated whether the use of a selection of clinical scales/scores added to a single global measure during rehabilitation care, may lead to a better functional outcome for stroke inpatients.
DESIGN: Retrospective study.
SETTING: Neurorehabilitation inpatients.
POPULATION: Consecutive patients affected by first-ever stroke.
METHODS: Patients in the control group (CG) (N.=139) were assessed at admission and at discharge with the Functional Independence Measure (FIM), while patients in the study group (SG) (N.=127) were evaluated by means of a basic core-set of clinical scales/scores as well as with the FIM. Patients in both groups were evaluated and treated by the same multiprofessional team, following the same rehabilitative treatment approaches.
RESULTS: At discharge both groups significantly improved at the FIM total Score, compared to the admission; a significant improvement was also reported for all the clinical scales in SG. However, the CG showed longer length of stay (LOS) than the SG and between-group analysis revealed statistical significant differences in the FIM total score, in the FIM gain and in all the indices of performance (FIM efficiency, FIM absolute efficacy, FIM relative efficacy), in favor of the SG.
CONCLUSIONS: The use of a selection of scales added to a global functional measure, allows a better definition of both the person's profile of disability and the rehabilitative goals, and is associated to a better functional outcome at discharge.
Clinical Rehabilitation Impact. Clinical scales may be used in clinical practice to better define the person's profile of disability, allowing the design of patient tailored goals, and to favor team working.

(*Cite this article as*: Bartolo M, Zucchella C, Tortola P, Spicciato F, SAndrini G, PierellI F. Clinical scales for measuring stroke rehabilitation promote functional recovery by supporting teamwork. Eur J Phys Rehabil Med 2016;52:195-202)

Key words: Stroke - Instrumentation - Rehabilitation.

Stroke represents one of the most devastating of all neurological conditions that accounts worldwide for about 5.5 million deaths annually and 44 million disability-adjusted life-years lost.[1]

The increased prevalence of stroke in advanced age combined with the dramatic aging of the population, suggests that the incidence of stroke is expected to increase significantly over the next several decades and with it the request for rehabilitative interventions.[2, 3]

In fact, because of advances in medical care, about two/thirds of all people who endure a stroke survive although presenting residual neurological deficits with a

significant impact on individual, family and community health[4, 5] that often persist even in the long term.[6]

In this scenario, clinical end points such as stroke mortality or stroke recurrence, although useful, do not fully capture the devastating effect of a disabling stroke and measures of functional recovery/disability are recommended as primary or coprimary end point for stroke intervention trials.[7] Consistently, the growing interest in documenting the effectiveness of rehabilitative treatments has led to a progressive increasing focus on the analysis and use of clinical tools to measure stroke-survivor recovery.[7, 8] Indeed, the use of standardized outcome measures in clinical field has frequently been recommended as a way to promote evidence-based clinical best practices [9-12] as well as a mean of improving patient outcomes.[13]

The Barthel Index (BI) [14] and the Functional Independence Measure (FIM) [15] are two of the most widespread scales in rehabilitation [16] used to assess the outcomes, in terms of disability and functional status respectively, but can also be applied in the earliest stages after the acute event to define a baseline status in order to plan the rehabilitative interventions. However, as no single measure fully describes or predicts all dimensions of stroke recovery and disability,[17] in the last decades a huge range of validated and reliable measurement tools have been proposed to measure neurological deficits, specific body functions and stroke outcome.[18]

In clinical practice, however, a general agreement on the instruments to be used in stroke disability assessment still seems to be lacking and, mainly due to time constraints, the use of clinical scale is often limited to the scales of global function.

To the best of our knowledge, no previous studies focused on the relationship between the use of scales/scores in the clinical context and the outcome of stroke patients; specifically in this study, scales/scores to assess lower limb and trunk function have been used. Differently from lower limb and ambulation recovery, trunk stability is often overlooked as an essential component of balance and coordinated extremity use for daily functional activities. Trunk participates in anticipatory postural adjustments to counteract the perturbing effect of the arm movement on body, and in the reaching movements, particularly when the target is outside the anatomical reaching distance. Overall, it has been demonstrated that daily activities require head and trunk stability as well as trunk mobility.

Therefore, the hypothesis of this study was that adding a selection of clinical scales/scores to the use of a single global measure during rehabilitation care, may lead to a better functional outcome for stroke inpatients, allowing a more precise definition of the rehabilitative goals.

