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A review of clinical upper limb assessments within the framework of the WHO ICF

Cheryl Metcalf[1] BA (Hons) MSc, **Jo Adams**[2] DipCOT MBAOT MSc PhD, **Jane Burridge**[2], **Victoria Yule**[2] BSc MMedSci PhD, and **Paul Chappell**[1] BSc PhD CEng MZET MIPEM MIEEE

[1]*School of Electronics & Computer Sciences, University of Southampton, UK,*
[2]*School of Health Professions & Rehabilitation Sciences, University of Southampton, UK*

Abstract

This paper is intended to provide a practical overview for clinicians and researchers involved in assessing upper limb function. It considers 25 upper limb assessments used in musculoskeletal care and presents a simple, straightforward comparative review of each. The World Health Organization International Classification on Functioning, Disability and Health (WHO ICF) is used to provide a relative summary of purpose between each assessment. Measurement properties of each assessment are provided, considering the type of data generated, availability of reliability estimates and normative data for the assessment. Copyright © 2007 John Wiley & Sons, Ltd.

Key words: Upper limb, assessment, function, rehabilitation

Introduction

Useful and reliable assessment of the upper limb is important in both research and clinical practice. There are a large number of upper limb assessments available, and selecting the most appropriate outcome measure to communicate the effectiveness of clinical interventions can be challenging. Each outcome measure will have its own measurement properties and will be likely to have a primary assessment focus – for example, body functions and structures, activities or impact on social participation.

This short report reviews 25 upper limb functional assessments (ULAs) currently reported in research and clinical practice. These assessments are categorized into their prime assessment focus; body functions and structures, activities and/or

impact on social participation (World Health Organization, 2002). The paper presents a summary of the reliability properties of each of the 25 ULAs, in order to provide a practical overview for clinicians and researchers, to assist with the decision of which ULA might be the most appropriate to use for defined assessment purposes.

Measurement

Measurement is essential for today's health services. Robust outcome measures are required to provide reliable information to endorse evidence-based practice, and communicate the impact of disease and the effectiveness of health care interventions (Haywood, 2006). The introduction of the internal market in health care provision has forced the National Health Service to evaluate health service outcomes (Department of Health, 2007) and to strive to establish services that are efficient, cost effective and effective (Bowling, 2000).

There is no one distinct variable that can define and encompass functional ability. Fundamentally, outcome measures will utilize a number of variables to act as indicators (McDowell and Newell, 1996), and these can be compiled to form a clinical assessment to provide a clinically meaningful deduction from the measurement. Outcome measures can be categorized into subjective or objective measures. Subjective (self-report) measures rely on the patient's or clinician's report, whereas objective measures use data that have been generated by clinicians using validated equipment and standardized measurement protocols.

Choosing the most appropriate outcome measure(s), and having a clear understanding of their strengths and limitations, is important in both clinical and research terms. Using appropriate, valid and reliable outcome measures can improve understanding of how disease progresses, the level of structural impairment and how this impacts on the individual in terms of function and participation (Long and Scott, 1994). However, for specific assessment of the upper limb, challenges lie in choosing measures that are stable, valid and appropriate. There remains limited published data on reliability levels for many musculoskeletal ULAs (Ellis et al., 1997; Fowler and Nicol, 2001; Nordenskiöld, 2001).

This short report provides a review of 25 ULAs presented within the framework of the WHO ICF (World Health Organization, 2002) and provides practical information for both clinicians and researchers interested in the range and focus of ULAs used in musculoskeletal care.

Methods

An online search of AMED, CINAHL, Embase, Ovid Medline, Ovid Old Medline and Science Direct databases was undertaken to identify ULAs reported in the

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literature. The search criteria are included in Appendix A. In addition, other ULAs were recommended for inclusion by clinical colleagues, based on frequency of use in practice, and ULAs from previous reviews were also sourced (McPhee, 1987; Jones, 1989; Light et al., 1999; Finch et al., 2002). Using the results from the literature search, discussions and previous reviews, 25 ULAs were identified.

Each ULA was presented and compared using the framework of the WHO ICF (World Health Organization, 2002). Assessments were classified under the ICF categories of *Body Functions & Structures*, *Activities* and *Participation* (Figure 1).

