J Rehabil Med 2011; 43: 81–180

THE TESTING AND VALIDATION OF THE ICF CORE SETS FOR THE ACUTE HOSPITAL AND POST-ACUTE REHABILITATION FACILITIES – TOWARDS BRIEF VERSIONS

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 doi: 10.2340/16501977-0668
 ISSN 1650-1977

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J Rehabil Med 2011; 43: 85–86

FOREWORD

With the International Classification of Functioning, Disability and Health (ICF) the framework for the classification of functioning has been set by the World Health Organization (WHO) (1). The ICF arguably serves as a reference classification on all levels, including practice (interaction on the micro-level), service provision (meso-level) and healthcare planning (macro-level). Clinically, it can help to measure the changes brought by interventions across a multitude of dimensions, from body functions to personal activities, societal participation and environmental factors. It also provides the potential framework for transition along the continuum of care.

A classification must be exhaustive by its very nature and becomes very complex in daily use unless it is transformed into practice-friendly tools (2). Comprising over 1400 categories, the entire volume of the ICF cannot be applied by the clinicians to all their patients. In daily practice clinicians will need only a fraction of the categories found in the ICF. Although there are generic instruments based on the ICF that are designed as practical translations of the ICF and are usable across a wide range of applications, the generic character may be a drawback in specific settings. Thus, in this trade-off between generalizability and the need to capture the detail, the ICF must be adapted to the perspectives and needs of different users. The need to tailor ICF to the needs of particular contexts is the primary motivation behind the ICF Core Set project, which aims to extract selections of ICF categories from the entire classification that are relevant to specific health conditions or care situations. This on-going project of selection of the so-called ICF Core Sets will define common standards for what should properly be measured and reported (3).

Comprehensive ICF Core Sets for the acute hospital and for early post-acute rehabilitation facilities were developed for patients with neurological (4, 5), cardiopulmonary (6, 7) and musculoskeletal conditions (8, 9) and for aged patients (10). Thanks to the consensus process, the ICF Core Sets for the acute hospital and early post-acute rehabilitation facilities in their present version are comprehensive, with applicability for the assessment of individual problems and needs. As such, they permit the estimation of prognosis and the potential for rehabilitation, with general applicability for assessment of functioning in any rehabilitation situation. However, a minimally sufficient data set, which is feasible for use in clinical practice, may encompass only 20 different concepts or topics, but not much more, as contained in the comprehensive ICF Core Sets. Thus, subsets can be extracted from the comprehensive Core Sets, according to the specific needs of the individual user.

This issue of the *Journal of Rehabilitation Medicine* sets out to examine the comprehensive acute and post-acute ICF Core Sets along those lines. The first article proposes the methods used for an empirical validation of ICF Core Sets and the selection of candidate categories for briefer ICF Core Sets out of the comprehensive sets (11). The 3 following articles deal with empirical testing of the comprehensive ICF Core Sets for patients in the acute hospital and in early post-acute rehabilitation facilities, namely by examining the respective ICF categories according to their prevalence and sensitivity for change (12–14). The validation is supplemented by 3 articles about patient goals, indicating the usefulness of the comprehensive ICF Core Sets to recognize patients' needs and rehabilitation goals in the acute and early post-acute situation (15–17). The next 3 articles employ the proposed methods for identifying candidate categories for ICF Core Sets out of the comprehensive acute and post-acute ICF Core Sets for the reporting and measurement of functioning in patients in the acute hospital and early post-acute rehabilitation facilities (18–20). Statistical selection yielded between 22 and 29 categories of the functioning component of the ICF qualifying as candidates. Last, but not least, there are two articles from our colleagues from the University Hospital of Zurich, Switzerland, who describe the practical application of ICF Core Sets in the acute hospital (21) and the reliability of categories when operationalized by physiotherapists (22). This is the first time that the implementation of ICF Core Sets by health professionals is described in detail. Appendix I (p. 180–182) gives an overview of all ICF Core Sets for the acute and early-post-acute situation, their validation and testing.

The result of this identification process is by no means exhaustive; those categories have to be seen as practical tools to encourage and facilitate assessment of functioning across the continuum of care. The ICF is emerging as the standard for describing patients' functioning in both rehabilitation care provision and research. The International Society of Physical and Rehabilitation Medicine (ISPRM) has endorsed the ICF and has adopted the ICF Core Sets as assessment tools for Physical Medicine and Rehabilitation (23). Preliminary experiences with the ICF Core Sets have shown that the practical implementation of the ICF contributes to an increased recognition of patients' needs and improved care provision, thus contributing to the quality of rehabilitation care in the acute hospital and in early post-acute rehabilitation facilities.

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J Rehabil Med 2011; 43: 87–91

ORIGINAL REPORT

CRITERIA FOR VALIDATING COMPREHENSIVE ICF CORE SETS AND DEVELOPING BRIEF ICF CORE SET VERSIONS

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Objective: **To describe the empirical processes used to (*i*) validate the comprehensive International Classification of Functioning, Disability and Health (ICF) Core Sets, and (*ii*) develop brief ICF Core Sets from the ICF Categories of these more comprehensive ICF Core Sets.**

Design: **Prospective multi-centre cohort study.**

Patients: **Patients receiving rehabilitation interventions for musculoskeletal, neurological or cardiopulmonary injury or disease in acute hospitals or early post-acute rehabilitation facilities.**

Methods: **Functioning was coded using the ICF. For validation, absolute and relative frequencies (prevalences) of impairment, limitation or restriction were reported at admission and end-point (discharge or 6 weeks after admission). Aspects not covered were extracted and translated into the best corresponding ICF category. The criterion for selecting candidate categories for the brief ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, the independent variables being all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables.**

Conclusion: **We present an algorithm to identify candidate categories for brief ICF Core Sets extracted from the comprehensive acute and post-acute ICF Core Sets.**

Key words: ICF; rehabilitation; health status measurements; classification; regression analysis; outcome assessment.

J Rehabil Med 2011; 43: 87–91

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Submitted May 24, 2010; accepted August 19, 2010

INTRODUCTION

Human functioning and its converse notion disability are universal experiences, which must be understood in the context of an individual's personal resources, particular health conditions and expectations, and in interaction with the environment (1). Transient or permanent disability may arise from any acute injury or disease, interfering in the individual's engagement in normal function. Indeed, the World Health Assembly in its resolution on disability, its prevention, management and rehabilitation, has called for the timely identification of disability in the clinical setting (2). Consequently, obtaining the means for objective measurement of functioning is a necessary first step towards recognizing and ameliorating the course of disability following acute illness. As Lord Kelvin said in his defence of empiricism, "when you can measure what you are speaking about, … you know something about it; but when you cannot measure it, … your knowledge is of a meagre and unsatisfactory kind" (3). This principle drawn from the physical sciences generalizes to the case of disability, the understanding and management of which requires the use of appropriate measuring scales or instruments (4).

Healthcare professionals in the acute hospital should be able to make a brief assessment of their patients' functioning, and set in motion timely strategies for meeting their subsequent rehabilitation needs. Care providers have first to identify especially vulnerable patients, such as the aged, or those with co-morbidity. In order to communicate their patients' particular needs with rehabilitation professionals, there must be a standard system of describing human functioning and rating disability. In situations entailing post-acute and long-term rehabilitation, professionals specialized in rehabilitation management should share this understanding of functioning, and utilize clinical assessment instruments that are based on a standard model of functioning. While a multitude of measuring instruments has been used in post-acute rehabilitation settings, typical instruments vary with respect to their underlying models and scales, and are tailored for specific populations. Accordingly, the methods differ in their sensitivity to discover incremental gains in recovery of functioning (5). Thus, there is urgent need for implementing improved and standardized outcome measurement in rehabilitation (6).