Material and methods

Participants

The study enrolled all the consecutive patients affected by first-ever stroke (ischemic or hemorrhagic) referred to the Neurorehabilitation unit between 1st January 2008 to 31st December 2011. All the patients were admitted when they reached steady clinical conditions (usually within 2 weeks from the acute event). Clinical diagnosis of stroke was made according to the WHO definition and confirmed by neuroimaging (Computed Tomography or Magnetic Resonance, CT or MR). Additional neurologic or psychiatric disorders and a previous history of stroke were considered exclusion criteria.

The study was approved by the local ethics committee and was conducted in accordance with the revised version of the Helsinki Declaration. Any informed consent from human subjects was obtained as required.

Measures

All patients were evaluated by means of validated clinical scales/scores, identified among those supported by evidence from the literature, and a core-set was selected taking into account the need to provide a comprehensive and multidimensional assessment of the motor and functional status of the inpatients involved in neurorehabilitation programs.

The following validated clinical scales/scores were used:

— Functional Independence Measure (FIM):[15] it is a measurement of functional status. Items are scored according to the person's level of assistance required to perform activities of daily living. The scale includes 18 items, each one receiving a score ranging from 1 (total dependence) to 7 (complete independence). The total score is the sum of the scores reported for each item and it ranges from 18 to 126, with higher scores indicating more independence;

— Sitting Balance Score:[19] it assesses the maintenance of balance in sitting position. The scores can range from 1 to 4: the test assigns 1 point to the person unable to hold a static sitting position, 4 points if able to perform the tasks of the test without any assistance;

— Standing Balance Score:[20] it evaluates the ability to stand. The scores reported for each item range from 0 to 4 points. The test assigns 4 points for the ability to maintain self-standing, with shoes on smooth floor, and assigns a score of 0 to those unable to erect. Three attempts can be repeated, and the score is assigned for the best performance;

— Hauser Index:[21] it evaluates the gait using nine categories, with a score ranging from a maximum of 9 (no walking function, confined to a wheelchair) to a minimum of 0 (asymptomatic walking). This test includes the use of aids in the definition of individual categories;

— Massachusetts General Hospital Functional Ambulation (MGHFA):[22] it provides a classification of the severity of gait disorders, with scores ranging from 0 (walking with two people attending) to 6 (independent gait).

Study design

The study was designed as a retrospective study.

The control group (CG) included patients hospitalized in neurorehabilitation between the 1st January 2008 and 31st December 2009, assessed at the admission and at the discharge with the FIM.

Since the 1st January 2010, after a revision of the clinical assessment tools at our institution, the standard assessment of patients admitted to neurorehabilitation was implemented, adding a basic core-set of clinical scales/scores to the FIM. Therefore, for the study group (SG) we enrolled patients admitted to neurorehabilitation between the 1st January 2010 and 31st December 2011, and evaluated by means of the basic core-set as well as with the FIM.

Patients in both groups were evaluated and treated by the same health multiprofessional team, following the same rehabilitative treatment approaches. Patients were discharged when they had reached functional stability and were no longer present rehabilitative goals to be pursued in intensive regimen.

Rehabilitative treatment

Following the basic principles of rehabilitation, the rehabilitative programs were tailored on patients' needs, although the rehabilitative sessions were structured according to a standardized model.

All patients underwent neuromotor rehabilitative treatment consisting of individual 60-minutes sessions, performed once a day, six days per week. In detail, each daily session included: 1) passive/assisted stretching exercises for the shoulder, elbow, ankle and knee, in order to increase the range of motion of the affected extremities and prevent contractures; 2) passive/assisted strengthening exercises for trunk muscles and upper and lower limbs; 3) strengthening exercises in a functional context to promote upper limb and/or hand use; 4) balance exercises, initially in sitting position and then in standing position (once patient had recovered the ability to stand, even with assistance); 5) ground-floor walking (including step control) first with assistance, then under supervision. The components of this rehabilitation program are supported by evidence in the literature.[23-27] The duration, intensity, frequency, as well as the timing to start each exercise, were decided on the basis of the patients' levels of physical activity and conditions, which were carefully monitored.

For both groups, the rehabilitation team discussed the clinical cases weekly and updated the rehabilitation projects accordingly. Moreover, in the SG the clinical scales/scores were weekly repeated.

When aphasia was diagnosed, patients also underwent speech therapy (individual 60-minutes daily sessions, 6 days per week).

