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ICF-based classification and measurement of functioning

G. STUCKI [1, 2, 3], N. KOSTANJSEK [4], B. ÜSTÜN [4], A. CIEZA [2, 3]

If we aim towards a comprehensive understanding of human functioning and the development of comprehensive programs to optimize functioning of individuals and populations we need to develop suitable measures. The approval of the International Classification of Functioning, Disability and Health (ICF) in 2001 by the 54th World Health Assembly as the first universally shared model and classification of functioning, disability and health marks, therefore an important step in the development of measurement instruments and ultimately for our understanding of functioning, disability and health. The acceptance and use of the ICF as a reference framework and classification has been facilitated by its development in a worldwide comprehensive consensus process and the increasing evidence regarding its validity. However, the broad acceptance and use of the ICF as a reference framework and classification will also depend on the resolution of conceptual and methodological challenges relevant for the classification and measurement of functioning. This paper therefore describes first how the ICF categories can serve as building blocks for the measurement of functioning and then the current state of the development of ICF-based practical tools and international standards such as the ICF Core Sets. Finally, it illustrates how to map the world of measures to the ICF and vice versa and the methodological principles relevant for the transformation of information obtained with a clinical test or a patient-oriented instrument to the ICF as well as the development of ICF-based clinical and self-reported measurement instruments.

KEY WORDS: Rehabilitation, methods - Clinical protocols - Disability.

Corresponding author: G. Stucki, MD, MS, Department of Physical Medicine and Rehabilitation, Munich University Hospital, Ludwig Maximilian University, Marchioninistr. 15, 81377 Munich, Germany. E-mail: gerold.stucki@med.uni-muenchen.de

[1]Department of Physical Medicine and Rehabilitation Munich University Hospital, Ludwig Maximilian University Munich, Germany
[2]ICF Research Branch of WHO FIC CC (DIMDI) IHRS, Ludwig Maximilian University, Munich, Germany
[3]Swiss Paraplegic Research, Nottwil, Switzerland
[4]World Health Organization, CTS Team Geneva, Switzerland

Lord Kelvin has pointed out that «to measure is to know» and «if you can not measure it, you can not improve it». If we aim towards a comprehensive understanding of human functioning and the development of comprehensive programs to optimize functioning of individuals and populations we need to develop suitable measures.

Ideally, measures of human functioning or aspects of it are based on a common and universally shared framework and classification. The mutually exclusive and cumulative exhaustive categories of such a classification can serve as reference standards for the reporting of functioning across a wide range of measures. They can also serve as building blocks for the development of clinical and self-reported measurement instruments tailored to the need of prospective users and suitable for varying purposes.

The approval of the International Classification, Disability and Health (ICF) in 2001 by the 54th World Health Assembly [1] as the first universally shared model and classification of functioning, disability and health [2] marks therefore an important step in the development of measurement instruments and ultimately for our understanding of functioning, disabil-

