

Physical therapy tests in stroke rehabilitation

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Introduction

The purpose of this chapter is to present an overview of physical therapy tests used in stroke rehabilitation.

The rationale for using tests in perspective of evidence based medicine and the classification of function, introduced by the World Health Organization will also be discussed. Furthermore, the strengths and weaknesses with qualitative and quantitative tests are presented and prerequisites for tests in general are discussed.

Finally, three tables presenting current valid tests in stroke rehabilitation, in relation to the three levels of the ICF model, are introduced. These tables are meant to give a visual of outcomes and which aspect of care that is being evaluated by the same.

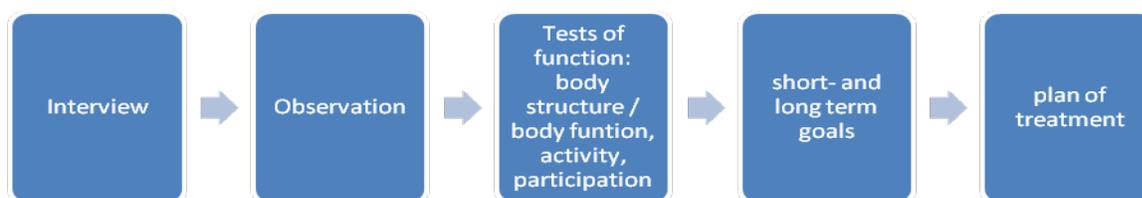
Stroke rehabilitation involves a process where the physical therapists, the rehabilitation team and the patient have to discuss goals and what future directions might be considered in view of the stroke event and its consequences. This process often means change, a change from the life one lead before the stroke incidence to a life with a reduced function; this reduction can be varying in degree. The rehabilitation process also involves an evaluation of the clinical condition, planning of a treatment and evaluating the result of treatment. The 14th general meeting of the World Confederation for

Physiotherapy (WCPT) defined the profession and the process as follows: “The nature of physical therapy is providing services to people and populations to develop, to maintain and to restore maximum movement and functional ability throughout the lifespan. Physical therapy includes the provision of services in circumstances where movement and function are threatened by the process of aging or that of injury or disease. Full and functional movements are at the heart of what it means to be healthy “.

Furthermore: “The nature of the physical therapy process is the service only provided by, or under the direction and supervision of a physical therapist and **includes assessment, diagnosis, planning, intervention and evaluation**” (1).

There are different ways of evaluating clinical conditions and interventions. Interviews and observation / clinical observation are two important methods (2). Testing / measuring function is another method. Ideally, the assessment process involves all three; an interview, where the patient’s perceptions of the main problems are at focus, observations of performance, and tests of performance followed by a process of interpreting the information into goals, a treatment plan and continuously evaluate outcome throughout the intervention process (3).

Figure 1. Assessment plan.



Evidence based Medicine / EBM and Evidence Based Practice / EBP

Evidence-based practice (EBP) has been defined as “integrating individual clinical expertise with the best available external clinical evidence from systematic research” (5). In clinical practise EBP includes the five components assess, ask, acquire, appraise and apply and this includes the selection of standardised assessment tools, the interpretation of scores on assessment tools and the selection of therapeutic, rehabilitative, or preventive interventions (4- 5). EBP relies upon good research on clinical questions for development of clinical guidelines so that the practice at all times is of high standard and up-dated as a consequence of research. “Golden standards” of clinical research are meta-analyses, systematic reviews and randomised controlled trials.