The International Classification of Functioning, Disability and Health (ICF), a part of the international family of classifications of the World Health Organization (WHO), was established as just such an approach to standardizing the assessment of functioning of individuals and populations. The ICF endeavours to organize all domains of functioning and

their contextual factors that are encountered in human life, and may thus arguably constitute the prototypical framework for all medicine. It also provides the potential framework for transition along the continuum of care. For example, assessment of functioning in acute care cannot be carried over to other episodes of care, such as rehabilitation, unless there is a common assessment scheme. An assessment must be exhaustive by its very nature and becomes very complex in daily use unless it is transformed into practice-friendly tools. Comprising over 1400 categories, the entire volume of the ICF cannot be applied by the clinicians to all their patients. In daily practice clinicians will need only a fraction of the categories found in the ICF. Although there are generic instruments based on the ICF that are designed as practical translations of the ICF and are usable across a wide range of applications, the generic character may be a drawback in specific settings. Thus, in this trade-off between generalizability and the need to capture detail, the ICF must be adapted to the perspectives and needs of different users. The need to tailor ICF to the needs of particular contexts is the primary motivation behind the ICF Core Set project, which aims to extract selections of ICF categories from the entire classification that are relevant to specific health conditions or care situations.

In general, the ICF Core Set project defines on an empirical basis a category as relevant if it describes a problem frequently encountered in typical patients, measures an end-point in clinical trials, or emerges as relevant in discussion among health professionals. The resultant information is then summarized and implemented as the basis for a formalized consensus process involving expert health professionals (7). By including all potentially relevant categories, the selection process is comprehensive, omitting only those factors that proved to be irrelevant to designing treatment strategy or assessing outcome. Early feedback from health professionals suggested that the definition of ICF Core Sets was a step in the right direction towards establishing evidence-based measurement in rehabilitation. Due to the consensus process, the comprehensive ICF Core Sets in their present version are applicable for the assessment of individual problems and needs, and for the estimation of prognosis and the potential for rehabilitation, and for assessment of functioning in the acute and post-acute situation. As such, the comprehensive ICF Core Sets can be used to coordinate rehabilitation interventions, e.g. at the intensive care unit, or to communicate, e.g. in a rehabilitation team conference. However, a minimally sufficient data-set that is feasible in clinical practice may encompass only 20 different concepts or topics, but not much more as contained in the comprehensive ICF Core Sets. Thus, subsets can be extracted from the comprehensive Core Sets according to specific needs of the individual user.

In order to identify abbreviated ICF Core Sets, i.e. brief ICF Core Sets, suited for use in particular contexts, one must possess an adequate understanding of the methodological framework used for creating measures. The Outcome Measures in Rheumatology project identifies 3 different properties relevant to the applicability of measures, namely truth, discrimination and feasibility (8). The criterion *truth* refers to the question of what should be measured. As noted above, the process for the development of comprehensive ICF Core Sets assured that all the relevant aspects of functioning were included, but the empirical validation of the choice of categories remains to be completed. The criterion *discrimination* refers to the ability of a measure to discriminate between different states of functioning or medical conditions. A discriminating measure must enable the distinguishing between different patient groups in a cross-sectional manner, and assess change in functioning over time. Finally, the term *feasibility* is satisfied when a measure can, in practical terms, be applied by health professionals, given circumstances of restricted time and resources. Given this consideration, we settled on defining practical and applicable brief ICF Core Sets with no more than 20 items or ICF categories. Setting this upper limit was based on the precedent of generic health status measures, e.g. the SF-12 (9) with 12 items, or the Stanford Health Assessment Questionnaire (10) with 20 items. The categories must be selected with care, so as to remain representative of the comprehensive ICF Core Sets.

Therefore, to satisfy the criteria truth, discrimination and feasibility for these comprehensive and brief ICF Core Sets, we make a point of validating the comprehensive ICF Core Sets and identifying candidate categories for practical and applicable subsets, the brief ICF Core Sets.

The first objective of the present study was to describe the empirical process used for validating the comprehensive ICF Core Sets. A further objective of this study was to propose general methods for identifying candidate categories for brief ICF Core Sets, selected from the comprehensive acute and post-acute ICF Core Sets.

METHODS

Study design and population

The study design was a prospective multi-centre cohort study conducted from May 2005 to August 2008. The study population was recruited from 5 acute hospitals and 9 early post-acute rehabilitation facilities, including 5 facilities specialized in geriatric rehabilitation (Appendix I). Patients were eligible if they were at least 18 years of age and received rehabilitation interventions for musculoskeletal, neurological or cardiopulmonary injury or disease. On the basis of these inclusion criteria, participants were selected consecutively by the study centre coordinators. Informed consent was obtained from the patients or from the patient's care giver in cases where the patient was unable to make an informed decision. Approval was obtained from institutional ethics committees from all involved institutions prior to starting the study.

Measures

ICF Core Sets. The ICF is a multipurpose classification belonging to the WHO family of international classifications. The ICF provides a comprehensive framework for quantifying and depicting functioning, health and health-related domains (11), and was designed to facilitate communication between different users, including healthcare workers, researchers, policymakers and the public. The classification is organized in a hierarchical structure consisting of two main parts, each with separate components. The first part encompasses functioning and disability with 3 components: "Body Functions" (coded b) and "Body Structures" (s), and "Activities and Participation" (d). The second part of ICF covers contextual factors, and has two components: "Environmental Factors" (e) and "Personal Factors" (not coded). The

ICF categories of each component, with exception of the "Personal Factors", which are not yet classified, have a further hierarchical taxonomy, with as many as 4 levels, divided into dimensions and chapters. The hierarchical code system is represented as an abbreviation of the component, with an extension for the chapter number (e.g. b2 Sensory functions and pain), and further extensions for the second (e.g. b210 Seeing functions), third (e.g. b2100 Visual acuity functions) and fourth levels (e.g. b21000 Binocular acuity of distant vision).

We have developed the comprehensive ICF Core Sets in order to facilitate and encourage the use of the ICF in clinical practice and research. The comprehensive ICF Core Sets are selections from the entire list of ICF categories, which emerged from a multi-stage consensus process seeking to identify those aspects of functioning most relevant for patients in specific settings or with specific health conditions. The consensus approach integrated evidence from empirical studies and input from experts. In particular, a consortium consisting of the ICF Research Branch of the WHO Collaborating Center of the Family of International Classifications (Deutsches Institut für Medizinische Klassifikation und Information, DIMDI, Germany) at the University of Munich, Germany, the Classifications, Assessments and Survey Team and its partner organizations, developed 6 comprehensive ICF Core Sets for patients with neurological, cardiopulmonary and musculoskeletal conditions in the acute and post-acute situation, and one comprehensive ICF Core Set for aged patients (12–18).