Statistical analysis

Student's *t*-test and the χ^2 Test were used to compare demographic and baseline clinical features between the two groups.

A longitudinal analysis to test changes within the SG at the different evaluation times for all the clinical scales was performed by means of the Friedman Test; *post-hoc* analysis with Wilcoxon signed-rank Test was conducted with a Bonferroni correction applied, resulting in a significance level set at $P<0.012$, to examine where the differences actually occurred.

TABLE I.—*Demographic and clinical features.*

	Study group (N.=127)	Control group (N.=139)
Age (yrs) (mean±SD)	68±12.1	70.5±12.9
Gender Female N.(%)	63 (49.6)	70 (50.4)
Male N.(%)	64 (50.4)	69 (49.6)
Comorbidities		
Diabetes mellitus, N.(%)	57 (44.9)	55 (39.6)
Hypertension, N.(%)	109 (85.8)	112 (80.6)
Heart disease, N.(%)	23 (18.1)	26 (18.7)
Atrial fibrillation, N.(%)	16 (12.6)	19 (13.7)
Hypercholesterolemia, N.(%)	61 (48)	66 (47.4)
Current smoking, N.(%)	22 (17.3)	28 (20.1)
Stroke related characteristics		
Stroke type		
Ischemic N.(%)	102 (80.3)	118 (84.9)
Haemorrhagic N.(%)	25 (19.7)	21 (15.1)
Lesion side		
Left hemisphere N.(%)	68 (53.6)	61 (43.9)
Right hemisphere N.(%)	53 (41.7)	70 (50.3)
Bilateral N.(%)	6 (4.7)	8 (5.8)
Lesion site		
Cortical N.(%)	77 (60.6)	85 (61.1)
Subcortical N.(%)	32 (25.2)	35 (25.2)
Infratentorial N.(%)	18 (14.2)	19 (13.7)
Bamford Classification		
TACS N.(%)	36 (28.4)	39 (28.1)
PACS N.(%)	54 (42.5)	59 (42.4)
LACS N.(%)	22 (17.3)	29 (20.9)
POCS N.(%)	15 (11.8)	12 (8.6)
Aphasia N.(%)	42 (33)	38 (27.3)
Time for admission (days) (mean±SD)	11.0±1.9	10.9±1.5
People living alone N.(%)	15 (11.8)	16 (11.5)
NIH (mean±SD)	15.3±1.8	14.9±1.8

TACS: total anterior circulation stroke; PACS: partial anterior circulation syndrome; LACS: lacunar syndromes, POCS: posterior circulation syndrome. NIH: National Institute of Health. *P<0.05

TABLE II.—*Outcome measures at baseline and follow-up: within-group analysis.*

Scales	Baseline	3° week	6° week	9° week	Discharge
Study group					
Sitting Balance Score	2.36 (2.15-2.57)	2.65 (2.46-2.86) [a]	3.14 (2.95-3.31) [b]	3.43 (3.28-3.57) [c]	3.57 (3.43-3.72) [d]
Standing Balance Score	0.75 (0.51-0.97)	1.27 (1.04-1.50) [a]	1.84 (1.58-2.09) [b]	2.29 (2.01-2.57) [c]	2.50 (2.22-2.80) [d]
Hauser Index	7.65 (7.20-8.09)	7.08 (6.61-7.53) [a]	6.32 (5.84-6.81) [b]	5.65 (5.09-6.21) [c]	5.20 (4.62-5.78) [d]
MGHFA	1.20 (0.94-1.47)	1.46 (1.20-1.75) [a]	1.99 (1.70-2.28) [b]	2.50 (2.17-2.81) [c]	3.00 (2.65-3.33) [d]
FIM	38.4 (36.1-42.0)				75.4 (71.4-82.4) [e]
Control group					
FIM	35.2 (32.7-38.0)				66.5 (61.8-72.0) [e]

Data are expressed as Mean (Confidence Interval).
MGHFA: Massachusetts General Hospital Functional Ambulation; FIM: Functional Independence Measure; [a] 3° week *versus* baseline; [b] 6° week *versus* 3° week; [c] 9° week versus 6° week; [d] discharge *versus* 9° week P≤0.012; [e] Discharge *versus* baseline P≤0.05.

In the CG changes within group for the FIM score were investigated using the Wilcoxon-signed rank Test.