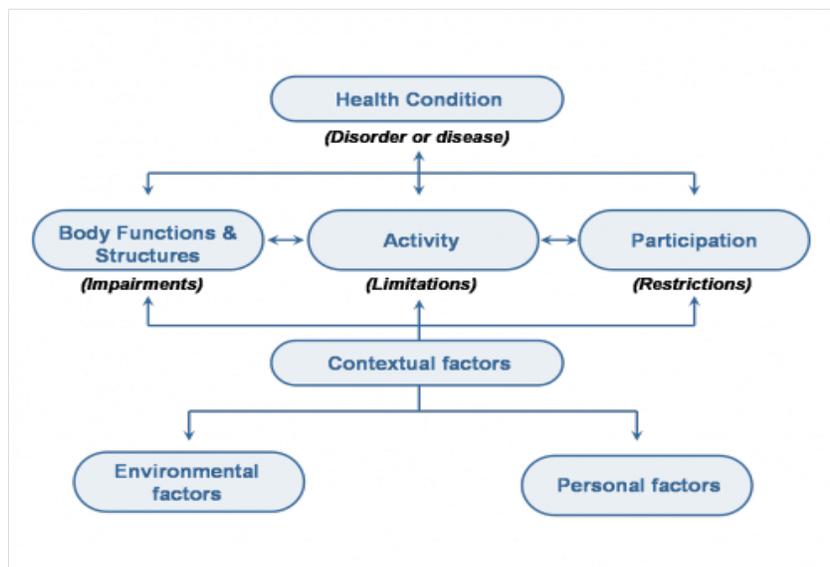
The principles in Evidence Based Medicine (EBM) have in recent years inspired physical therapists to evaluate the interventions and practices used in clinical practice to a higher degree (5). The main aim of EBM is to seek to assess the quality of evidence relevant to the risks and benefits of treatments, including lack of treatment (6). This goal has highlighted that observations and interviews are not precise enough to evaluate interventions and it is difficult to compare the data acquired in one unstructured interview with another. The information obtained in observations and interviews can give in depth knowledge of what the person with stroke experiences as a problem and the person’s goals for the future. It can also give valuable information in order to identify pathology and start interventions. However, the information is not possible to use in order to compare the effectiveness of an intervention or to compare one person with a norm scale or develop norm figures for the same condition. In order to evaluate cost effectiveness, both amount of change achieved and the costs associated with the interventions need to be considered. In order to meet this demand, there has been a steady development of clinical outcome measures over the years and the importance of developing a clinical

outcome measures in neurological rehabilitation and within physical therapy especially has been stressed. There are now several outcome measures available and some physiotherapy associations have produced summaries over outcome measures in rehabilitation and neurological physiotherapy (7-8).

Classification of function

The International Classification of Function (ICF) developed by the World Health Organization (WHO) can be helpful in organizing outcomes and tests (9).

Figure 2



The ICF is divided into body structures and function, activity and participation. Function and disability are umbrella terms within the ICF and used to refer to capacity or performance in all domains whereas disability refers to restrictions; impairments, activity limitations and participations restrictions. In addition, contextual factors like environmental and personal factors can be taken into account.

International classification of function can be used to classify measurements in relation to body

structures/ functions, activities and participation. The measurements / tests can furthermore be categorized as functional, relating to what the person can do, or as disability, relating to what the person cannot do. The ICF model has no hierarchical direction but can be used and understood in any direction (9).

Top down or bottom up

Top down and bottom up is borrowed from the computer language and software development and has been used in describing a rehabilitation approach (10).

A top down approach refers to the process of breaking a complex problem down into easily-understood and achievable parts. Top down represents a holistic approach that studies systems theory. Systems theory is a framework by which one can analyze and/or describe any group of objects that work in concert to produce some result. Top down, in relation to the ICF model and measurements can be understood as beginning the process with evaluation of participation and activities and form an understanding of what underlying factors that might contribute to function and disability. Tests and outcome measures state which aspects of rehabilitation that is being evaluated and what consequences of the stroke that is being targeted. A top down approach would then focus on tests relating to participation, as for example instrumental activities of daily living (I-ADL), health related quality of life (HRQoL), and activities, as for example walking, transfers, activities of daily living (ADL), in order to get an overview of what the patient can or cannot do. The therapeutic approach could then be to restore function through task oriented exercises in an environmental context, and cognitive training, in order to influence attitudes and motivation.