For scoring of the Core Sets, the ICF suggests using qualifiers ranging from 0 to 4 for each category. Because the properties of all qualifiers are not yet sufficiently evaluated, in the present study we used a simplified qualifier, defined as follows. Each category of the components Body Functions and Activities and Participation was graded with the qualifiers 0 for "no impairment/limitation", 1 for "moderate impairment/limitation", and 2 for "severe impairment/limitation". The categories of the component Body Structures were graded with the qualifiers 0 for "no impairment" and 1 for "impairment". The categories of the component Environmental Factors were graded either as facilitator or barrier, or both, with 0 for "no barrier/facilitator" and 1 for "barrier/facilitator". Impairments of body functions or structures, and limitations or restrictions of activities and participation were recorded if they were directly associated with the condition necessitating rehabilitation. In order to investigate the completeness of the comprehensive ICF Core Sets, the interviewers were asked to identify any aspects of functioning relevant to their patients not covered by the comprehensive ICF Core Sets.

Visual analogue scale for functioning. To describe an overall view of functioning, the patients were asked to appraise their personal limitations in overall functioning at the using a horizontal visual analogue scale, ranging from 0, for complete limitation in all aspects of functioning to 10, for no limitation in functioning. "Overall functioning" was defined as encompassing all aspects of physical or mental state, of daily living, mobility and interaction with the environment and with others. Patients were asked to relate to their current health condition and their present state. Independently, and blinded to the patients' responses, the health professionals were asked to appraise their patients' functioning on the same analogue scale, also for the current health condition and the present state.

Data collection procedures

Patients were recruited and interviewed by health professionals trained in the application and principles of the ICF. Interviewers were trained during a structured one-day meeting, and were provided with a comprehensive manual. Ongoing supervision of interviewers was ensured by periodic telephone calls between each interviewer and the responsible member of their research team. Data were collected primarily from patients' medical record sheets, by interview with health professionals in charge of the patients, and by patient interviews. ICF Core Set categories from the components Body Functions, Body Structures and Activities and Participation were assessed within the first 24 h after admission (baseline) and within the last 36 h before discharge or, if length of stay was longer than 6 weeks, at 6 weeks after admission (end-point). ICF categories from the component Environmental Factors were assessed only at baseline, since no change was to be expected during the hospital stay. The incoming case record forms were checked for conspicuous errors by a member of the research team before being entered in the database, with consultation of the responsible interviewer as required to resolve discrepancies.

Statistical analysis

Validation of the comprehensive ICF Core Sets. For the categories of the ICF components Body Functions, Body Structures and Activities and Participation, we calculated the absolute and relative frequencies (prevalences) of impairment, limitation or restriction at baseline and end-point. For the categories of the ICF component Environmental factors, we calculated the absolute and relative frequencies (prevalences) of persons who regarded a specific category as constituting either a barrier or facilitator. Relative frequencies of persons for whom the ICF category changed during the study period were calculated, along with their 95% confidence intervals.

Aspects of functioning not covered by the comprehensive ICF Core Sets but identified as relevant were extracted and translated into the best corresponding ICF category (19). Absolute and relative frequencies of occurrence of those ICF categories were reported; any such category with prevalence below 5% and not showing significant change over time was considered as not relevant. Significance was evaluated using binomial tests, with significance level set at 0.05. Because of the exploratory nature of the test procedure, we refrained from correcting for multiple testing.

Decision rules for candidate categories for ICF Core Sets. The criterion for selecting candidate categories for the ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, in which the independent variables were all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables. To improve prediction accuracy, and to derive small subsets of independent variables having the strongest effects on the dependent variable, we used the least absolute shrinkage and selection operator (LASSO) (20). This procedure minimizes the residual sum of squared errors with a bound on the sum of the absolute values of the coefficients. To avoid large variance, as often occurs in ordinary least square regression, the LASSO sets some regression coefficients to zero and shrinks others based on a pre-set regularization parameter, the so-called penalty. Thus, the method acts recursively to select valid subsets with adequate discrimination. The number of variables, i.e. ICF categories, included in the subsets can be increased or decreased by changing the penalty. It can be interpreted that those categories included in the model with a high penalty value have stronger effects than those entering later in the process, when the penalty is relaxed.

To validate the approach for selection of ICF Core Sets described above, we additionally used the Random Forest algorithm, which is based on Classification and Regression Trees (CART) non-parametric regression techniques. CART divides a population into several subpopulations depending on certain characteristics defined by successive binary splits in predictor variables. Successive subpopulations emerge as homogenous as possible with regard to the outcome variable, in the case the overall functioning as reported by patients and health professionals. Of the many different ways to construct CART, we employed the technique proposed by Breiman (21) and Breiman et al. (22).

A brief description of the CART procedure follows. All predictor variables are considered for possible splits, with selection of that split leading to the teo most homogenous subgroups with regard to the outcome. The data-set is then partitioned according to the predictor variable that yields the most homogenous subgroups with regard to the outcome by using a single binary split. After initial partitioning, the subsets are considered for re-partitioning based on the remaining

predictor variables applied in random sequence. This algorithm is repeated until a pre-set stop criterion is reached. The recursive partitioning strategy results in a tree, wherein the root is the whole dataset, and the leaves are the final subsets, which are as selected so as to be as homogenous as possible with regard to the dependent outcome variable. Using the Random Forest algorithm, 10,000 different trees were then calculated, for each of which *n* cases were randomly drawn by replacement, where *n* equalled the original sample size of patients. Observations that were not used in the fitting process of each tree were then used to validate the same tree. Thus, we calculated for each predictor variable two mean square errors: one for the original values, and a second after randomly permuting each predictor variable. The first mean square error estimate stands for the population value with the observed association to the outcome, the second estimate from the random permutation stands for a population wherein predictor and outcome are only randomly associated. The difference of these two mean square errors yields the so-called variable importance measure. The optimization is based on the expectation that the random permutation of an informative predictor variable, i.e. a predictor variable associated with the outcome should highly increase the mean square error, while random permutation of a non-informative predictor variable should have little effect on the mean square error. The difference of the two mean square errors can thus be interpreted as having variable importance, such that greater difference indicates greater importance of the variable in determining the outcome.

All data analyses were carried out with R 2.9.0 (23).

DISCUSSION

In this report we have described the empirical and theoretical process used to validate the comprehensive ICF Core Sets for the acute hospital and for post-acute rehabilitation and by extension propose a selection method for defining candidate categories for brief ICF Core Sets. The development of comprehensive ICF Core Sets has become highly standardized and straightforward. Thus, it is timely and appropriate to develop an equally standardized algorithm for their empirical validation and for the selection of briefer ICF Core Sets. Three criteria were applied to the comprehensive ICF Core Set categories, namely truth, discrimination and feasibility.

To validate the comprehensive ICF Core Sets, truth was the foremost criterion. Analysis of frequency eliminates those candidate categories that are impaired or restricted only in a minority of patients. This process surely reduces the occurrence of floor effects, notwithstanding that frequency is not synonymous for relevance, and that the 5% threshold employed for "sufficiently frequent" is arbitrary. Since even an initially infrequent aspect of functioning may become important over the time course of therapy we additionally reported significant change as an important characteristic to monitor. The resulting comprehensive ICF Core Sets consequently contain categories that are either prone to change, or are impaired in more than 5% of the cases, or both. Including patients' expressed goals for rehabilitation is another validation criterion, and serves to indicate categories that should not be omitted from consideration.

To propose valid candidates for ICF Core Sets that are relatively briefer and thus more practical tools, we used the second criterion, discrimination. We included categories indicating the initial (admission) and the final (discharge) status of functioning so as to apprehend those categories accounting for disability at the beginning and conclusion of rehabilitation. By using both initial and final status and by considering the perspectives both of patients and health professionals we tried to minimize bias.