The between group analysis by means of the Mann-Whitney U Test was performed to compare the groups' functional status at admission and discharge and some selected indices of performance: length of stay (LOS), FIM gain (difference between admission and discharge values), FIM efficiency (mean gain calculated by dividing the mean change in the FIM ratings by the mean rehabilitation length of stay), absolute efficacy (a percentage calculated by dividing the mean change in the FIM ratings by the gap between the maximal FIM total rating and the FIM rating at admission and multiplied by 100), and relative efficacy (a percentage calculated

TABLE III.—*Patients' functional status: between-group analysis.*

Measures	Study group	Control group	P
Discharge FIM Score mean (CI)	75.4 (71.4-82.4)	66.5 (61.8-72.0)	0.03
FIM gain mean (CI)	36.5 (33.7-41.6)	30.9 (27.9-35.5)	0.03
FIM efficiency mean (CI)	1(0.7-1.6)	0.5 (0.4-0.6)	0.00
FIM absolute efficacy mean (CI)	45.4 (41.7-52.3)	36.4 (32.2-42.1)	0.03
FIM relative efficacy mean (CI)	1.3 (0.9-2.0)	0.6 (05-0.8)	0.01
LOS mean (CI)	65.3 (59.5-71.4)	72 (67-76.5)	0.00

CI: Confidence Interval; FIM: functional independence measure; LOS: length of stay.

by dividing the absolute efficacy by the mean rehabilitation LOS). Specifically, the FIM efficiency represents the average functional daily gain during rehabilitation; absolute effectiveness is the average actual implementation of the functional potential expressed in percentages; relative effectiveness indicates the implementation of this potential as a function of LOS, representing the implementation of the functional potential by day.

The non parametric statistics were applied as Shapiro-Wilk Test revealed that data were not normally distributed.

Statistical analysis was performed using the Statistical Package for the Social Sciences version 17.0 for windows (version 17.0. SPSS Inc., Chicago, IL, USA). Significance was set at $P \leq 0.05$, unless otherwise specified.

Results

Among the 527 consecutive stroke patients admitted to the Neurorehabilitation, 278 fitted the inclusion criteria and were enrolled into the study, respectively 132 patients in the SG and 146 patients in the CG.

5 patients (3.8%) in the SG and 7 patients (4.8%) in the CG were excluded from the study as their data at discharge were missing because they died during the hospitalization; therefore the statistical analysis was performed on 127 patients in the SG and 139 in the CG.

At admission, the two groups were homogeneous, without statistical differences with regard to demographic and clinical features. Data are summarized in Table I. The mean FIM rating at admission was 38.47±15.9 for the SG and 35.22±14.73 for the CG, with no statistical difference among groups.

The within-group analysis showed a statistically significant improvement at the FIM total score for both SG and CG, and at the clinical scales/scores for the SG when comparing baseline and discharge values. A significant improvement was reported also at the intermediate evaluations (3rd, 6th and 9th week) for all the clinical scales in the SG, Table II.

Between-group analysis at discharge showed that patients in the CG had significantly longer LOS than patients in the SG and revealed statistical significant differences in the FIM total Score, in the FIM gain and in all the indices of performance (FIM efficiency, FIM absolute efficacy, FIM relative efficacy), in favor of the SG. Data are shown in Table III.

Discussion

The study aimed at verifying the usefulness of clinical scales/scores during rehabilitation care, showed that the use of a selection of scales added to a global measure is associated to a better functional outcome at discharge. Moreover, data showed that patients in the SG had significantly shorter hospital stay when compared with the CG.

These findings seem to suggest that the use of clinical and functional scales that focus on specific aspects of motor impairment, may provide a better definition of the person's profile of disability and motor functions along the intensive rehabilitative care.

The selection of the scales was based on the fundamentals of motor recovery after cerebrovascular damage,[28, 29] and focused on trunk control, standing posture, balance and walking, according to the World Health Organization's International Classification of Functioning, Disability and Health (WHO-ICF), that gives a conceptual framework for the classification of the scales, helping in the choice of appropriate measure for a particular purpose.