A bottom-up approach is piecing together systems to give rise to grander systems. In a bottom-up approach the individual base elements of the system are first specified in great detail. These elements

are then linked together to form larger subsystems, which then in turn are linked, sometimes in many levels, until a complete top-level system is formed. In relation to the ICF model and measurements this can be understood as starting the measurements on body structures and functions and with this base form an understanding of function and disability in relation to the activity and participation parts. Tests and outcome measures would target consequences of stroke on body functions like for example tests on strength, tone, flexibility, endurance, sensation etc. The therapeutic approach could then be to restore or compensate for the reduced body functions through strength training, reducing or stimulate tone, stretching, improving endurance through aerobics or bicycling, the use of different approaches to enhance sensation in order to improve underlying factors for activity and participation, in the hope that this will lead to better performance.

The top down or bottom up approach might seem trivial but probably has influence on therapies chosen and how and what they will activate (11-13). The top down model could be said to stimulate holistic thinking, activating different solutions and a broader approach. In contrast, the bottom up approach would stimulate building of parts to a whole, where the functions of parts are seen as separate and not as a whole.

Physical therapy and tests

Physical therapists working in stroke rehabilitation develop treatment plans for their clients; this may be in the acute or chronic conditions with short term and long term goals. Outcome measures and tests are important tools in the planning and evaluation of treatment in stroke rehabilitation and in evidence based practice in particular. Outcome measures are designed to discriminate, predict or evaluate physical function (1). Questions like; is this performance within the norms for a general population

(discriminate poor performance in regard to the norms), or is this performance related to good or poor recovery (predict) are of interest in a clinical setting. It is of increasing importance to evaluate interventions used in the rehabilitation process because of several reasons; patients are more aware of the risks and benefits and wants “the best treatment”, health systems are costly and need to front the most effective treatment, evidence based medicine is practiced in all health education which makes health staff more aware of the pro’s and con’s of different treatments and approaches (7). There are different ways and methods to achieve this knowledge and outcome measures can be categorized as qualitative or quantitative methods.

Qualitative methods

Qualitative methods aim to gather an in-depth understanding of human behavior and the reasons that govern such behavior. The advantage of using qualitative methods is that they generate rich, detailed data that leave the participants' perspectives intact and provide a context for health behavior. The disadvantages may be that hypotheses are generated during data collection and analysis, and measurement tends to be subjective.

Examples of methods for gathering information can be participant observation, non-participant observation, field notes, reflexive journals, structured interview, and unstructured interview (15).

The most common analysis of qualitative data is observer impression. That is, expert or layman observers examine the data, interpret it via forming an impression and report their impression in a structured and sometimes quantitative form. Another analysis is coding. It is an interpretive technique that both organizes the data and provides a means to introduce the interpretations of it into certain quantitative methods. (16).

Quantitative methods

Quantitative method is the systematic scientific investigation of quantitative properties and phenomena and their relationships, focused on the collection and analysis of numerical data and statistics. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships (2). The strengths of the quantitative paradigm are that its methods produce quantifiable, reliable data that are usually generalizable to some larger population. The researcher is considered external to the actual research, and results are expected to be replicable no matter who conducts the research. Quantitative measures are appropriate for conducting needs assessments or for evaluations comparing outcomes with baseline data. A weakness of the quantitative approach might be that it decontextualizes human behavior in a way that removes the event from its real world setting if this is not considered in the model (17).

Quantitative methods are either descriptive (subjects usually measured once) or experimental (subjects measured before and after a treatment) (2).

Measurements may be categorical or numerical. Categorical are *nominal*, from “Nome” = name, example; male / female, or ordinal, which means more than two categories and in an order / rank = *ordinal* for example; minimal/ moderate/severe/ unbearable, stages of breast cancer I, II, III, IV.

Numerical data can be discrete data or continuous data. Discrete numerical data is when the observations only can take certain values as for example number of children. Continuous data are obtained by some form of measurement. Continuous data can be *interval*, a known and equal distance but not related to a true zero score or *ratio scales*, a known and equal distance and related to a true zero score (7).