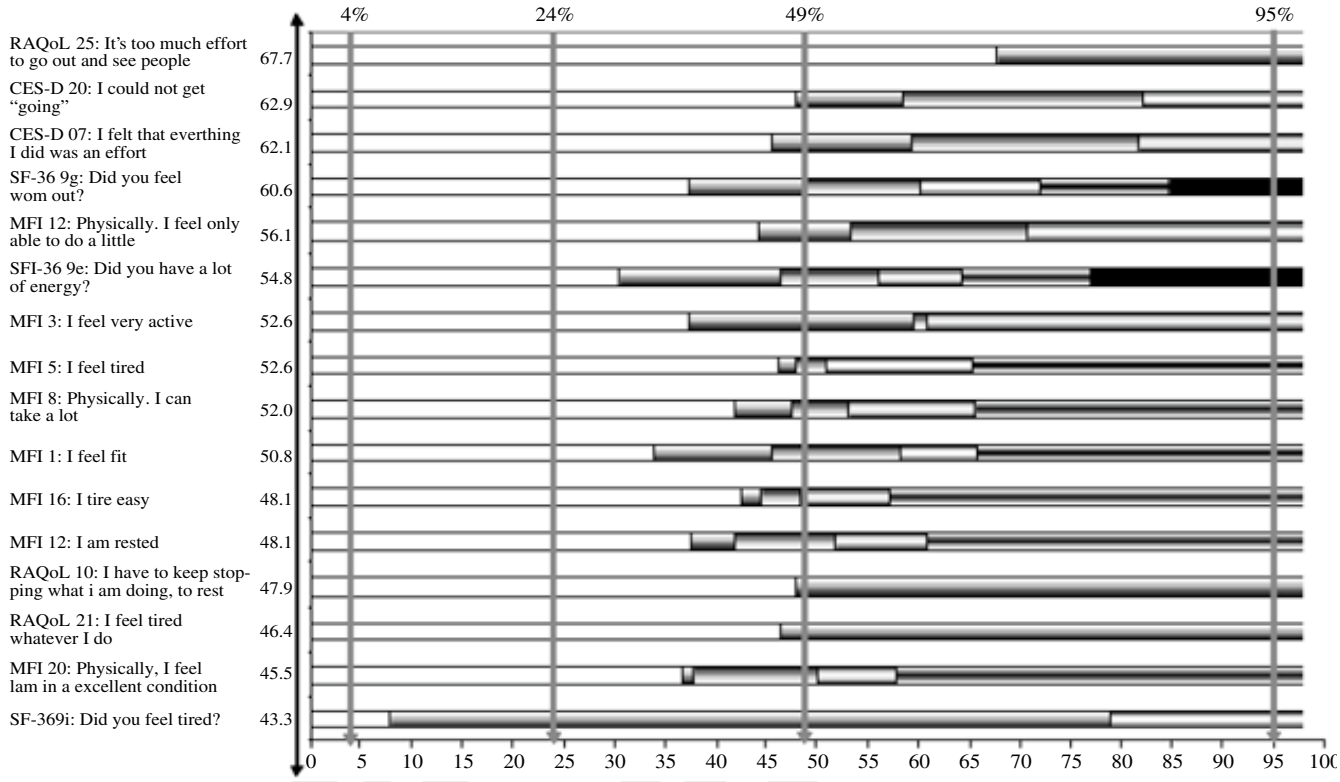


Figure 1.—Rasch scale for measurement items mapped to the ICF *category b130 Energy and drive* [13]. The x- and the y-axes represent the ICF category interval scale of the continuum *energy and drive,* with values ranging from 0 to 100. Not all values from zero to 100 are represented on the y-axis because of space constraints. The 16-items in order of difficulty from the easiest item (bottom) to the most difficult item (top) are presented on the y-axis. The value corresponding to the position of the items is presented next to them. The position of the thresholds of the response options of the items are represented by the bars in the diagram. The different grey tones represent the different response options for each individual item. The vertical arrows represent the position of each of the response options of the ICF qualifier. RAQoL: Rheumatol Arthritis Quality of Life Scale; CES-D: Center for Epidemiologic Studies and Depression Scale; SF36: short from 36; MFI: Multidimensional Fatigue Inventory. Rheumatoid Arthritis Quality of Life Questionnaire (RAQoL), the Health Assessment Questionnaire (HAQ), the Medical Outcomes Study Short Form 36 (SF-36), the European Quality of Life Instrument (EQ-5D), the Multidimensional Fatigue Inventory (MFI), and the Center for Epidemiological Studies Depression Scale (CES-D).

ity and health. As described in the paper of Cieza *et al.*[3] in this special section of the EJPRM, the ICF has since its launch in 2001, attracted wide interest in the health sciences and particularly in the field of measurement and outcomes research.

The acceptance and use of the ICF as a reference framework and classification has been facilitated by its development in a worldwide comprehensive consensus process and the increasing evidence regarding its validity.[3, 4] However, the broad acceptance and use of the ICF as a reference framework and classification will also depend on the resolution of conceptual and methodological challenges relevant for the classification and measurement of functioning.

First of all it is important to clearly distinguish and clarify the conceptual difference between categories of a classification such as the ICF and "items" for example of so called "psychometric measures". Secondly, the usefulness of a classification relies on the development of international standards and practical tools such as the ICF Core Sets.[5-7] Thirdly, it is essential to develop methodological approaches which allow mapping of the world of measures to the ICF and vice versa. Finally, the acceptance of the ICF will depend on its usefulness to serve as basis for the construction of new measures which are based on the universally agreed and shared concept and categories of the ICF.

The objective of this paper therefore is to illustrate

TABLE I.—*ICF Core Set development.*

ICF Core Set		Protocol paper	Preparatory phase: Patient perspective	Preparatory phase: Expert perspective		Consensus conference	Validation phase: Patient perspective	Validation phase: Expert perspective		Validation phase: Economic perspective
			ICF data collection	Literature review	Delphi method		Focus groups or patient interwievs	Linking	Delphi method	Nursing resources
Acute context		10	15	n.p.	16			17		
	Neurological conditions	10	15	n.p.	16	18				
	Musculoskeletal conditions	10	15	n.p.	16	19				
	Cardiopulmonary conditions	10	15	n.p.	16	20				
Early post-acute context		10	n.p.	21	n.p.			17, 22		
	Neurological conditions	10	23	21	n.p.	24		17, 22		
	Musculoskeletal conditions	10	n.p.	21	n.p.	25		17, 22		
	Cardiopulmonary conditions	10	n.p.	21	n.p.	26		17, 22		
	Geriatric patients	10	27	21		28		17, 22		
Long term context		9	29		30					
	Chronic widespread pain	9	29	31	30	32				
	Low back pain	9	29	31	30	33				
	Osteoarthritis	9	29	31	30	34				
	Osteoporosis	9	29	31	30	35				
	Rheumatoid arthritis	9	29	31	30	36	37, 38		39	
	Chronic ischemic heart disease	9	29	40	30	41				
	Diabetes	9	29	40	30	42				
	Obesity	9	29	40	30	43				
	Obstructive pulmonary diseases	9	29	40	30	44				
	Depression	9	29	45	30	46				
	Breast cancer	9	29	47	30	48				
	Stroke	9	29	49	30	50				
	Psoriasis and psoriatic arthrits			51						
	Ankylosing spondylitis		52							
	Spinal cord injury	53								
	Systemic lupus erythematosus	54								
	Multiple sclerosis	55								
	Head and neck cancer	56								
	Bipolar disorders	57								

n.p.: not performed.

how to use the ICF for the classification and measurement of functioning.

The specific aims are to describe 1) the ICF categories as building blocks for the measurement of functioning; 2) the current state of the development of ICF-based practical tools and international standards such as the ICF Core Sets; 3) how to map the world of measures to the ICF and vice versa, and 4) the methodological principles relevant for the transformation of information obtained with a clinical test or a patient-oriented instrument to the ICF and the development of ICF-based clinical and self-reported measurement instruments.