Trunk control represents a main point for all motor activities, including sitting posture, postural transfers,

standing and walking activities.[30] Specifically, it is well know that standing control is strongly related to walking and functional activities.[30-33] Therefore baseline assessment of these aspects allows treatment goals to be set in terms of functional recovery, and follow-up scales can provide somewhat of a monitor of the level of achievement of such goals.[34] It is likely that this will enable greater precision in defining the rehabilitative project and individual programs, setting them in a step-by-step approach and providing the opportunity to make more accurate rehabilitative prognosis. Moreover, choosing the appropriate objective outcome measure can help clinicians not to over-or underestimate the true effects of a treatment, with a profound impact on clinical care.[35] As the existing stroke scales/scores measure different aspects of function, a single scale does not seem enough to describe the spectrum of outcomes from stroke interventions: the integration of multiple scales in order to have a more unified assessment and a global outcome view, was suggested as a valid approach.[16, 17]

The use of scales therefore seems to be particularly useful along all the rehabilitative care, as scales allow to establish a baseline description, they screen for risk factors or undetected problems, assist in diagnosis, set realistic rehabilitative goals and monitor the patient's clinical course. Moreover, the adoption of scales/scores, providing a quantitative evaluation of motor and functional parameters, allows a "personalization" of the intervention, consisting in different duration, intensity, frequency and, in our view, particularly the timing of each exercise. In this sense, the step-by-step tailoring of rehabilitative program could be described mainly in terms of timing of selection of specific exercises that could have been anticipated (*i.e.* standing, balance exercises, starting of ambulation, etc.) with a positive impact on the effectiveness of the treatment.

As well as being a valid support to the clinical activities, in our opinion the scales represent also an effective "organizational" tool that support the development of team working; a lot of evidence exist for the effectiveness and broad applicability of organized inpatient stroke rehabilitation provided in the first weeks after stroke by a multidisciplinary team:[36, 37] in this sense quantitative data, as provided by clinical scales, represent a shared and objective support for interaction among health professionals. In fact, interdisciplinary rehabilitation requires a process for exchanging information among team members, patients, and their families so that a common plan is agreed on and they work together to achieve the same goals.[38, 39] Data transmission systems therefore must be as homogeneous as possible and above all objective: in this sense, the use of common tools facilitates data sharing and the definition of common objectives.[40] Inter-professional cooperation in fact is considered an essential quality aspects for people working in rehabilitation as it should avoid competing priorities during therapy, duplicate clinical diagnostic examinations, time loss and absence of continuity as well as uncertainty for the patient.

Despite the undoubted usefulness of the clinical scales, as previously suggested, it is obvious that whatever measure cannot be a replacement for clinical decision-making but should support clinical reasoning, provide an objective confirmation to clinical impression and aid communication.[13, 41]

Furthermore, in the healthcare setting that requires the optimization of available resources, the objective assessment also ensures the proper use of resources themselves, both human and economic.[42]

The financial and social implications of prolonged hospitalization in fact have prompted increasing interest in services to facilitate early return to the community;[43] data of this study show that the use of a core-set of scales leads to a significant reduction in the average length of stay with respect to the functional outcomes achieved, allowing a more efficient rehabilitative care, as indicated by the parameter derived from the FIM (FIM efficiency). Moreover, it should be emphasized that the decision to discharge patients has never been driven by merely economic considerations (*e.g.* growing funding pressure to discharge people quicker), but has always been based on clinical data.

Despite these strengths, the adoption of scales into clinical practice is not well established and often haphazard. A wide range of objective measurement tools have been developed, but most are designed for research purposes and many are impractical, irrelevant or inadequately developed for generalized use in everyday clinical practice.[18, 44, 45] If clinically meaningful interpretations are to be made from instruments, a basic point is that the scales used are easy to administer, not burdensome for the patients, sensitive in detecting changes, and provide useful and rigorous measures of the effects they purport to quantify.[8]

Scales used in this study are not disease-specific, but are used for clinical and functional evaluation of patients admitted to neurorehabilitation. They provide a framework on the residual motor skills and allow to set and monitor rehabilitation goals. For the purposes of this study, considering the widespread of the disease, we selected only patients suffering from stroke, but it would be of considerable interest to verify their use also for other neurological diseases.

Conclusions

In conclusion, data from this study seem to indicate that rating scales that objectively quantify deficits and track change over time, can be particularly useful in a rehabilitation setting where they represent a guide in the recovery of patients and may be decisive in sensitizing and making the rehabilitation team cohesive for providing support to the patient. In addition, the use of rating scales, by encouraging better management of human and economic resources used, facilitates the process of improving continuity of care and especially the improvement of quality of research in rehabilitation.