By restricting the number of categories for the brief ICF Core Sets we made a concession to the third criterion, i.e. feasibility. We are well aware that one or the other relevant aspect may then be missing from the brief ICF Core Sets. However, since comprehensive ICF Core Sets are already available, they might serve as default tools for a more comprehensive assessment.

Selecting categories by 3 empirical criteria, truth, discrimination and feasibility, however, also has several limitations. First, it is important to recall that the ICF was first developed as a reference classification and not as a tool for assessment. Thus, any direct application of the ICF categories in a clinical context may be called into question. There is, however, limited evidence that ICF categories can in fact be used reliably for assessment in the hands of experienced health professionals (24). Secondly, the process of selecting categories is data driven. The frequency of any given symptom or problem is therefore dependant on the choice of the sample, and is thus subject to selection bias. We contend that a sufficiently representative sample was studied, recruited from 13 institutions, such that selection bias was minimized. Thirdly, discriminative validity also depends on the sample, such that regression models can deliver highly unstable results that should undergo further validation in a different independent sample or by split sample techniques, such as cross-validation. By using several outcomes and two different regression techniques, both of which are inherently more stable than conventional linear regression, we hope to have stabilized results. Nonetheless, any selection has limitations. Specifically, scale building techniques such as Rasch analysis can serve to assure that the categories represent the whole spectrum of functioning. Further attempts to validate the brief ICF Core Sets in different samples are in progress.

We present here an algorithm to identify candidate categories for brief ICF Core Sets extracted from the comprehensive acute and post-acute ICF Core Sets. The algorithm furthermore validates the ICF Core Set categories for implementation in a clinical context. Appropriate selection and validation processes will ultimately result in the formulation of sets of categories that are useful for health professionals in acute and post-acute situations.

ACKNOWLEDGEMENTS

The authors thank Dr Paul Cumming for critical reading of the manuscript. The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501 and by the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften (TP 1).

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APPENDIX I. Participating institutions

Participating acute hospitals
University Hospital Vienna, Department of Physical Medicine and Rehabilitation, Vienna, Austria
Kaiser-Franz-Josef-Spital, Institute for Physical Medicine and Rehabilitation, Vienna, Austria
University Hospital Zurich, Department of Rheumatology and Institute for Physical Medicine, Zurich, Switzerland
Hannover Medical School, Department of Rehabilitation Medicine, Hannover, Germany
Orthopaedic University Hospital, Heidelberg, Germany
Participating rehabilitation facilities
University Hospital Munich, Department of Physical and Rehabilitative Medicine, Munich, Germany
General Hospital Schwabing, Clinic for Physical Medicine und Early Rehabilitation, Munich, Germany
Nuremberg Hospital, Clinic and Institute for Physical and Rehabilitation Medicine, Nuremberg, Germany
Ingolstadt Hospital, Institute for Physical and Rehabilitative Medicine, Ingolstadt, Germany
Sophienspital, Institute for Physical Medicine and Rehabilitation, Vienna, Austria
Kaiser-Franz-Josef-Spital, Institute for Physical Medicine and Rehabilitation, Vienna, Austria
Malteser Hospital Bonn, Clinic for Geriatrics, Bonn, Germany
Schön Klinik Rosenheim, Centre for Geriatric Rehabilitation, Rosenheim, Germany
Arbeiterwohlfahrt Clinic for Geriatric Rehabilitation, Würzburg, Germany

J Rehabil Med 2011; 43: 92–101

ORIGINAL REPORT

VALIDATION OF THE COMPREHENSIVE ICF CORE SETS FOR PATIENTS RECEIVING REHABILITATION INTERVENTIONS IN THE ACUTE CARE SETTING

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Objective: **To examine the relevance and completeness of the comprehensive International Classification of Functioning, Disability and Health (ICF) Core Sets for patients with rehabilitation needs in acute hospital care.**
Design: **Multi-centre cohort study.**
Patients: **A total of 391 patients (50.1% female, mean age 63.4 years) from 4 university hospitals in Austria, Germany and Switzerland and one Austrian general hospital.**
Methods: **Data on functioning were collected using the respective comprehensive acute ICF Core Sets. Data were extracted from patients' medical record sheets and interviews with health professionals and patients.**
Results: **Most of the categories of the comprehensive ICF Core Sets describing impairments, limitations or restrictions occurred in a considerable proportion of the study population. The most outstanding limitations and restrictions of the patients were problems with sleep and blood vessel functions, walking and moving and self-care. Thirty-eight aspects of functioning not previously covered by the comprehensive ICF Core Sets were ranked as relevant.**
Conclusion: **Categories of the comprehensive ICF Core Sets for the acute hospital situation were confirmed. Some additional categories not covered by the Set in its present version emerged from the interviews, and should be considered for inclusion in a finalized version.**

Key words: ICF; cohort study; intensive care; outcome assessment; classification.

J Rehabil Med 2011; 43: 92–101

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Submitted May 25, 2010; accepted August 30, 2010

INTRODUCTION

Despite the rapid progress in survival after an acute injury or disease, which has been afforded by modern medicine, long-term outcomes can be less favourable. Typically, the risk for subsequent disability is particularly elevated in critically ill patients, in patients with complications or long-term intensive care stays, in persons with disabilities or pre-existing chronic conditions, and in older patients. Any of these circumstances may result in prolonged immobilization, which can give rise to contractures ultimately restricting the patients' ability for self-care (1), or otherwise engender a wide range of adverse neuropsychological effects (2) specifically due to immobilization.

It is increasingly recognized that an appropriate and early start to rehabilitation contributes importantly to the maintenance of functioning, prevention of disability, and optimal recovery of patients in the acute situation (3–4). Thus, the needs for rehabilitative intervention of those patients in acute hospital care with an increased risk for considerable loss of functioning should be identified as early as possible (5). To this end, healthcare professionals in the acute hospital should be able to make a brief assessment of their patients' functioning, and set in motion timely strategies for meeting their subsequent rehabilitation needs. The acute care providers have first to identify especially vulnerable patients, such as the aged, or those with co-morbidity. In order to communicate their patients' particular needs with rehabilitation professionals, there must be a standard system of describing human functioning and rating disability.

The International Classification of Functioning, Disability and Health (ICF) (6), a part of the international family of classifications of the World Health Organization, was established as just such an approach to standardizing the assessment of functioning of individuals and populations. The ICF endeavours to organize all domains of functioning and their contextual factors that are encountered in human life, and may thus arguably constitute the prototypical framework for all medicine. Comprising over 1400 categories, the ICF must nonetheless be adapted to the perspectives and needs of different users. This task is the primary motivation behind the ICF Core Set project, which aims to extract a selection of ICF categories from the entire classification that are relevant for specific health conditions or care situations. This on-going selection of the

comprehensive ICF Core Sets shall define common standards for what should properly be measured and reported.

In general, the ICF Core Set project defines on an empirical basis a category as relevant when it describes a problem that is frequently encountered in typical patients, measured as an endpoint in clinical trials, or was otherwise identified as being relevant following discussion among health professionals. The resultant information is then summarized and implemented as part of a formalized consensus process involving expert health professionals (7). Comprehensive ICF Core Sets for the acute hospital have already been developed for patients with neurological, cardiopulmonary and musculoskeletal conditions (8–10).

Comprehensive ICF Core Sets can be used for the assessment of problems and needs in the acute situation, as well as for the estimation of prognosis and rehabilitation potential (8). Likewise, they can be used to coordinate rehabilitation interventions, e.g. at the intensive care unit. Finally, the Sets can serve as a list of potential candidate categories for creating new measures tailored to the needs of the respective user.