Each ULA was then considered within the ICF framework to clarify which domain(s) were being measured by each ULA (Figure 2). The criteria for assigning each ULA to a particular category of the ICF were as follows. If the ULA:

- Generated clinician-assessed reports on physiological function (e.g. range of motion or grip strength)
  - *Body Functions & Structures* category
- Generated clinician-observed reports and/or patient self-reports of activities of daily living (ADL) ability (e.g. dressing or feeding ability)
  - *Activities* category
- Generated patient self-reports on quality of life and participation (e.g. ability to access the community, work or leisure pursuits)
  - *Participation* category
- Generated clinician-assessed reports on physiological function and also included some clinician-assessed reports on functional ADL assessment
  - *Body Functions & Structures* category leading into *Activities* category

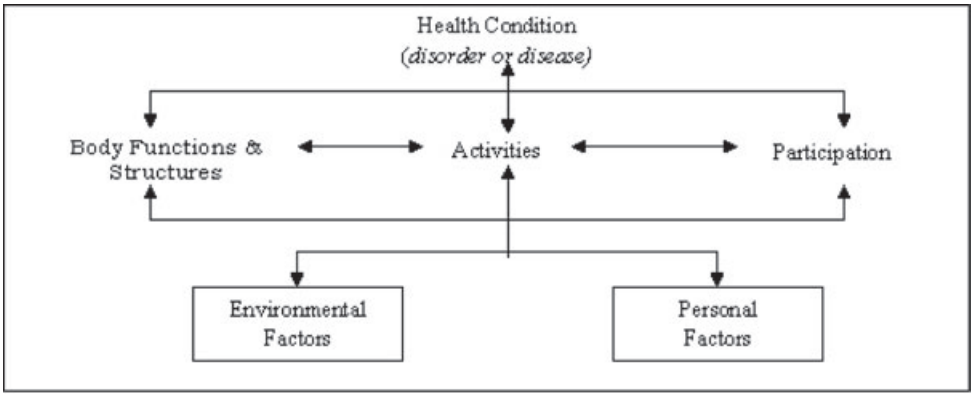

FIGURE 1. ICF framework (World Health Organization, 2002)

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- Generated data from clinician-observed reports on ADL assessment and generated some interval/ratio data from clinician-assessed reports on physiological function
  – *Activities* category leading into *Body Functions & Structures* category
- Generated data from clinician-assessed reports on ADL assessment and with some ordinal measures of quality of life from patient self-reports
  – *Activities* category leading into *Participation* category
- Generated data patient self-report on quality of life with some clinician-assessed reports on ADL assessment
  – *Participation* category leading into *Activities* category
- Generated predominantly ordinal data from patient self-reports on quality of life and with some interval/ratio data generated from clinician-assessed reports on physiological function
  – *Body Functions & Structures* category and *Participation* category

The characteristics of each ULA were then considered. The following criteria were used to provide sub-categories for each ICF-classified ULA; these sub-categories were:

- Generated self-report (subjective) data
- Generated clinician-assessed outcome using standardized protocols and equipment (objective) data
- Generated ordinal or interval/ratio data
- Were designed as a disease or pathology-specific assessment
- Had associated published test-retest and inter-rater reliability statistics
- Had associated data from unimpaired participants

Results

Figure 2 categorizes each ULA within the framework of the WHO ICF. The level to which a ULA crosses over into another ICF category is subjective, but it provides a basis for understanding at a glance the content of a particular ULA under consideration.

Twenty-five ULAs are presented and summarized (full details of all ULAs are presented in Appendix B, including the full titles of those referred to by acronyms in Table 1). Table 1 presents the breakdown of each ULA into the type of data recorded by the measure; whether the measure is considered to produce objective or subjective outcomes; if it has been designed specifically for musculoskeletal conditions; and whether there is any evidence of published reliability values and normative data for comparison purposes.