ICF categories: building blocks and reference units

The ICF categories are the discrete, meaningful, universally shared and understood elements which allow users to comprehensively *classify* and *measure* functioning of individuals and populations. They are thus the building blocks for the construction of ICF based practical tools such as the *ICF checklist* [8] and the *ICF Core Sets* [5-7, 9, 10] as well as *clinical measurement instruments* such as the *ICF Core Set Index* currently under development for Ankylosing Spondylitis [11] and

self-reported measurement instruments such as the WHODAS-II.[12]

While ICF-based practical tools such as the ICF *Core Sets* allow the classification of functioning states, clinical and *self-reported measurement instruments* allow the measurement and hence the estimation of *functioning status* or aspects of it in relation to specific purposes. Vice versa, the ICF categories serve as meaningful and universal reference units for reporting and communicating results of measurements of aspects of functioning made with any measurement instrument from the infinite universe of measurement instruments.[2]

In this context it is important to recall the difference between the mutually exclusive and discrete elements of a classification such as the *ICF categories* vs *measurement items* or simply items e.g. of self-reported health status measures. As meaningful and universally shared elements, *ICF categories* represent constructs while items as indicators of constructs are used to estimate the variation in a construct, *e.g.* an ICF category. As shown in a following paragraph, there are *e.g.* many items used in a wide range of self-reported health status measures which can serve as indicators to estimate the level of the ICF category *b130 energy and drive functions* [13] (Figure 1).

ICF based practical tools: ICF Checklist and ICF Core Sets

To implement the ICF in clinical medicine, service provision and policy, practical tools need to be developed.[6, 14] In this context it is important to recall that the ICF has been developed as a reference classification and is not intended to be a practical tool. To address the needs of prospective users, the FDRG of the WHO FIC CC Network collaborates with international organizations in official relation with WHO including ISPRM and a wide range of partners in the development of ICF-based practical tools including the *ICF Core Sets*.

The main challenge to the application of the ICF is the size of the classification system with its 1 424 categories. Dr. Üstün, the leader of WHO's CTS team has pointed out that "a clinician cannot easily take the main volume of the ICF and consistently apply it to his or her patients. In daily practice, clinicians will only need a fraction of the categories found in the ICF".[6]

TABLE II.—*ICF categories identified as candidate ICF categories for the Generic ICF Core Set.*[61]

ICF component	Candidate ICF categories for Generic ICF Core Sets
Body functions	b130 Energy and drive functions b152 Emotional functions b230 Vestibular functions b280 Sensation of pain b730 Muscle power functions
Activity and participation	d450 Walking d620 Acquisition of goods and services d640 Doing housework d660 Assisting others d850 Remunerative employment d920 Recreation and leisure
Environmental factors	e450 Individual attitudes of health professionals e580 Health services, systems and policies

ICF checklist

The ICF checklist is a 12-page, "short" version of the ICF with 125 second-level categories. All information from written records, primary respondent, other informants, and direct observation can be used.[8] It takes around 1 hour to complete but may take much longer in patients with multiple impairments, activity limitations, and participation restrictions. It has been applied in a wide range of surveys and in studies in the process of developing ICF Core Sets (Table I).

ICF Core Sets

THE ICF CORE SET PROJECT

The goal of the *ICF Core* Set project is to systematically develop parsimonious and hence practical sets of ICF categories for clinical practice, service provision and research and to link the ICF to health conditions as coded with the ICD.[5-7] The ICF Core Sets serve first as practical tools for the documentation of functioning and second as international reference standards for the reporting of functioning [2] irrespective of which measurement instruments were used. They are also the starting point for the development of clinical and self-reported measurement instruments.[11, 58, 59]

The ICF Core Set Project is a joint project of the ICF Research Branch of the WHO FIC CC Germany (DIMDI) at the Institute for Health and Rehabilitation Sciences at the Ludwig-Maximilian-University in

Munich, Germany,[60] together with WHO´s CTS team, ISPRM and a large number of partner organizations and associated institutions as well as committed clinicians and scientists.[5-7]

Conceptual approach

The conceptual approach for the development of the ICF Core Sets was derived from two perspectives: 1) the perspective of people who share the experience of the same condition (*e.g.* multiple sclerosis) or condition group (*e.g.* neurological conditions) and 2) the perspective of the health service context along the continuum of care and the life span.

ICF Core Sets for the acute hospital and (early) post-acute rehabilitation facilities

The *ICF Core Sets for the Acute Hospital* including the ICF Core Sets for neurological, cardiopulmonary and musculoskeletal conditions are intended for use by physicians, nurses, therapists and other health professionals not specialized in rehabilitation care provision.[7, 10] By contrast, the ICF Core Sets for (early) post-acute rehabilitation facilities including the ICF Core Sets for neurological, cardiopulmonary and musculoskeletal conditions as well as the ICF Core Set for geriatric patients are intended for use by physicians, nurses, therapists and other health professionals specialized in rehabilitation or geriatric care provision in the.[7, 10] The use of the term early indicates the early part of rehabilitation where patients have both, medical needs requiring hospital care and rehabilitation needs.

ICF Core Sets for Chronic Conditions

The ICF Core Sets for chronic conditions are intended for use in the community-oriented (late) phase of rehabilitation and the community.[5, 6, 9] For each chronic health condition, both a *Brief ICF Core Set* and a *Comprehensive ICF Core Set* have been developed. While the *ICF Core Sets* serve as practical tools for single encounters, minimum data sets for the reporting of clinical and epidemiological studies and health statistics, the *Comprehensive ICF Core Sets* are intended for use in multidisciplinary settings.

Generic ICF Core Set

While the condition and context-oriented ICF Core Sets are useful when classifying functioning for patients with specific health problems in specific health care situations, a parsimonious set of categories is needed to be able to assess and compare functioning across conditions and contextual factors. The *Generic ICF Core Set* is currently being developed in an iterative process involving a number of criteria and methodological approaches. A first study in this process examined the explanatory power of determined ICF categories in relation to external standards across the 12 chronic conditions for which condition-specific ICF Core Sets have already been developed.[61] The categories identified as candidate categories from this study are shown in Table II.