In order to validate the comprehensive ICF Core Sets designed for use in particular contexts, one must possess an adequate understanding of the methodological framework used for creating measures. For example, the Outcome Measures in Rheumatology (OMERACT) project identifies 3 different properties relevant to the applicability of measures, namely truth, discrimination and feasibility (9). The first two of these criteria, truth and discrimination, can be applied to test the validity of the comprehensive sets. The criterion *truth* refers to the question of what should be measured. As noted above, the process for generating the comprehensive ICF Core Set assured that all the relevant aspects of functioning were included, but the empirical validation of the choice of categories remains to be completed. The criterion *discrimination* refers to the ability of a measure to discriminate between different states of functioning or medical conditions. A discriminating measure must distinguish between different patient groups in a cross-sectional manner, and assess change in functioning over time.

The objective of this study was to examine the relevance and completeness of the comprehensive ICF Core Sets for patients receiving rehabilitation interventions in the acute care setting. Specifically, we wanted to examine which aspects of functioning included in the comprehensive acute ICF Core Set:

- were frequent at admission to and at discharge from acute care,
- changed during hospital stay, and
- also to identify new relevant aspects for inclusion in the revised ICF Core Set.

METHODS

Study design

A full description of the methods used in this study has been reported elsewhere (10). In brief, study design was a prospective multi-centre cohort study conducted from May 2005 to August 2008. The study population was recruited from 4 university hospitals in Austria, Germany and Switzerland and one Austrian general hospital; approximately 57% of the patients were recruited from the Austrian centres, 24% from the German centres, and 19% from the Swiss centre. Patients were eligible if they were at least 18 years of age and received team integrated multiprofessional rehabilitation interventions for acute musculoskeletal, neurological, or cardiopulmonary injury or disease. As such, rehabilitation interventions could be provided either at a dedicated rehabilitation ward situated in the acute hospital or by mobile rehabilitation teams caring for patients on medical or surgical wards. Written informed consent was obtained from the patients or from the patient's caregiver in cases where the patient was unable to make an informed decision. Approval was obtained from institutional ethics committees from all involved institutions prior to starting the study.

Measures

For the assessment of functioning, we used the 3 comprehensive ICF Core Sets for patients in the acute hospital situation, which were earlier developed to address the specific situations of patients with neurological, musculoskeletal, or cardiopulmonary conditions (11–13). For all patients, impairments in categories of the component Body Structures were graded as present or absent. Limitations or restrictions in categories of the components Body Functions and Activities and Participation were graded as "none", "slight/moderate/severe" or "complete" limitation or restriction. The categories of the component Environmental Factors were graded either as facilitator or barrier, or both facilitator and barrier, or neither facilitator nor barrier.

We elected to report only those impairments, limitations and restrictions directly associated with the conditions causing the need for rehabilitation. The interviewers obtained information from the ward staff in charge about which of the impairments, limitations or restrictions resulted from the referring condition or principal diagnosis, and which occurred as a result of a specific co-morbidity. In order to validate the completeness of the comprehensive ICF Core Sets, the interviewers were furthermore asked to identify any aspects of functioning relevant to the patient, but not currently covered by the comprehensive ICF Core Sets. Additionally, socio-demographic (sex, age, education, living and occupation situation) and condition-specific data (underlying diagnosis, time until rehabilitation, number of co-morbidities and length of stay) were recorded.

Data collection procedures

Data were collected primarily from patients' medical record sheets, health professionals in charge of the patients, and from patients' interviews. Interviewers collecting data had been trained in the application and principles of the ICF, and provided with a manual. All interviewers were health professionals (physicians, medical students in clinical training, physical therapists, or nurses). During data collection interviewers obtained support and information from the ward staff in charge. Ongoing supervision of the interviewers was ensured by periodic telephone calls.

Data collection took place within the first 24 h after admission to the hospital (baseline) and within the last 36 h before discharge or, if length of stay was longer than 6 weeks, at 6 weeks after admission (end-point). ICF categories from the component Environmental Factors were assessed only at admission, since we did not expect any change in these categories during hospital stay.

Statistical analysis

For the categories of the ICF components Body Functions, Body Structures and Activities and Participation we calculated the absolute and relative frequencies (prevalences) of impairment, limitation or restriction at baseline and end-point. For the categories of the ICF component Environmental Factors, we calculated the absolute and relative frequencies (prevalences) of persons who regarded a specific category as constituting either a barrier or facilitator. Relative frequencies of persons for whom the ICF category changed during the study period were calculated, along with their 95% confidence intervals (CI). Frequencies were calculated based on all available participants; change was calculated based on participants with data at baseline and at

end-point. A difference between baseline and endpoint was considered as change if the percentage of change was different from null and the confidence interval did not include the null.

Aspects of functioning not covered by the comprehensive ICF Core Sets but identified as relevant were extracted and translated into the best corresponding ICF category. Absolute and relative frequencies of occurrence of those ICF categories were reported; any such category with prevalence below 5% was considered as not relevant.

RESULTS

Sociodemographics

In total, 391 patients were included. Mean age at admission was 63.4 years (median 65.6; standard deviation (SD) 18.2 years). Mean length of stay was 14.9 days (median 10; SD 13.7). Fifty percent of the patients were female. Ninety-one had a neurological, 109 a cardiopulmonary and 191 a musculoskeletal condition. Twenty patients (5%; 3 neurological, 3 cardiopulmonary, 14 musculoskeletal) were lost to follow-up because of unplanned discharge from hospital or death. The most frequent admission diagnoses classified according ICD-10 in patients with neurological conditions were "cerebrovascular diseases" (including cerebral haemorrhages and infarctions) ($n=46$; 50.5%), and "diseases of the nervous systems", including transient cerebral ischaemic attack, hemi- or tetraplegia ($n=18$; 19.8%). The most frequent admission diagnoses in patients with cardiopulmonary conditions were "Other forms of heart disease" (including cardiomyopathy, myocarditis, and heart failure) ($n=30$; 27.5%) and "Ischaemic heart diseases" (including myocardial infarction) ($n=22$; 20.2%). The most frequent admission diagnoses in patients with musculoskeletal conditions were "Other dorsopathies" (including disc disorders and low back pain) ($n=46$; 24.1%) and "Arthropathies" (including arthritis and arthrosis) ($n=24$; 12.6%). For further socio-demographic and condition-related variables see Table I.

Functioning and disability

Tables II–IV give the prevalence of impairment or restriction both at admission and discharge as well as the corresponding 95% CI for the frequency of change in impairment or restriction, for each category of underlying condition.

Of the categories of the components Body Functions and Structures and Activities and Participation from the comprehensive ICF Core Sets, 55% were impaired or restricted for patients with neurological conditions in at least one-third of the patients, vs 71% from the cardiopulmonary patient group, and 57% from the musculoskeletal patient group.

Functioning and disability in patients with neurological conditions

The frequency of impairments or restrictions in patients with neurological conditions ranged from 2% to 86% (mean 38%) at admission and from 1% to 82% (mean 26%) at discharge. There were 3 categories with prevalence below 5% at admission or discharge: *Heart functions* (b410), *General metabolic functions* (b540), *Structure of respiratory system* (s430), and *Hearing functions* (b230).