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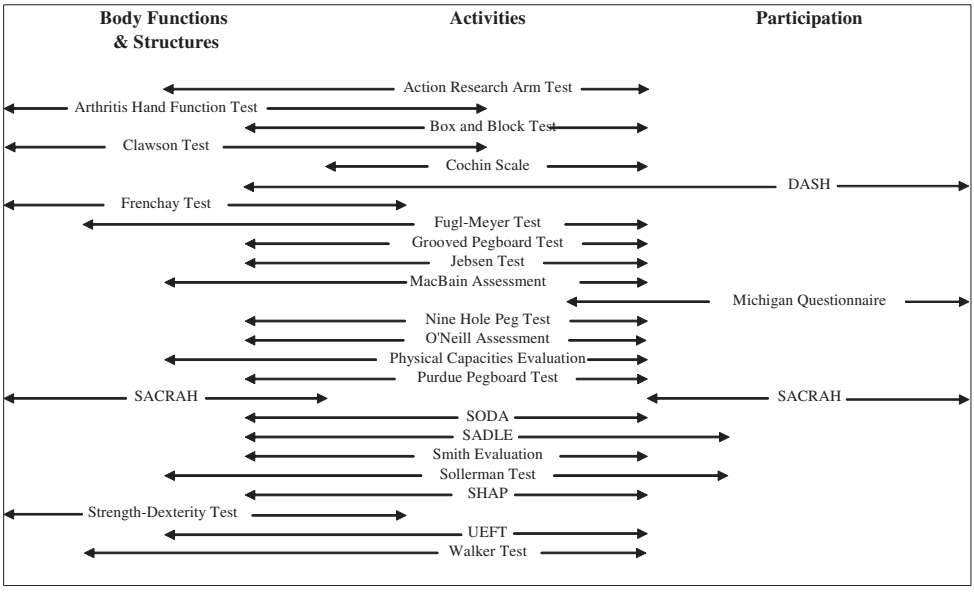

FIGURE 2. Overlap in ICF classifications in upper limb assessments. Full details of each ULA, including key texts, can be found in Appendix B.

Together with Table 1, the options for assessing the structural impairment, functional ability and impact of upper limb injury or disease can be reviewed and considered, with a practical understanding of the content, reliability and assessment remit of 25 commonly used regional ULAs.

Discussion

Comparing Table 1 with Figure 2 illustrates that clinician-observed and patient self-report ULAs tend to fall into the *Activities* or *Participation* sections of the ICF breakdown and generate ordinal (i.e. non-parametric) data. These assessments usually rely on categories of subjective observations and employ a ranked scoring system, whereby the individual or observer/assessor assigns a number, and level of ability or structural impairment for the completion of any given task. Subjective methods of assessment such as this provide informed observations, or a useful means of understanding an individual's perspective. Commentators (Ashcroft, 1996; Carr, 1996a, 1996b; Wolfe and Pincus, 1999; Guillemin, 2000; Haywood, 2006) have rightly criticized the over-dependence of health professional-defined outcomes in musculoskeletal health care and encouraged the use of patient self-report measures. However, self-report and clinician-observed report measures are

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TABLE 1. Twenty-five upper limb assessments

Review of Upper Limb Assessments

	Data Type			Assessment Type			Pathology			Evidence of Reliability		Normative Data
Assessment	Ordinal	Interval/ Ratio	Both	Objective	Subjective	Both	Musculoskeletal	Neurological	Non-Specific/ Both	Inter-rater	Test-retest	
*Action Research Arm Test**	✓			✓			✓	✓	✓	✓§	✓‡	
*Arthritis Hand Function Test***		✓		✓			✓			✓	✓‡	✓
*Box and Block Test**		✓		✓					✓	✓	✓‡	✓
Clawson Test	✓	✓	✓	✓			✓					
*Cochin Rheumatoid Hand Disability Scale**	✓			✓			✓					NA
*DASH**	✓				✓				✓		✓‡	✓
Frenchay Arm Test	✓			✓				✓		✓	✓	
Fugl-Meyer Test	✓			✓	✓	✓		✓			✓‡	
*Grooved Pegboard Test**		✓		✓				✓			✓	✓
*Jebsen Test**		✓		✓			✓	✓	✓		✓	✓
MacBain Hand Function Assessment		✓		✓			✓					
*Michigan Hand Outcomes Questionnaire**	✓				✓		✓	✓	✓		✓	NA