Descriptive data and graphical methods provide ways of making quantitative data manageable and easy to comprehend. Inferential statistics usually examines differences between two sets of scores or associations between variables, more complex tests can examine the combined effects of more than one variable at a time (2, 17).

Clinical Methods

Interviews

Interviews are useful for getting the story behind a participant's experiences. The interviewer can pursue in-depth information around the topic (18). An interview can be scripted/ structured, semi scripted/ structured or ad lib (18). The questions or, alternatively, both the questions and the answers can be structured in the scripted/ structured interview. A semi scripted / structured interview has a framework of themes but is more flexible allowing new questions to be brought up during the interview. An ad lib interview is a non-directive interview where the person is encouraged to speak freely and as much as possible about a subject, as for example "in-depth-interviews". The anamnesis interview represents a combination of semi structured and ad lib interview, the questions are partly structured but giving the patient the possibility to add information as they desire. The reliability of interviews is dependent on the respondent's ability to remember correctly and to describe in an objective and precise way facts related to the questions posed by the interviewer. The reliability of the interview on the other hand is also dependent on how the interviewer explicitly and correctly observes, interprets and registers the respondent (18).

Observation

Observation can be either an activity of a human being / therapist, consisting of receiving knowledge of the outside world through the senses, or the recording of data using scientific instruments. Observation

can be non-participant or participant. Non-participant observation can also be divided into overt observation, which is the investigator explain the purpose of their observations but does not take part in the activity. Or the observation can be covert, in this case the observer does not identify themselves and they observe undetected, or they observe from a distance. In participant observation the researcher takes part in the same activity as the subject. As a participant, the evaluator is in a position to gain additional insights through experiencing the phenomena for themselves; a weakness might be that the observer tends to lose their objectivity.

Clinical observation refers to receiving knowledge of the outside world through the senses and is based on the formal, informal knowledge and the experience of the therapist (2). Clinical observation incorporates tacit knowledge referring to conceptual and sensory information, and informal education practice representing a qualitative approach methodologically (19). Observation, as a method, is an important tool to diagnose and evaluate clinical practice, but observational research can be subject to many limitations and pitfalls of interpretation, even when it is carefully planned and meticulously carried out. Observations are subjective, they may differ from therapist to therapist and often the observations are not structured, so that the information can vary from occasion to occasion (20). The observation, in itself, may affect the process being observed. So that, instead of doing what the subject normally would do, the subject changes behavior to what he/she thinks is ideal or what they think the observer wants the subject to do (17).

In order to overcome some of these weaknesses structured observations has been developed ensuring that therapists routinely goes through a check list, covering the main problem areas and include developing goals for treatment, as for example SOAP (Subjective, Objective, Aims, Programme) or other more detailed physical therapy examinations.

Measurement-tests

Measurements can be seen as a form of structured observation; “measurement is simply the quantification of an observation against a standard” (3). Measurements represent a quantitative approach but the measurement needs to be interpreted on different levels in order to do an assessment. This process involves an individual evaluation in relation to person and personal progress, to norm scores in order to make a discriminating decision about a patient’s needs and to individually tailor a treatment plan and if possible make a prediction of progress in order to plan for the future (3). Measurements can be generic / global or specific (7).

Generic

Generic / global measures can be used to assess and compare client populations with different levels of disablement (21). Generic / global measures primarily address physical function or multidimensional characteristics including social and community life in conjunction with physical function. A disadvantage of generic / global measures is that they are less sensitive to change than specific measures (21). Another problem is that they might have ceiling or floor effects, limiting the ability to reflect change at the high or low end of construct they are measuring (21).

Specific

Specific measures are specific to a certain condition, body region or client. They are designed for a specific client population having a condition, or disability in one part of the body. The comparisons are limited to other clients within the same population. Specific measures are more responsive to that condition or disability because of their narrower focus, on the other hand these measures may be less likely to identify unanticipated effects of treatment (8).