Further efforts must be directed at developing tools designed for clinical use, spreading their application in daily clinical practice, so that comprehensive objective measurements can be considered as part of evidence-based practice that provides relevant and appropriate information to both clinicians and health-managers, rather than being considered a waste of time.

References

1. Mukherjee D, Patil CG. Epidemiology and the global burden of stroke. World Neurosurg 2011;76(6 Suppl):S85-90.
2. Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. Lancet 2006;367:1747-57.
3. Norrving B, Kissela B. The global burden of stroke and need for a continuum of care. Neurology 2013;80(Suppl 2):S5-S12.
4. Leal J, Luengo-Fernandez R, Gray A, Petersen S, Rayner M. Economic burden of cardiovascular diseases in the enlarged European Union. Eur Heart J 2006;27:1610-9.
5. Donnan GA, Fisher M, Macleod M, Davis SM. Stroke. Lancet 2008;371:1612-23.
6. Luengo-Fernandez R, Paul NLM, Gray AM, Pendlebury ST, Bull LM, Welch SJ, *et al*. Population-based study of disability and institutionalization after transient ischemic attack and stroke.10-Year Results of the Oxford Vascular Study. Stroke 2013;44:2854-61.
7. Harrison JK, McArthur KS, Quinn TJ. Assessment scales in stroke: clinimetric and clinical considerations. Clin Interv Aging 2013;8:201-11.
8. Baker K, Cano SJ, Playford ED. Outcome measurement in stroke. A scale selection strategy. Stroke 2011;42:1787-94.
9. Chartered Society of Physiotherapy. Core Standards of Physiotherapy Practice. London: Chartered Society of Physiotherapy; 2000.
10. Hammond R. Evaluation of physiotherapy by measuring the outcome. Physiotherapy 2000;86:170-2.
11. Rudd A, Pearson M, Georgiou A. Measuring Clinical Outcome in stroke (acute care): Clinical effectiveness and evaluation unit. London: Royal College of Physicians; 2000.
12. Intercollegiate Stroke Working Party. National Clinical Guidelines for Stroke. Second edition. London: Royal College of Physicians; 2004.
13. Tyson S, Greenhalgh J, Long AF, Flynn R. The use of measurement tools in clinical practice: an observational study of neurorehabilitation. Clin Rehabil 2010;24:74-81.
14. Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md State Med J 1965;14:61-5.
15. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The functional independence measure: a new tool for rehabilitation. Adv Clin Rehabil 1987;1:6-18.
16. Skinner A and Turner-Stokes L. The use of standardized outcome measures in rehabilitation centres in the UK. Clin Rehabil 2006;20:609-15.
17. Kasner SE. Clinical interpretation and use of stroke scales. Lancet Neurol 2006;5:603-12.
18. Tyson SF, Connell LA. How to measure balance in clinical practice. A systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions. Clin Rehabil 2009;23:824-40.
19. Sandin KJ, Smith BS. The measurement of balance in sitting stroke rehabilitation prognosis. Stroke 1990;21:82-6.
20. Bohannon RW. Correlation of lower limb strengths and other variables with standing performance in stroke patients. Physiotherapy Canada 1989;41:198-202.
21. Hauser SL, Dawson DM, Lehrich JR, Flint Beal M, Kevy SV, Propper RD, *et al*. Intensive immuno-suppression in progressive multiple sclerosis: a randomised, three arm study of high-doses intravenous cyclophosphamide, plasma exchange and ACTH. N Engl J Med 1983;308:173-80.
22. Holden MK, Gill KM, Magliozzi MR, Nathan J, Piehl-Baker L. Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. Phys Ther 1984;64:35-40.
23. Pollock ML, Franklin BA, Balady GJ, Chaitman BL, Fleg JL, Fletcher B, *et al*. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription: an advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association. Circulation 2000;101:828-33.
24. Palmer-McLean K, Harbst KB. Stroke and brain injury. In: Durstine JL and Moore GE, editors. ACSM's Exercise Management for Persons With Chronic Diseases and Disabilities. Second edition. Champaign, IL: Human Kinetics; 2003. p. 238-46.
25. Gordon NF, Gulanick M, Costa F, Fletcher G, Franklin BA, Roth EJ, *et al*. Physical Activity and Exercise Recommendations for Stroke Survivors: An American Heart Association Scientific Statement From the Council on Clinical Cardiology, Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the Council on Nutrition, Physical Activity, and Metabolism; and the Stroke Council. Circulation 2004;109:2031-41.
26. O'Sullivan SB. Stroke. In: O'Sullivan SB and Schmitz TJ, editors. Phys Rehabil. Philadelphia: FA Davis Company; 2007. p. 744.
27. Verheyden G, Vereeck L, Truijen S, Troch M, Lafosse C, Saeys W, *et al*. Additional exercises improve trunk performance after stroke: a pilot randomized controlled trial. Neurorehabil Neural Repair 2009;23:281-6.
28. Timmermans AA, Seelen HA, Willmann RD, Kingma H. Technology-assisted training of arm-hand skills in stroke: concepts on reacquisition of motor control and therapist guidelines for rehabilitation technology design. J Neuroeng Rehabil 2009;20:1.
29. Breceda EY, Dromerick AW. Motor rehabilitation in stroke and traumatic brain injury: stimulating and intense. Curr Opin Neurol 2013;26:595-601.
30. Verheyden G, Nieuwboer A, De Wit L, Thijs V, Dobbelaere J, Devos