TABLE 1. *Continued*

Review of Upper Limb Assessments

	Data Type			Assessment Type			Pathology			Evidence of Reliability		Normative Data
Assessment	Ordinal	Interval/ Ratio	Both	Objective	Subjective	Both	Musculoskeletal	Neurological	Non-Specific/ Both	Inter-rater	Test-retest	
*Nine Hole Peg Test**		✓		✓					✓	✓	✓	✓
*O'Neill Hand Function Assessment***	✓	✓	✓	✓			✓			✓	✓	✓
Physical Capcities Evaluation of Hand Skill		✓		✓			✓	✓	✓			
*Purdue Pegboard**		✓		✓					✓	✓	✓	✓
*SACRAH**	✓	✓	✓	✓	✓	✓	✓					NA
*SODA**	✓			✓	✓	✓	✓			✓	✓	
SADLE		✓		✓				✓			✓	
Smith Hand Function Evaluation		✓		✓					✓			✓
*Sollerman Hand Function Test**	✓			✓				✓		✓	✓	
*SHAP**		✓		✓					✓	✓	✓	✓
Strength-Dexterity Test		✓		✓			✓				✓	✓
Upper Extremity Function Test	✓			✓			✓	✓	✓	✓	✓	✓
Walker Test		✓		✓			✓					✓
Total	***12***	***16***	***3***	***23***	***5***	***5***	***14***	***10***	***11***	***11***	***18***	***13***

§ = kappa and ‡ intraclass correlation coefficient;* = available from the internet/download or can be purchased, and ** = need to be made up in department
NA = not applicable

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not without their limitations. Many will produce ranked ordinal data, and, as such, confidence intervals cannot then be used to extrapolate research findings (that use such measures) to a wider population. Dixon (1996) criticizes patient-defined outcomes in rheumatology as 'soft' and too subjective to be used in robust research. Van Den Ende et al. (1995) have also demonstrated further issues for consideration when, in the case of individuals with rheumatoid arthritis, there may be discordance between self-report and clinician-rated measures. Snaith et al. (1976) state that such measures are liable to be influenced by the individual's ability to read/write and their wish to present themselves in a positive light. Studies by Ward (1994) and Spiegel et al. (1988) recount that self-report measures of pain and global status are confounded by the individual's mood. Thus, on interpreting self-report measures, one needs to be mindful that changes in self-report measures might not be reflected by similar changes in clinician-rated measures. Self-report measures have been seen to be simple, inexpensive ways of obtaining good clinical data (Wolfe and Cathey, 1991), and in many instances they are easy to score and interpret for the clinician, adding valuable information to the clinical picture (Jacobs et al., 1992). As health is a social as well as a biological construct, individuals' own views of their health state may be the most important to consider (Blaxter, 1990). Finally, the assumption that self-report measures may be 'soft', and that using clinician-assessed variables are more reliable, is misguided. Both types of measurement suffer from the same threats to reliability and there are few guarantees to assure that any individual, whether a professional or a patient, will be consistent and reliable in their findings from day to day. If an outcome measure is badly designed, with weak psychometric properties, neither patients nor health care professionals will able to record reliable data.

By contrast, most clinician-assessed ULAs use measurements that are examined in terms of mathematical or physical variables, such as range of movement or velocity. These are argued to be more objective methods of assessment, and should provide an unbiased and comparable form of collecting information. Yet they may not truly reflect what matters to patients' daily lives (Hewlett et al., 2001). For clinical researchers interested in generating wider generalizations from their research studies, this may be particularly relevant, as associated confidence intervals may be calculated, providing wider estimations than *p* values and significance levels alone (Gardner and Altman, 2000); something that cannot be achieved with ordinal data. Clinician-assessed ULAs tend to fall between the *Body Functions & Structures* section and the *Activities* section, and will produce internal/ratio data.

There are notable exceptions to these assignments, namely the clinician-observed ULAs in the *Body Functions & Structures* section. In the Frenchay Arm Test (De Souza et al., 1980), although each task measures an element of body function or structure, an assessor scores each test according to the particular criteria of

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the assessment. Some overlaps also occur when ULAs contain both subjective (self-report and clinician-observed report) and objective (clinician-assessed) elements. For example, the Arthritis Hand Function Test (Backman et al., 1991) could be assigned to both *Body Functions & Structures* and *Activities*, whereas the Score for Assessment and Quantification of Chronic Rheumatic Affections of the Hands (Leeb et al., 2003) could be assigned to both *Body Functions & Structures* and *Participation*.