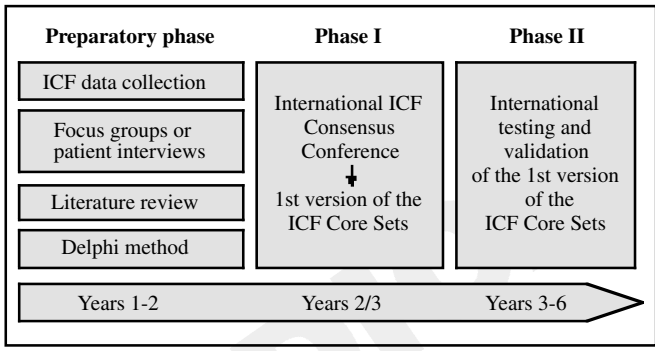


Figure 2.—Illustration of the process to develop ICF Core Sets.

Development process

While there are some singularities in the process of developing ICF Core Sets in relation to the context for which they are being developed, the development as illustrated in Figure 2 involves an international consensus process based on evidence gathered in a preparatory phase and an international testing and validation phase in the six WHO world regions (Africa, the Americas, the Eastern Mediterranean, Europe, South-East Asian, and the Western Pacific).[9]

The preparatory phase consist of: 1) an empirical data collection, based on the ICF, reflecting the perspective and the situation of the patient; 2) an expert survey using the Delphi method; 3) a systematic review on outcomes used in observational and experimental clinical studies, which also represents the view of experts. Additionally, for ICF Core Sets now in the preparatory phase 4) a qualitative study using focus group or patient interviews, representing the view of patients complement the methods. The results of the preparatory studies are presented at a consen-

TABLE III.—*Mapping of measurement instruments to the ICF.*

Context	Health condition	Reference	Measurements/Instruments
Early postacute context	Neurological conditions, musculoskeletal conditions, cardiopulmonary conditions, geriatric patients	2	Functional Independence Measure (FIM); Functional Assessment Measure (FAM); Barthel Index (BI)
Long term context	Obesity	64	Bariatric Analysis and Reporting Outcome System (BAROS); Bariatric Quality of Life Index (BQL); Lite, Impact of Weight on Quality of Life Questionnaire (IWQOL); LEWIN-TAG Questionnaire (LEWIN-TAG); Obesity Adjustment Survey-Short Form (OAS-SF); Obesity-Related Coping (OCQ); Obesity-Related Distress Questionnaire (ODQ); Obesity Eating Problems Scale (OE); Obesity-Related Problems Scale (OP); Obesity-Related Well-being Questionnaire (ORWELL); Short-Specific Quality of Life Scale (OSQOL); Obesity and Weight-Loss Quality of Life (OWL-QOL); Weight-Related Symptom Measure (WRSM)
	Osteoarthritis	65	Health Assessment Questionnaire (HAQ); Australian/Canadian Osteoarthritis Hand Index (AUSCAN); Cochin scale; Functional Index of Hand OA (FIHOA); Score for Assessment and Qualification of Chronic Rheumatoid Affections of the Hands questionnaire (SACRAH); Arthritis Impact Measurement 2 Short Form questionnaire (AIMS2-SF)
	Osteoarthritis	66	Western Ontario and McMaster Universities (WOMAC) and Lequesne-Algofunctional Indices
	Low back pain	67	North American Spine Society Lumbar Spine Outcome Assessment Instrument (NASS); Oswestry Low Back Disability Questionnaire (ODI); Roland-Morris Disability Questionnaire (RMQ)
	Osteoporosis	68	Quality of Life Questionnaire of the European Foundation for Osteoporosis (QUALEFFO-41); Osteoporosis Assessment Questionnaire (OPAQ 2.0); Osteoporosis Assessment Questionnaire Short Version (OPAQ-SV)
	Stroke	69	Stroke Impact Scale (SIS); Stroke-Specific Quality of Life Scale (SSQOL); Stroke and Aphasia Quality of Life Scale (SAQOL-39); Quality of Life Index - Stroke Version (QLI-SV); Stroke-Adapted Sickness Impact Profile-30 (SA-SIP30); Burden of Stroke Scale (BOSS); Quality of Life Instrument for Young Hemorrhagic Stroke Patients (HSQuale)
	Ankylosing spondylitis	70	Bath Ankylosing Functional Index (BASFI); Dougados Functional Index (DFI); Health Assessment Questionnaire modified for the spondylarthropathies (HAQ-S); Revised Leeds Disability Questionnaire (RLDQ)
	Chronic obstructive pulmonary diseases	71	St. George's Respiratory Questionnaire (SGRQ); Chronic Respiratory Questionnaire, Standardized Version (CRQ-SAS); Pulmonary Functional Status & Dyspnea Questionnaire, Modified Version (PFSDQM); Pulmonary Functional Status Scale (PFSS); Breathing Problems Questionnaire (BPQ); Seattle Obstructive Lung Disease Questionnaire (SOLDQ); Quality of Life for Respiratory Illness Questionnaire (QOLRIQ); Airway Questionnaires 20 (AQ20); London Chest Activity of Daily Living Scale (LCADL); Maugeri Foundation Respiratory Failure Questionnaire (MRF28); Clinical COPD Questionnaire (CCQ).
Generic	Different conditions	72	Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36); Nottingham Health Profile (NHP); Quality of Life Index (QLI); World Health Organization Quality of Life Scale (WHOQOL-BREF); World Health Organisation Disability Assessment Shedule II (WHODASII); European Quality of Life Instrument (EQ-5D)
	Different conditions	69	Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36); Reintegration to Normal Living Index (RNL); Sickness Impact Profile (SIP); European Quality of Life Instrument (EQ-5D); LHS London Handicap Scale (LHS); Nottingham Health Profile (NHP); Dartmouth COOP Charts (COOP); 15-Dimensional Measure of Health Related Quality of Life Test (15-D); Assessment of Life Habits (LIFE-H); Assessment of Quality of Life (AQoL); Craig Handicap Assessment and Reporting Technique (CHART); Health Utilities Index Mark II (HUI II); Health Status Questionnaire (HSQ); Lancashire Quality of Life Profile (LQLP); Quality of Life Index (QLI); World Health Organization Quality of Life Scale (WHOQOL)
Occupational context	Different conditions	73	Canadian Occupational Performance Measure (COPM); Assessment of Motor and Process Skills (AMPS); Sequential Occupational Dexterity Assessment (SODA); Jebsen Taylor Hand Function Test (JT-HF); Moberg Picking Up Test (MPUT); Button Test (Button); Functional Dexterity Test (FDT)