Important properties for measurement-tests

A useful measure provides room on the scale to demonstrate improvement or deterioration. A ceiling effect occurs when test items are not challenging enough for a group of individuals. The individual may continue to improve but the test does not capture that improvement. The floor effect is when data cannot take on a value lower than some particular number. Clinical decline may not register as a change in score because there are no items within the test those measure declines from the lowest possible score. Other vital properties for a test are reliability and validity (7-8). Reliable in the respect that the measure demonstrates consistency and the ability to differentiate among the objects of measurement, valid to the extent that it assesses what it is intended to measure.

Reliability

Reliability is to what extent to which a measurement is consistent and free from error (22). A reliable measure fulfills two requirements; it provides consistent values with small errors and it differs among the clients on whom the measurements are being applied (8). Types of reliability which should be considered are:

- *Intra-rater reliability* = the same assessment is completed by the same rater on two or more occasions on the same person, and the degree to which the scores agree on the different occasions
- *Inter-rater reliability* = parallel assessments by different raters; stability of measurement between two or more trained observers in rating the one performance
- *Test - re- test reliability* = the stability of the measurement over two or more measurement occasions

Validity

Validity is the degree to which an assessment measures what it is supposed to measure (22).

- *Face validity*; to what extent a measure appears to be measuring what it is intended to measure
- *Content validity*; to what extent a measure is a comprehensive sample of items that completely assess the domain of interest
- *Criterion validity* ;examines to what extent a measure provides results that are consistent with a gold standard
- *Predictive validity* ; measurement on the target set at a set time can be used to predict future outcome

Tests in stroke rehabilitation

Over the years several tests have been developed for stroke rehabilitation, some generic and some specific (7-8). The most common tests evaluating persons with stroke are presented in tables 1-3. The tests are presented in view of to the International Classification of Function; body structure/body function (Table 1), activity (Table 2) and participation (Table 3) (9). The tests are presented in the tables in regard to representation that is, if they are generic - or specific stroke tests. The tests presented are widely used and tested for reliability and validity in a stroke population (7-8). For the reader it is obvious that most tests reflect impairments, disabilities and restrictions in participation; what the person cannot do. This is slightly opposed to the intentions with the model International Classification of Function which aimed at inspiring to the positive, healthy aspect of function and to focus on what the person with stroke can do. There are few tests reflecting participation, both regarding generic and specific tests.

Tests can be performance based, that is in order to get a score the person has to perform an action. Or tests can be self reports; that is the person is interviewed or answer a questionnaire about different aspects of disablement (2). Tests regarding body function / body structures are mainly performance based whereas tests regarding activity and participation often are self reports.

Tests regarding body function / body structures and activity are, with few exceptions, presented in ordinal scales (Tables 1 and 2). The tests are standardized in relation to the rating of the scores, which means that the clinician must use a certain level of interpretation in order to put a score on the performance. It is important that the tests are evaluated according to the standardization in order to get as few measure errors as possible in the test procedure. All involved in the testing procedure should be well acquainted with the tests and, if possible, the same individual should perform the test at baseline and at follow-up testing intervals in order to avoid different interpretations of the scoring.

The tests regarding participation are performed as self administered questionnaires or interviews (Table 3). The test manuals often consist of yes or no questions. Some tests, like Nottingham Health Profile and the SF-36, have statistical analysis; syntaxes, which automatically combine related questions into categories. The categories can be analyzed in a quantitative way but the clinician should remember that the data represent self reports, not performance based measures, and interpret them as such.

Summary

Tests and measurements are important tools in the rehabilitation of persons with stroke. Assessments in stroke rehabilitation should preferably include both qualitative and quantitative methods and the methods should be valid and reliable. Ideally, the tests should reflect the levels in relation to the

International Classification of Function. A top down approach in the assessment process is beneficial in order to relate to everyday life in the goal setting.

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Table 1. Outcome measures ranked in view of the International Classification of Function and related to body structures / body functions. The generic / global test column indicates that the tests are not disease specific. The specific test column indicates that the tests are developed for persons with stroke. Functional indicate norm related tests, evaluating healthy level. Impairment indicates that the tests screen for the pathology in the performance.