One of the main criticisms of outcome measures that classify categories of function, assessed by clinicians' observed reports, is that the categories may not have specific relevance to the individuals' lifestyles or daily routines (Wylde et al., 2006). Relying solely on such methods of assessment can be open to assumption and misunderstanding of the personal impact of functional (dis)ability. It has been seen that musculoskeletal patients' perspectives of disease and functional ability can differ from health professionals' assessments at different stages of the disease (Kievit et al., 2005), and that the perception of activity and function may be substantially different between health professionals and their patients (Nothnagl et al., 2005). Conversely, objective methods of assessment concentrate solely on the feedback from a device, and therefore can be susceptible to errors of inaccuracy and inadequate calibration due to human error. Objective methods of assessment also provide no place for the individual's perspective, relying only on the data received. More recently, outcome measures have been developed with the input of relevant patient groups, but the relevance of assessment tasks to patients has not always been considered in the development of measures (Carr, 1996b).

Limitations

This review is not without limitations. Formal appraisal of the literature using quality-scoring tools was not carried out; instead, more practical aspects of the assessments have been considered. This was intended to enhance the usability of the report for clinicians, but, in so doing, readers need to be aware that this short review does not necessarily follow the formal guidelines for systematic reviews. Moreover, the levels of validity of the ULAs are not compared or presented within this paper, and future consideration should be given to this area.

Conclusion

A review of the literature and online database search was undertaken, identifying 25 ULAs. The review highlights the content and specific characteristics of each ULA, and emphasizes which ULAs have associated information that testify to its

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reliability. Each ULA has been categorized within the context of the WHO ICF framework, the results of which identify the type of data generated by the ULA, as well as whether the assessment is subjective or objective in nature. This review should serve as a reference for clinicians and researchers to locate an appropriate ULA, or a battery of tests that fulfil the needs for measuring the impact of disease, evaluating treatment effectiveness and communicating this to both patients and wider audiences. Historically, the emphasis when selecting an appropriate ULA has been on assessing limitation and impairment of function; a more positive approach in the future, focusing on ability and participation, would ultimately benefit the patients and maximize their potential for functional recovery.

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Nothnagl T, Andel I, Sautner J, Leder S, Bogdan M, Maktari A, Rintelen B, Leeb BF (2005). Improvement and deterioration of rheumatoid arthritis: The patient's perspective. Annals of Rheumatic Disease 64: 182.

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Correspondence should be sent to Cheryl Metcalf, School of Electronics & Computer Sciences, Room 1001, Building 86, University of Southampton, Southampton, SO17 1BJ, UK. Tel: 02380 599204; Fax: 02380 592901. E-mail: cdm03r@ecs.soton.ac.uk

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Appendix A

The following key words were included in the search in February 2007:

1. Scale
2. Measurement
3. Assessment
4. Test
5. Outcome
6. Function
7. Hand
8. Upper extremity
9. Upper limb
10. 7 AND 8 AND 9
11. 6 AND 10
12. 1 AND 11 OR 2 AND 11 OR 3 AND 11 OR 4 AND 11 OR 5 AND 11
13. 11 AND 12

The search was restricted to English language and human. Duplicates were then removed from 13.

Appendix B

Action Research Arm Test
Lyle RC (1981) A performance test for assessment of upper limb function in physical rehabilitation treatment and research. International Journal of Rehabilitation Research 4(4): 483–492.

Arthritis Hand Function Test
Backman C, Mackie H, Harris J (1991) Arthritis Hand Function Test: Development of a standardized assessment tool. Occupational Therapy Journal of Research 11(4): 254–255.

Box and Block Test
Mathiowetz V, Volland G, Kashman K, Weber K, (1985) Adult norms for the Box and Block Test of manual dexterity. American Journal of Occupational Therapy 39(6): 386–391.

Clawson Test
Clawson DK, Souter WA, Carthum CJ, Hymen ML (1971) Functional assessment of the rheumatoid hand. Clinical Orthopaedics and Related Research 77: 203–210.

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Cochin Rheumatoid Hand Disability Scale
Lefevere-Colau MM, Poiraudeau S, Fermanian J, Etchepare F, Alnot JY, Le Viet D, Leclercq C, Oberlin C, Bargy F, Revel M (2001) Responsiveness of the Cochin Rheumatoid Hand Disability Scale after surgery. Rheumatology 40(8): 843–850.