H, *et al*. Time course of trunk, arm, leg, and functional recovery after ischemic stroke. Neurorehabil Neural Repair 2008;22:173-9.
31. Di Monaco M, Trucco M, Di Monaco R, Tappero R, Cavanna A. The relationship between initial trunk control or postural balance and inpatient rehabilitation outcome after stroke: a prospective comparative study. Clin Rehabil 2010;24:543-54.
32. Hacmon RR, Krasovsky T, Lamontagne A, Levin MF. Deficits in intersegmental trunk coordination during walking are related to clinical balance and gait function in chronic stroke. J Neurol Phys Ther 2012;36:173-81.
33. Wu CY, Chen YA, Lin KC, Chao CP, Chen YT. Constraint-induced therapy with trunk restraint for improving functional outcomes and trunk-arm control after stroke: a randomized controlled trial. Phys Ther 2012;92:483-92.
34. Kelley RE, Borazanci AP. Stroke rehabilitation. Neurol Res 2009;31:832-40.
35. Bagiella E, Novack TA, Ansel B, Diaz-Arrastia R, Dikmen S, Hart T, *et al*. Measuring outcome in traumatic brain injury treatment trials: recommendations from the traumatic brain injury clinical trials network. J Head Trauma Rehabil 2010;25:375-82.
36. Dewey HM, Sherry LJ, Collier JM. Stroke rehabilitation 2007: what should it be? Int J Stroke 2007;2:191-200.
37. Momsen AM, Rasmussen JO, Nielsen CV, Iversen MD, Lund H. Multidisciplinary team care in rehabilitation: an overview of reviews. J Rehabil Med 2012;44:901-12.
38. Wade DT. Goal planning in stroke rehabilitation: what? Top Stroke Rehabil 1999;6:8-15.
39. Sivaraman Nair KP, Wade DT. Satisfaction of members of interdisciplinary rehabilitation teams with goal planning meetings. Arch Phys Med Rehabil 2003;84:1710-13.
40. Vyt A. Interprofessional and transdisciplinary teamwork in health care. Diabetes Metab Res Rev 2008;24(Suppl. 1):S106-109.
41. Greenhalgh J, Flynn R, Long AF, Tyson S. Tacit and encoded knowledge in the use of standardised outcome measures in multidisciplinary team decision-making: a case-study in neurorehabilitation. Soc Sci Med 2008;67:183-94.
42. Smithard DG, O'Neill PA, Park C, Morris J. Complications and outcome after acute stroke. Does dysphagia matter? Stroke 1996;27:1200-4.
43. Quinn TJ, Paolucci S, Sunnerhagen KS, Sivenius J, Walker MF, Toni D, *et al*. Evidence-based stroke rehabilitation: an expanded guidance document from the European Stroke Organization (ESO) guidelines for management of ischaemic stroke and transient ischaemic attack 2008. J Rehabil Med 2009;41:99-111.
44. Pollock A, Legg L, Langhorne P. Barriers to achieving evidence-based stroke rehabilitation. Clin Rehabil 2000;14:611-7.
45. Greenhalgh J, Tyson S, Long A, Flynn R. How do multidisciplinary teams use clinical outcome measures in clinical practice? Proceedings of Society for Research in Rehabilitation in Clinical Rehabilitation 2006;20:1105.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.
Received on August 26, 2014.
Article first published online: January 9, 2015. - Manuscript accepted: January 8, 2015. - Manuscript received: August 26, 2014.