TABLE IV.—*Illustration of the linkage procedure [62, 63] with parts of a conversation recorded during a focus group interview. The information has been divided into meaning units, concepts have been identified within the meaning units and they have been linked to the ICF.*

ID	Transcription divided according to meaning units	Identified concepts	ICF categories
	Question by researcher: If you think about your body and mind, what does not work the way it is supposed to?		
2	— My nails break more. I used to have long, strong nails, but now they break easily. Also, my thumbnails split quickly.	— breaking nails — thumbnails split	b860 functions of nails B860 functions of nails
2	— My hands; they are not painful but I have no power. Things often drop.	— no power in hands — things drop	b7300 power of isolated muscles and muscle groups d440 fine hand use
1	— For the past couple of years I´ve noticed that my nails are not strong.	— nails are not strong	b860 functions of nail
3	— I have always had bad nails. That´s why I can´t judge whether they´ve become worse. But my hair has been falling out. Could be due to the medication. It´s hard to say. It´s awful.	— hair falling out due to medication	b850 functions of hair e1101 drugs
4	— I haven´t lost any hair, but I stopped dyeing it. I thought that, since I already have to take such strong medication, I should do without hair dye and let the natural color grow in again.	— stopping dyeing hair — strong medication (+) without hair loss	d5202 caring for hair e1101 drugs
	[….]		

sus conference. They represent the starting point for a structured decision-making and consensus process in which clinicians and health professionals, experts in the field for which the specific ICF Core Set is to be developed, participate. Finally, the ICF Core Sets are tested and validated in an international effort in a wide range of contexts.

Mapping the world of measures to the ICF

Applications

Since the ICF is the universal and standardized language to describe and report functioning and health, users need to be able to map the world of measures to the ICF. The qualitative mapping of measurement instruments to the ICF relies on *linkage rules*.[62, 63] The quantitative mapping relies on transformations using the Rasch model.[13]

Qualitative mapping is applied for the content comparison of measurement instruments e.g. when studying their comparative content validity. The ICF-based comparison of measurement instruments can therefore assist researchers and clinicians to identify and select a most suited measurement instrument for a specified purpose. ICF-based comparisons also enable researchers to ensure that all ICF categories of a suitable ICF Core Set are covered by candidate measurement instruments. Table III lists studies which have compared most widely used measurement instruments for specified health conditions as well as a comparison of generic health status measures.

Qualitative in combination with quantitative mapping is used for the identification of items addressing the construct covered by a specified ICF category and the construction of Rasch scales to estimate the level of functioning for this category. As we will describe in more detail in the paragraph following this involves the identification of items from measurement instruments which address the construct of a specified ICF category within their scope. Another example of qualitative combined with quantitative mapping is the transformation of information from electronic records.[74]

Linkage methodology

The linking methodology consists of two main steps. The first step refers to the identification of concepts within the health-related information to be translated to the ICF. The second step refers to linking those concepts to the ICF.

STEP ONE, IDENTIFICATION OF CONCEPTS

The fist step, the identification of concepts, varies slightly depending on the origin of the information that is to be translated. In health-status questionnaires, the concepts refer to the different contents addressed in each of its items. A single item may contain more than one concept. For example, item 8 of the SF-36 "During the past four weeks, how much did pain interfere with your normal work (including both work outside the home and housework)" contains three different concepts "pain", "work outside the home", and "housework".[62]

In *qualitative data* collection with open-ended questions in focus groups, patient interviews or e-mail surveys, the process of identification of concepts is similar to the process followed with questionnaires. However, while in questionnaires the concepts are identified within items, in qualitative data the concepts are identified within 'meaning units'. A meaning unit is defined as a specific unit of text of either a few words or a few sentences with a common theme.[75] A meaning unit division does not follow linguistic grammatical rules. Rather, the text is divided wherever the researcher discerns a shift in meaning.[76] Table IV presents an example of meaning units identified in an extract of the information collected in a focus group.[77]

When linking *clinical assessments*, concepts refer to the aims with which a clinical assessment was performed. For example, when pulse rate is assessed to measure "exercise tolerance", this aim is considered the meaningful concept of the clinical assessment "heart rate". However, when pulse rate is assessed to measure "heart rate" and "heart rhythm" these two aims are considered the meaningful concepts addressed in the same clinical assessment "heart rate".

STEP TWO, LINKING OF CONCEPTS TO THE ICF

When linking *clinical interventions*, the concepts also refer to the aims with which an intervention was applied. For example, nurses mobilize their patients with different aims, for example, "mobility improvement" or "prevention of skin ulcer". Thus, "mobility improvement" or "prevention of skin ulcer" is identified as concept for the intervention "mobilization" depending on the aim with which the intervention was performed.

After the concepts have been identified, the second step involves the linking of those concepts to the ICF according to ten rules. The most relevant and obvious rule states that concepts must be linked to the ICF category or categories which most precisely represent them. An example of the linkage of concepts to the ICF is shown in Table IV.