Disabilities of the Arm, Shoulder and Hand (DASH)
The Institute of Work & Health, (1997) The DASH outcome measure user's manual. Ontario, Canada. Available at http://www.dash.iwh.on.ca [Accessed 22 August 2005].

Frenchay Arm Test
De Souza LH, Langton-Hewer R, Miller S (1980) Assessment of recovery of arm control in hemiplegic stroke patients I: Arm function tests. International Rehabilitation Medicine 2: 3–9.

Fugl-Meyer Test
Fugl-Meyer AR, Jääskö L, Leyman I (1975) The post-stroke hemiplegic patient I: A method for evaluation of physical performance. Scandinavian Journal of Rehabilitation Medicine 7: 13–31.

Grooved Pegboard Test
Knights RM, Moule AD (1968) Normative data on the motor steadiness battery for children. Perceptual and Motor Skills 26: 643–650.

Jebsen Test
Jebsen RH, Taylor N, Triesschmann RB, Tratter HJ, Howard LA (1969) An objective and standardized test of hand function. Archives of Physical Medicine and Rehabilitation 50: 311–319.

MacBain Hand Function Assessment
MacBain KP (1970) Assessment of function in the rheumatoid hand. Canadian Journal of Occupational Therapy 37(3): 95–102.

Michigan Hand Outcomes Questionnaire
Chung KC (1998) Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. Journal of Hand Surgery 23A(4): 575–587.

Nine Hole Peg Test
Mathiowetz V, Weber K, Kashman N, Volland G (1985) Adult norms for the Nine Hole Peg Test of Finger Dexterity. Occupational Therapy Journal of Research 5(1): 24–38.

O'Neill Hand Function Assessment
O'Neill G (1995) The development of a standardized assessment of hand function. British Journal of Occupational Therapy 58(11): 477–480.

Physical Capacities Evaluation of Hand Skill
Bell E, Jurek K, Wilson T (1976) Hand skill: A gauge for treatment. American Journal of Occupational Therapy 30(2): 80–86.

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Purdue Pegboard
Tiffin J, Asher EJ (1948) The Purdue Pegboard: Norms and studies of reliability and validity. Journal of Applied Psychology 32: 234–247.
Score for Assessment and Quantification of Chronic Rheumatic Affections of the Hands (SACRAH)
Leeb BF, Sautner J, Andel I, Rintelen B (2003) SACRAH: A score for assessment and quantification of chronic rheumatic affections of the hands. Rheumatology 42(10): 1–6.
Sequential Occupational Dexterity Assessment (SODA)
Van Lankveld W, van't Pad Bosch P, Bakker J, Terwindt S, Franssen M, van Riel P (1996) Sequential Occupational Dexterity Assessment (SODA): A new test to measure hand disability. Journal of Hand Therapy 9: 27–32.
Simulated Activities of Daily Living Examination (SADLE)
Potvin AR, Tourellotte WW, Dailey JS, Albers JW, Walker JE, Pew RW, Henderson WG, Snyder DN (1972) Simulated Activities of Daily Living Examination. Archives of Physical Medicine and Rehabilitation 53: 476–486.
Smith Hand Function Evaluation
Smith HB (1973) Smith Hand Function Evaluation. American Journal of Occupational Therapy 27(5): 244–251.
Sollerman Hand Function Test
Sollerman C, Ejeskär A (1995) Sollerman Hand Function Test. Scandinavian Journal of Plastic and Reconstructive Surgery of the Hand 29: 167–176.
Southampton Hand Assessment Procedure (SHAP)
Light CM, Chappell PH, Kyberd PJ (2002) Establishing a standardized clinical assessment tool of pathologic and prosthetic hand function: Normative data, reliability, and validity. Archives of Physical Medicine and Rehabilitation 83(6): 776–783.
Strength-Dexterity Test
Valero-Cuevas FJ (2005) An integrative approach to the biomechanical function and neuromuscular control of the fingers. Journal of Biomechanics 38(4): 673–684.
Upper Extremity Function Test
Carroll D (1965) A quantitative test of upper extremity function. Journal of Chronic Diseases 18: 479–491.
Walker Test
Walker PS, Davidson W, Erkman MJ (1978) An apparatus to access function of the hand. Journal of Hand Surgery 3(2): 189–193.

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