The Body Functions and Body Structures most frequently impaired both at admission and discharge were *Muscle power functions* (b730) (81% at admission/72% at discharge), *Control of voluntary movement functions* (b760) (69%/53%), *Blood vessel functions* (b415) (60%/52%) *Muscle tone functions* (b735) (60%/51%), *Structure of brain* (s110) (86%/82%), and *Structure of cardiovascular system* (s410) (72%/61%).

The ICF categories from the component Activities and Participation (A&P) most frequently limited at admission were *Caring for body parts* (d520) (76%), *Moving around using equipment* (d465) (75%) and *Hand and arm use* (d445) (73%), the most frequently limited at discharge were *Fine hand use* (d440) (51%), *Hand and arm use* (d445) (49%) and *Moving around using equipment* (d465) (45%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 0% to 44% for the different ICF categories. The most frequent improvements were observed in A&P categories *Moving around using equipment* (d465) (44%), *Toileting* (d530) (42%), *Changing basic body position* (d410)

Table I. *Characteristics of participants*

Variable	All conditions	Neurological conditions	Cardiopulmonary conditions	Musculoskeletal conditions
Number of participants, *n*	391	91	109	191
Mean age (SD)	63.4 (18.2)	64.6 (16.9)	68.9 (16.1)	59.7 (19.2)
Mean number of comorbidities (SD)	2.7 (2.2)	2.9 (2.0)	3.4 (2.1)	2.3 (2.2)
Mean length of stay (SD)	14.9 (13.7)	17.7 (14.7)	14.4 (14.1)	13.9 (12.8)
Female gender, %	50.1	50.5	45.9	52.4
Diagnosis, *n* (%)				
Diseases of the respiratory system (J00–J99)	28 (7.2)	2 (2.2)	26 (23.9)	0 (0)
Diseases of the circulatory system other than cerebrovascular diseases (I00–I52 and I70–I99)	69 (17.6)	3 (3.3)	66 (60.6)	0 (0)
Cerebrovascular diseases (I60–I69)	46 (11.8)	46 (50.5)	0 (0)	0 (0)
Diseases of the nervous system (G00–G99)	18 (4.6)	18 (19.8)	0 (0)	0 (0)
Diseases of the musculoskeletal system and connective tissue (M00–M99)	87 (22.3)	3 (3.3)	1 (0.9)	83 (43.5)
Injury, poisoning and certain other consequences of external causes (S00–T98)	80 (20.5)	4 (4.4)	0 (0)	76 (39.8)
Neoplasms (C00–D48)	37 (9.5)	11 (12.1)	7 (6.4)	19 (9.9)
Other diagnoses	26 (6.6)	4 (4.4)	9 (8.3)	13 (6.8)

SD: standard deviation.

Table II. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Functions – percentage of participants with impairment at admission/discharge and the extent of change over time*

		Neurological conditions, $n=91$					Cardiopulmonary conditions, $n=109$					Musculoskeletal conditions, $n=191$				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
ICF	ICF Code Description	n[a]	%[b]	n[a]	%[b]	% (95% CI)[c]	n[a]	%[b]	n[a]	%[b]	% (95% CI)[c]	n[a]	%[b]	n[a]	%[b]	% (95% CI)[c]
b110	Consciousness functions	91	27	88	14	23 (14–33)	109	7	105	4	10 (5–17)	191	3	177	0	2 (1–6)
b114	Orientation functions	89	20	87	14	13 (7–22)	109	10	106	6	11 (6–19)					
b130	Energy and drive functions	89	53	88	27	38 (28–49)	109	48	106	31	22 (14–31)	191	31	177	20	18 (12–24)
b134	Sleep functions	90	57	87	37	36 (26–47)	109	58	106	41	25 (17–34)	191	66	177	44	29 (23–37)
b140	Attention functions	90	36	88	31	25 (17–36)										
b147	Psychomotor functions	90	37	88	23	22 (14–32)										
b152	Emotional functions	88	35	87	22	25 (16–36)						191	27	177	19	14 (9–20)
b156	Perceptual functions	89	33	86	26	26 (17–37)										
b167	Mental functions of language	89	33	88	19	24 (16–35)										
b180	Experience of self and time functions	89	25	88	15	15 (8–24)						191	4	177	2	3 (1–6)
b210	Seeing functions	91	13	87	17	11 (6–20)										
b215	Function of structures adjoining the eye	89	10	85	7	10 (4–18)										
b230	Hearing functions	91	8	87	3	9 (4–17)										
b235	Vestibular functions	84	36	84	23	30 (20–41)										
b240	Sensations associated with hearing and vestibular function	88	40	85	28	34 (24–45)										
b260	Proprioceptive function	90	49	87	37	23 (15–34)						191	41	177	30	18 (13–25)
b265	Touch function	88	43	85	31	23 (15–34)										
b270	Sensory functions related to temperature and otherstimuli	86	36	84	24	17 (10–27)										
b280	Sensation of pain	90	48	88	33	36 (26–47)	109	47	106	27	26 (18–36)	191	91	177	66	35 (28–43)
b310	Voice functions	90	20	88	10	20 (12–29)										
b410	Heart functions	88	2	86	1	4 (1–10)	109	62	106	59	15 (9–23)					
b415	Blood vessel functions	90	60	88	52	45 (34–56)	109	61	106	55	16 (10–24)	191	55	177	34	26 (20–33)
b420	Blood pressure functions	91	16	87	10	11 (6–20)	109	44	106	42	18 (11–27)					
b430	Haematological system functions	87	24	83	14	14 (8–24)	109	43	106	37	12 (7–20)					
b435	Immunological system functions	86	15	83	16	5 (1–12)	109	37	106	24	14 (8–22)					
b440	Respiration functions	91	16	88	7	12 (6–21)	109	70	106	49	31 (22–41)	191	18	177	5	13 (8–19)
b445	Respiratory muscle functions						109	54	106	42	25 (17–34)					
b450	Additional respiratory functions	90	13	88	6	7 (3–14)	109	60	106	44	32 (23–42)					
b455	Exercise tolerance functions	76	21	82	20	5 (2–13)	106	98	103	87	34 (25–44)	186	45	172	31	22 (16–28)
b460	Sensations associated with cardiovascular and respiratory functions						109	83	105	64	29 (20–38)					
b510	Ingestion functions	91	23	88	14	23 (14–33)	109	21	106	16	19 (12–28)					
b525	Defecation functions	88	23	87	17	24 (15–34)						191	37	177	15	29 (22–36)
b535	Sensations associated with the digestive system	89	20	86	12	18 (10–28)										
b540	General metabolic functions	85	5	84	7	7 (3–15)										
b545	Water, mineral and electrolyte balance functions	85	20	83	12	13 (7–23)	109	26	106	15	19 (12–28)					
b610	Urinary excretory functions						109	11	106	8	10 (5–18)					
b620	Urination functions	91	34	88	16	33 (23–44)						191	29	177	6	24 (18–31)
b710	Mobility of joint functions	90	28	88	27	22 (14–32)	109	21	106	21	11 (6–19)	191	92	177	84	33 (26–40)
b715	Stability of joint functions	90	28	87	31	21 (13–31)						191	79	177	66	34 (27–41)
b730	Muscle power functions	88	81	87	72	25 (16–35)	106	49	105	49	15 (8–23)	187	94	175	85	26 (20–33)
b735	Muscle tone functions	91	60	87	51	25 (17–36)						190	55	177	37	28 (22–36)
b755	Involuntary movement reaction functions	89	49	88	38	24 (16–35)										
b760	Control of voluntary movement functions	91	69	88	53	36 (26–47)										
b810	Protective functions of the skin	91	25	88	18	11 (6–20)										
b820	Repair functions of the skin						109	22	106	15	12 (7–20)	141	14	174	13	6 (2–11)

[a]Number of valid answers; [b]Proportion of impairments in the category; [c]Proportion of patients experiencing change (improvement or worsening) in the category. 95% CI: 95% confidence interval.