TABLE V.—*ICF qualifier with percentage values provided by the WHO.*

ICF Qualifier*	Percentage of problem
0-NO problem (none, absent, negligible)	0-4%
1-MILD problem (slight, low)	5-24%
2-MODERATE problem (medium, fair)	25-49%
3-SEVERE problem (high, extreme)	50-95%
4-COMPLETE problem (total)	96-100%

* "Having a problem may mean an impairment, a limitation, a restriction or a barrier, depending on the construct", *i.e.* depending on whether we are classifying body functions and structures (impairments), activity and participation (limitations or restrictions) or environmental factors (barriers or facilitators).

Both steps of the linking methodology should always be performed by two trained health professionals independently of each other. Thus, after the second step, two independent results of the linking process exist. These results are compared. The reliability of the linking process is evaluated by calculating coefficients [78] and nonparametric bootstrapped confidence intervals [79, 80] based on the two independent linking results in order to indicate the degree of agreement between the two health professionals. Disagreement regarding the ICF categories selected during the linking process is resolved by structured discussion and an informed decision by a third expert. The result of applying the linking methodology is a list of ICF categories that is equivalent in content to the original health-related information.

ICF-based measurement of functioning

Measuring a single ICF category

In principle, there are two approaches to measure a specified ICF category, *i.e.* to quantify the extent of variation therein. The first is to use the *ICF qualifier* as a rating scale ranging from 0-4 (Table V). The second is to use information obtained with a clinical test or a patient-oriented instrument and to transform this information into the ICF qualifier.

DIRECT CODING OF THE ICF QUALIFIER

With this approach a physician or health professional integrates all accessible and suitable informa-

tion from the patient's history, clinical and technical exams to *code* a specified category according to established coding guidelines.[81] To ensure quality in a specific setting, it is advisable to regularly assess the reliability of coding.[82] Figure 3 shows a simple and informative graphical approach to assess the inter-observer reliability of *ICF qualifier codes*.[82] The rating of certain ICF categories may be facilitated by complementary instructions provided in addition to the descriptions of the ICF categories as provided in the ICF reference material. Table VI shows an additional instruction developed by the American Psychological Association (2007) [83] for the ICF category b130 Energy and drive functions for which the original description in the ICF reference material is shown in Table V. Similar instructions have been developed by the American Psychological Association for a large number of ICF categories.[83]

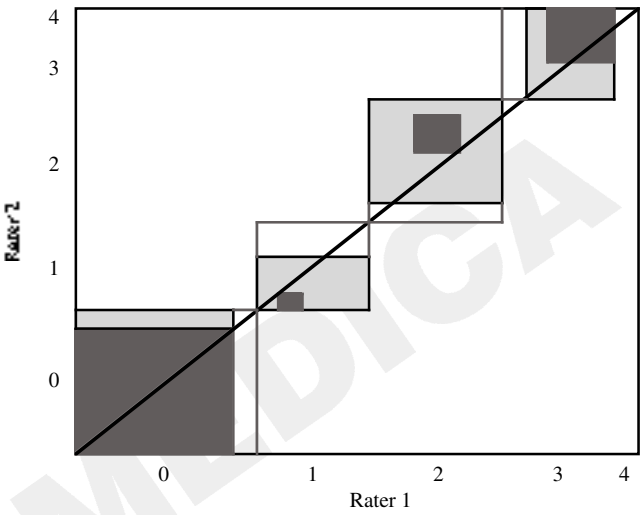


Figure 3.—Bangdiwala observer agreement chart for ICF-category d430 [82]. The chart is a square whose edges are determined by sample size. The edges of the black squares show the number of patients who got identical ratings from both observers. The large bright rectangle shows the maximum possible agreement, given the marginal totals. Partial agreement is showed by including a weighted contribution from off-diagonal cells, here represented by hatching. One observer's ratings would differ systematically from the other observer's ratings if all black squares were above or below the diagonal.

Transformation of information obtained with a clinical test or a patient-oriented instrument

With the second approach, the ICF Qualifier serves as a reference scale. The results from a clinical test or a patient-oriented measurement instrument are transformed into the ICF qualifier.

For many ICF categories there are suitable *clinical tests* which include standardized expert and technical examinations or *patient-oriented measurement instruments* which include patient and proxy-reported, self-administered or interview-administered questionnaires which are routinely used in clinical practice or for research purposes. In this case, information already available can be transformed to report the results in the standard language of the ICF.

Since the ICF qualifier is a rating scale for which WHO has provided percentage values as a reference (Table V), transformation to the ICF qualifier is straightforward in the case of interval-scaled clinical tests or patient-oriented instruments, which comprehensively and uniquely cover the content of a respective ICF category. For example, the visual analog scale (VAS) to assess pain can be used to address the ICF category b280 Sensation of pain. The values of VAS-Pain can be transformed into an ICF qualifier since it represents a 100 millimeter (mm) interval scale marked as "no pain" at one end and as "worst pain" at the other.[84] Considering the percentage values of the ICF qualifier in Table V, a person marking a level of pain between 0 (zero) and 4 mm would receive the qualifier 0 in the ICF category *b280 Sensation of pain* between 5 and 24 mm the qualifier 1, between 25 and 49 mm the qualifier 2, between 50 and 95 mm the qualifier 3, and between 96 and 100 mm the qualifier 4.

In the case where there are no readily available clinical tests or patient-oriented instruments with interval-scale properties that can be used to assess a specified ICF category one may consider the construction of an *ICF category interval scale* using parts of clinical test batteries or selected items of patient-oriented measurement instruments that cover a specified ICF category. Figure 1 illustrates the construction of an interval reference scale using the Rasch model to estimate the level of functioning for *b130 energy and drive functions*.[13] Sixteen of the 19 items linked from three instruments did fit the Rasch model and could be integrated in an ICF category interval scale. Based on this principle, clinicians can estimate the level of *b130 energy and drive functions* by adding the responses to the 16 items. In clinical practice, one would obviously need only a subset of possibly 5 items to reliably estimate the level of functioning in *b130 energy and drive functions*. Alternatively one

TABLE VI.—*Additional instructions for ICF categories illustrated with the example b130 Energy and drive functions.*[13]

b130: Energy and drive functions
General mental functions of physiological and psychological mechanisms that cause the individual to move towards satisfying specific needs and general goals in a persistent manner.
Inclusions: functions of energy level, motivation, appetite, craving (including craving for substances that can be abused), and impulse control.
Exclusions: consciousness functions (b110); temperament and personality functions (b126); sleep functions (b134); psychomotor functions (b147); emotional functions (b152).