Body structure / body function	Generic / Global test		Specific tests	
	Functional	Impairment	Functional	Impairment
	Timed-Stands Test(Csuka and McCarty 1985)	Visual Analogue Scale (VAS)(unknown)		Birgitta Lindmarks Motor Assessment (Lindmark 1988)
		Borg scale(Borg 1982)		Sødring Motor Evaluation Scale (Sødring et al 1995)
		Oxford scale (Unknown)		Chedoke-McMaster Stroke Assessment;6 dimensions (Gowland et al 1993)
		The Rivermead Assessment of Somatosensory performance (RASP)(Winward et al 2000)		Stroke Rehabilitation Assessment of Movement (STREAM)(Daley et al 1999)
		Nottingham Sensory assessment (Lincoln et al 1998)		Fugl-Meyer Assessment of sensorimotor recovery after stroke (FM)(Fugl-Meyer et al 1975)
		Modified Ashworth scale(Bohannon and Smith 1987)		Rivermead Motor Assessment (RMA) (Lincoln et al 1979)
		Tardieu scale (Tardieu et al 1954)		

Table 2. Outcome measures ranked in view of the International Classification of Function and related to the theme Activity. *The generic / global* test column indicates that the tests are not disease specific. *The specific test* column indicates that the tests are developed for persons with stroke. Functional indicate norm related tests, evaluating healthy level. Disability indicates that the tests screen for the pathology in the performance.

Activity	Generic / Global test		Specific tests	
	Functional	Disability	Functional	Disability
	Walk tests (Butland et al 1982)	Barthel Index (BI)(Mahoney and Barthel 1965)		Motor assessment Scale (MAS)(Carr & Shepherd 1985)
	Gait speed (unknown)			
	Timed -Up and Go (TUG)(Podsiadlo 1991)	Functional independence Measure (FIM)(Uniform Data System for Medical Rehabilitation 1987)		Action Research Arm test (Lyle 1981)
	Functional reach (Duncan et al 1990)	Berg Balance Scale (BBS)(Berg et al 1989)		Frenchay arm test (Heller et al 1986)
	Lateral Reach (Brauer et al 1999)	The clinical test of Sensory interaction and Balance (CTSIB)(Shumway-Cook and Horak 1986)		Chedoke-McMaster Stroke Assessment ; 2 dimensions (Gowland et al 1993)
		Pastor's test (Pastor et al 1993)		Stroke Impact Scale (SIS)(Desrosier et al 1993)
		Fall's efficacy test (FES)(Tinetti et al 1990)		Stroke Adapted Sickness Impact Profile(van Straten et al 1997)
		Four Square Step test (Dite and Temple 2002)		The Mobility Scale for Acute Stroke Patients (MSAS) (Simondson et al 1996)
		Dynamic Gait Index (DGI)(Shumway-Cook and Wollacott 1995)		Functional Ambulation Classification (FAC)(Holden et al 1986)
		The Functional Gait Assessment (FGA) (Wrisley et al 2004)		
		Nine Hole Peg test (Mathiewetz et al 1985)		
		Jebsen test of hand function (Jebsen et al 1969)		
		Sickness Impact Scale (SIP)(Bergner et al 1976)		

Table 3. Outcome measures ranked in view of the International Classification of Function and related to the theme Participation. The generic / global test column indicates that the tests are not disease specific. The specific test column indicates that the tests are developed for persons with stroke. Functional indicate norm related tests, evaluating healthy level. Restrictions indicate that the tests screen for the pathology in the performance.

Generic / Global test			Specific tests	
Participation	Functional	Restrictions	Functional	Restrictions
	Older Americans Resources and services Scale-Instrumental Activities of daily living (OARS-IADL) (Center for the study of aging and human development 1975)	Nottingham health Profile (Martini and McDowell 1975, Hunt and McEwen 1978)		The Stroke Adapted 30 item Version of the Sickness Impact Profile (SA-SIP30)(van Straten de Haan, Limburg, Schuling et al 1997)
		Short Form -36 (SF-36, SF -12) (Ware and Sherbourne 1992)		