Table III. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Structures – percentage of participants with impairment at admission/discharge and the extent of change over time*

		Neurological conditions $n=91$					Cardiopulmonary conditions $n=109$					Musculoskeletal conditions $n=191$				
		Admission		Discharge		Change % (95%	Admission		Discharge		Change % (95%	Admission		Discharge		Change % (95%
ICF	ICF Code Description	n^a	%[b]	n^a	%[b]	CI)[c]	n^a	%[b]	n^a	%[b]	CI)[c]	n^a	%[b]	n^a	%[b]	CI)[c]
s110	Structure of brain	90	86	88	82	3 (1–10)										
s120	Spinal cord and related structures	90	13	88	16	2 (0–8)										
s410	Structure of cardiovascular system	89	72	84	61	14 (8–24)	109	72	106	69	4 (1–9)	182	41	171	28	13 (8–19)
s430	Structure of respiratory system	88	3	85	7	6 (2–13)	108	55	106	46	12 (7–20)	183	7	172	4	3 (1–7)
s710	Structure of head and neck region	90	19	86	17	4 (1–10)						183	6	172	6	1 (0–4)
s720	Structure of shoulder region											183	15	172	15	3 (1–7)
s730	Structure of upper extremity											183	16	177	16	4 (1–8)
s740	Structure of pelvic region											182	31	172	28	8 (4–13)
s750	Structure of lower extremity											182	53	172	55	4 (1–8)
s760	Structure of trunk						109	27	106	25	3 (1–8)	183	37	172	31	9 (5–14)
s810	Structure of areas of skin						108	31	106	31	5 (2–11)	182	64	172	59	7 (3–11)

[a]Number of valid answers.
[b]Proportion of impairments in the category.
[c]Proportion of patients experiencing change (improvement or worsening) in the category. 95% CI: 95% confidence interval.

(41%), and *Caring for body parts* (d520) (41%). The Body Functions which improved most frequently were *Blood vessel functions* (b415) (38%), *Energy and drive functions* (b130) (30%), and *Control of voluntary movement functions* (b760) (28%). The most frequent improvement in Body Structures was found in the *Structure of cardiovascular system* (s410) (13%).

The percentage of patients who reported deterioration in any of the different ICF categories ranged from 0% to 11%, which

Table IV. *International Classification of Functioning, Disability and Health (ICF) categories of the component Activities and Participation – percentage of participants with restrictions at admission/discharge and the extent of change over time*

		Neurological conditions $n=91$					Cardiopulmonary conditions $n=109$					Musculoskeletal conditions $n=191$				
		Admission		Discharge		Change % (95%	Admission		Discharge		Change % (95%	Admission		Discharge		Change % (95%
ICF	ICF Code Description	n^a	%[b]	n^a	%[b]	CI)[c]	n^a	%[b]	n^a	%[b]	CI)[c]	n^a	%[b]	n^a	%[b]	CI)[c]
d240	Handling stress and other psychological demands						109	48	105	35	16 (10–25]	189	47	177	31	18 (13–25]
d315	Communicating with (receiving) nonverbal messages	90	19	88	8	17 (10–27)										
d330	Speaking	91	40	88	22	33 (23–44)	109	28	106	11	23 (15–32)					
d335	Producing nonverbal messages	91	26	88	12	18 (11–28)										
d360	Using communication devices and techniques	86	45	88	18	37 (27–48)										
d410	Changing basic body position	90	67	88	36	44 (33–55)	109	46	106	27	34 (25–44)	191	95	177	60	58 (50–65)
d415	Maintaining a body position	89	63	88	30	42 (31–53)	109	36	106	22	28 (20–38)	191	81	177	45	56 (49–64)
d420	Transferring oneself	89	61	87	32	42 (31–53)	109	44	106	22	34 (25–44)	191	90	177	36	64 (57–71)
d440	Fine hand use (picking up, grasping)	91	70	88	51	34 (24–45)										
d445	Hand and arm use	91	73	88	49	43 (33–54)						191	24	177	18	12 (7–18)
d450	Walking						109	61	106	36	36 (27–46)	191	88	177	71	49 (41–56)
d465	Moving around using equipment	77	75	69	45	45 (32–58)										
d510	Washing oneself	91	71	88	38	43 (33–54)	109	58	106	30	36 (27–46)	191	81	177	42	47 (40–55)
d520	Caring for body parts	91	76	88	42	43 (33–54)	109	56	106	28	38 (29–48)	191	81	177	49	46 (38–53)
d530	Toileting	89	67	86	28	45 (34–56)	109	53	106	22	38 (29–48)	191	72	177	24	58 (50–65)
d540	Dressing	88	69	86	37	45 (34–56)	109	56	106	27	38 (29–48)					
d550	Eating	91	51	88	28	34 (24–45)						191	32	177	16	20 (14–26)
d560	Drinking	91	41	88	20	31 (21–41)										
d760	Family relationships	85	26	83	14	17 (10–27)						181	22	168	12	12 (8–18)
d940	Human rights	82	11	83	6	11 (5–21)										

[a]Number of valid answers.
[b]Proportion of restrictions in the category.
[c]Proportion of patients experiencing change (improvement or worsening) in the category. 95% CI: 95% confidence interval.

was observed in both *Attention functions* (b140) and *Stability of joint functions* (b715).

Functioning and disability in patients with cardiopulmonary conditions

The frequency of impairments or restrictions in patients with cardiopulmonary conditions ranged from 7% to 98% (mean 46%) at admission and from 4% to 87% (mean 33%) at discharge. There was no category with prevalence below 5% at admission.

Body function categories had the highest prevalence of impairment both at admission and at discharge. As expected, impairments in *Functions of the respiratory system* (b440–b449) and *Additional functions and sensations of the cardiovascular and respiratory systems* (b450–b499) were most frequent in this patient group.

The Body Functions most frequently impaired at admission were *Exercise tolerance functions* (b455) (98%), *Sensations associated with cardiovascular and respiratory function* (b460) (83%), and *Respiration functions* (b440) (70%), the most frequently impaired at discharge were *Exercise tolerance functions* (b455) (87%), *Sensations associated with cardiovascular and respiratory function* (b460) (64%), and *Heart functions* (b410) (59%).

The Body Structures most frequently impaired both at admission and at discharge were *Structure of cardiovascular system* (s410) (72% at admission/69% at discharge), and *Structure of respiratory system* (s430) (55%/46%).

The ICF categories from the component A&P most frequently limited at admission were *Walking* (d450) (61%), *Washing oneself* (d510) (58%), *Caring for body parts* (d520) (56%), and *Dressing* (d540) (56%), the most frequently limited at discharge were *Walking* (d450) (36%), *Handling stress and other psychological demands* (d240) (35%), and *Washing oneself* (d510) (30%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 2% to 35% for the different ICF categories. The most frequent improvements were observed in A&P categories *Toileting* (d530) (35%), *Dressing* (d410) (33%), *Walking* (d450) (32%), and *Caring for body parts* (d520) (32%). The Body Functions which improved most frequently were *Exercise tolerance functions* (b455) (33%), *Respiration functions* (b130) (25%), and *Additional respiratory functions* (b450) (25%). However, impairments in *Exercise tolerance functions* (b455) were highly frequent also at discharge. The most frequent improvement in Body Structures was found in the *Structure of respiratory system* (s410) (10%).