Additional Information
This code includes general behavioral tendencies including Energy level b1300 and Motivation b1301 to move toward goals. It also includes the constructs of Appetite b1302 and Craving b1303, which may be general tendencies or relate to specific substances or behaviors (e.g., psychoactive substances, food, gambling). In addition, this code includes Impulse control b1304, which may refer to impulses in general or relate to more specific impulses to engage in particular behaviors. This code and its subcodes should be used only to refer to characteristics or behaviors that are consistent or occur frequently over time, not to single behaviors or transitory states.
These codes may be useful in a variety of settings. Motivation, craving, and impulse control are often a part of motivational assessment in relation to substance abuse treatment or other treatments that have the goal of reducing, avoiding, or abstaining from particular behaviors (e.g., substance use, overeating, gambling). In such cases, impairments related to these factors may be a part of the disorder. Energy level and motivation may also be important in cases of CNS injury or disease (*e.g.*, stroke), where concerns related to "lack of initiation" or "mental fatigue" may be present, and in patients with psychological disorders such as depression and bipolar disorder. Impairments in impulse control are by definition a part of substance abuse and impulse-control disorders, and may also be a central part of a variety of other psychological disorders including attention deficit hyperactivity disorder, conduct disorder, and bipolar disorder.
Generally, Energy level b1300 and Motivation b1301 should be reserved for cases in which abnormal levels or significant changes in energy level and motivation occur as a direct result of a disorder, disease process, or injury, or as an effect of treatment (e.g., decreased energy level is a side effect of some medications).
Motivation is considered to be particularly important in relation to the success of treatment for many health conditions. However, caution should be exercised in assigning this code. Body functions are meant to be coded with the ICF to the extent that impairments are attributable to a health condition or health-related state, which will not be the to the extent that high or low motivation is a general personality characteristic of the individual. This is not to say that it will not be highly relevant to treatment, only that it would correspond more closely in this case to what the ICF identifies as Personal Factors rather than to Body Functions. In addition, Motivation b1301 should not be used to describe an individual's motivation to comply with a specific treatment, such as physical therapy in rehabilitation programs. Finally, lack of motivation may be used by health care personnel or others in the patient's social environment as a pejorative explanation for a patient's lack of progress in treatment, one that attributes the problem to the patient. It is important not to attribute lack of motivation to patients who are physically or mentally unable to perform particular tasks or actions or who are not receiving the most appropriate treatments to help them progress.

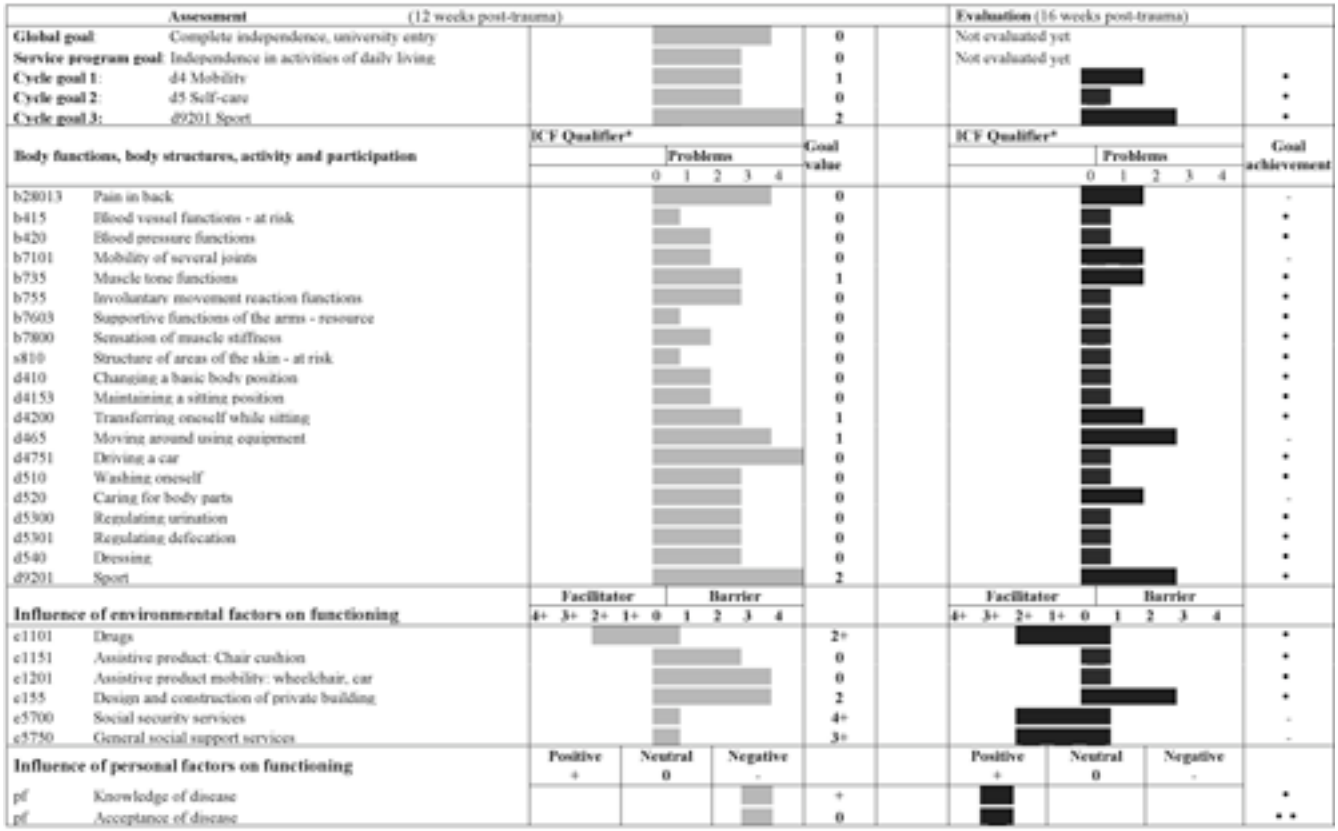
Case examples
Following a stroke, a 67-year-old woman has difficulty selecting or getting started on projects, and often complains of feeling "too tired" and "mentally worn out."
A 45-year-old man with an alcohol abuse disorder refuses all attempts at treatment, indicating that although he recognizes the negative consequences of substance use in his life, he is not willing to stop drinking.

Other codes within this section
— b1300: Energy level
— b1301: Motivation
— b1302: Appetite
— b1303: Craving
— b1304: Impulse control
— b1308: Energy and drive functions, other specified
— b1309: Energy and drive functions, unspecified

may increase efficiency by using computer adaptative testing (CAT). Whatever method is used, the obtained raw scores can then be transformed into the ICF qualifier which serves as a reference scale.

A major advantage of the second approach is that the original format of the items used to construct the *ICF category interval scale* remains unchanged. Thus, it is possible to use the information provided by items within the context of their original instruments and, at the same time, within the context of the ICF. This application can be extremely useful, given the increasing use of the ICF and the ICF qualifier as references when documenting and reporting functioning and disability.[85, 86]

TABLE VII.—*ICF-based assessment and evaluation including goal setting and goal achievement in a patient after Spinal Cord Injury. The functioning states at the start of rehabilitation and after 4 weeks are shown as categorical profiles based on expert ratings of the ICF qualifier.*



*ICF Qualifier range from 0=no problem to 4=complete problem in the components of body functions (b), body structures (s), activity and participation (d) and from -4=complete barrier to +4=complete facilitator in the environmental factors. In personal factors, the signs + and - indicate to what extent a determined personal factor has a positive or negative influence on the individual's functioning.

Measuring across ICF Categories

Self-reported ICF-based measurement instruments

Based on the ICF, WHO has developed the WHO Disability Assessment Schedule Version II (WHODAS II),[87, 88] a generic self-administered questionnaire used in adults >18 yrs of age which covers the ICF components activity and participation. It includes six domains: understanding and *communicating getting around, self care, getting along with others, house - hold and work activities, and participation in soci - ety*. It has been developed cross-culturally and is applicable across the spectrum of cultural and educational backgrounds. In addition to self-report, an interviewer and proxy version is available. The time to complete the questionnaire for the 12-item version is approximately 5 minutes and for the 36-item version is 20 minutes.

The first study applying the WHODAS II in rehabilitation using a German version found that it is a useful instrument for measuring functioning and disability in patients with musculoskeletal diseases, internal diseases, stroke, breast cancer and depressive disorder.[88] The results of this study also support the reliability, validity, dimensionality, and responsiveness of the WHODAS II. However, for the domain household and work activities, a clear distinction between *work activities* vs *household activities* was apparent in musculoskeletal and internal conditions.[88] Therefore,

one may in the future consider the separate scoring and reporting of these sub-domains.

For specific conditions and/or settings one may want to use a specific measurement instrument. A suitable starting point for the development for such measurement instruments are the ICF Core Sets. The ICF Research Branch of the WHO FIC CC Germany at the University of Munich is thus cooperating with and supporting research groups in the process to develop self-reported questionnaires based on the *ICF Core Sets*.[60]

ICF based clinical measurement instruments

Clinician's ratings of the *ICF Qualifier* (Table V) across a number of ICF categories, *e.g.* across the categories of an *ICF Core Set*, can be reported in the form of a categorical profile. A categorical profile across a valid set of ICF categories such as an *ICF Core Set* provides an estimation of a persons *functioning state*. The *functioning state* is the central information for clinicians when planning and reporting the results of a health care intervention. Table VII shows the example of *functioning states* at the start and the end of a rehabilitation program.

The aggregation of information obtained from a *categorical profile* using the Rasch model results in a summary score.[11, 59] In the case of aggregation of information across a valid set of categories such an *ICF Core Set*, the summary score provides an estimation of a persons *functioning status*. If using an electronic clinical chart, the creation of a score from a categorical profile created based on an ICF Core Set does not require additional work. *Functioning status information* provides clinicians with an intuitive, overall understanding of a patient's general level of functioning. It can be used by clinicians, service program providers and payers *e.g.* for the assignment of patients to suitable rehabilitation service programs, to monitor and manage persons functioning along the continuum of care and across service program providers, to evaluate service programs, to predict resources and hence costs and to derive payment schemes.

The principle of how to develop one- or multi-dimensional Clinical Measurement Instruments based on clinicians ratings of ICF Core Sets has been recently demonstrated.[11, 59] It could also be demonstrated how to apply such scores across countries by adjusting for differential item function. It is thus possible to compare functioning status information across countries and world regions.

Conclusions

In this paper we could show that the ICF categories can serve as building blocks for the measurement of functioning and more specifically for the development of ICF-based practical tools and international standards such as the ICF Core Sets as well as for the development of clinical and self-reported measurement instruments. We could also show how the ICF can serve as reference standard by mapping the world of measures to the ICF and vice versa including the quantitative transformation of the information obtained with a clinical test or a patient-oriented instrument into the ICF.

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