For the different ICF categories, the percentage of patients reporting a deterioration of functioning at discharge ranged from 0% to 8%, which was observed in 5 categories: *Blood pressure functions* (b420), *Additional respiratory functions* (b450), *Ingestion functions* (b510), *Changing basic body position* (d410), and *Maintaining a body position* (d415).

Functioning and disability in patients with musculoskeletal conditions

The frequency of impairments or restrictions in patients with musculoskeletal conditions ranged from 3% to 95% (mean 46%) at admission and from 0% to 85% (mean 31%) at discharge. There were two categories with prevalence below 5% at admission *Consciousness functions* (b110) and *Experience of self and time functions* (b180).

The Body Functions and Body Structures most frequently impaired both at admission and at discharge were *Muscle power functions* (b730) (94% at admission/85% at discharge), *Mobility of joint functions* (b710) (92%/84%), *Sensation of pain* (b280) (91%/66%), *Structure of areas of skin* (s810) (64%/59%), and *Structure of lower extremity* (s750) (53%/55%).

The ICF categories from the component A&P most frequently limited at admission were *Changing basic body position* (d410) (95%), *Transferring oneself* (d420) (90%), and *Walking* (d450) (88%), the most frequently limited at discharge were *Walking* (d450) (71%), *Changing basic body position* (d410) (60%), and *Caring for body parts* (d520) (49%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 1% to 64% for the different ICF categories. The most frequent improvements were observed in A&P categories *Transferring oneself* (d420) (64%), *Changing basic body position* (d410) (58%), *Maintaining a body position* (d415) (55%), and *Toileting* (d530) (55%). The Body Functions which improved most frequently were *Sensation of pain* (b280) (33%), *Mobility of joint functions* (b710) (31%), and *Stability of joint functions* (b715) (31%). The most frequent improvement in Body Structures was found in the *Structure of cardiovascular system* (s410) (12%).

For the different ICF categories, the percentage of patients reporting a deterioration of functioning at discharge ranged from 0% to 5%, which was seen for two categories: *Emotional functions* (b152) and *Muscle tone functions* (b735).

Common aspects of functioning and disability in the 3 patient groups

A comparison of the 3 condition groups showed that there were several categories with highly frequent impairment (> 50% of patients) irrespective of the category at admission. These frequently occurring impairments were *Sleep functions* (b134) (57–66%), *Blood vessel functions* (b415) (55–60%), *Walking and moving* categories (*Walking* (d450) in patients with cardiopulmonary and musculoskeletal conditions and *Moving around using equipment* (d465) in patients with neurological conditions) (61–88%), and some of the *Self-care* categories (d510–d540) (53–81%). In patients with neurological or musculoskeletal conditions at admission, the most frequent impairments and limitations were in *Muscle Functions* (b730–b735) (55–94%) and *Changing and maintaining body positions* (d410–d420) (61–95%).

Contextual factors

Table V gives an overview of the prevalence of categories from the component Environmental Factors, which served as facilitators or presented barriers, stratified by condition.

Environmental factors in patients with neurological conditions

The frequency of facilitators in patients with neurological conditions ranged from 16% to 100% (mean 75%), whereas the frequency of barriers ranged from 1% to 42% (mean

Table V. *International Classification of Functioning, Disability and Health (ICF) categories of the component Environmental Factors described as either facilitator or barrier at admission*

			Neurological conditions $n=91$		Cardiopulmonary conditions $n=109$		Musculoskeletal conditions $n=191$	
ICF	ICF Code Description	Specification	n^a	%[b]	n^a	%[b]	n^a	%[b]
e110	Products or substances for personal consumption	Barrier	87	11	107	16	188	24
		Facilitator	87	86	107	87	188	82
e115	Products and technology for personal use in daily living	Barrier	84	20	105	15	187	16
		Facilitator	84	80	104	77	186	78
e120	Products and technology for personal indoor and outdoor mobility and transportation	Barrier	67	16	96	4	180	14
		Facilitator	67	84	96	81	180	72
e125	Products and technology for communication	Barrier	82	17				
		Facilitator	82	74				
e150	Design, construction and building products and technology of buildings for public use	Barrier	78	17				
		Facilitator	78	73				
e240	Light	Barrier	88	18				
		Facilitator	86	50				
e250	Sound	Barrier	88	42	108	30		
		Facilitator	86	16	108	22		
e260	Air quality	Barrier			109	33		
		Facilitator			108	44		
e310	Immediate family	Barrier	81	4	98	3	179	10
		Facilitator	81	93	98	90	179	88
e315	Extended family	Barrier	73	3				
		Facilitator	73	78				
e320	Friends	Barrier	69	1	76	9	171	4
		Facilitator	69	88	76	78	172	73
e355	Health professionals	Barrier	88	6	109	2	190	8
		Facilitator	88	97	109	98	191	98
e360	Health related professionals	Barrier	65	2				
		Facilitator	64	70				
e410	Individual attitudes of immediate family members	Barrier	79	10	97	5	178	6
		Facilitator	78	88	97	86	178	88
e415	Individual attitudes of extended family members	Barrier	70	6				
		Facilitator	69	75				
e420	Individual attitudes of friends	Barrier	67	1	74	9	169	1
		Facilitator	66	80	74	74	169	72
e450	Individual attitudes of health professionals	Barrier	80	4	109	5	186	8
		Facilitator	79	100	109	95	186	94
e455	Individual attitudes of other professionals	Barrier	64	3				
		Facilitator	63	68				
e465	Social norms, practices and ideologies	Barrier	61	23				
		Facilitator	60	43				
e550	Legal services, systems and policies	Barrier	64	11				
		Facilitator	64	61				
e570	Social security, services, systems and policies	Barrier	77	10	104	8		
		Facilitator	76	75	103	85		
e580	Health services, systems and policies	Barrier	82	11	106	8	186	11
		Facilitator	81	96	106	89	188	92

[a]Number of valid answers; [b]Proportion of patients experiencing the category as barrier or facilitator, respectively.

11%). There were no facilitators with prevalence below 5%, but 7 barriers had prevalence below 5%. The most frequent facilitators were *Individual attitudes of health professionals* (e450) (100%), *Health professionals* (e355) (97%), *Health services, systems and policies* (e580) (96%), and *Immediate family* (e310) (93%). The most frequent barriers were *Sound* (e250) (42%), *Social norms, practices and ideologies* (e465) (23%), and *Products and technology for personal use in daily living* (e115) (20%).

Environmental factors in patients with cardiopulmonary conditions

The frequency of facilitators in patients with cardiopulmonary conditions ranged from 22% to 98% (mean 77%); there were no categories serving as facilitators in less than 5% of the patients. The most frequent barriers, which ranged from 2% to 33% (mean 11%), were *Air quality* (e260) (33%), *Sound* (e250) (30%), *Products or substances for personal consumption* (e110) (16%), and *Products and technology for personal*

use in daily living (e115) (15%); 5 categories were a barrier for less than 5% of the patients.

Environmental factors in patients with musculoskeletal conditions

The frequency of facilitators in patients with musculoskeletal conditions ranged from 72% to 98% (mean 83%). The most frequent facilitators were *Health professionals* (e355) (98%), *Individual attitudes of health professionals* (e450) (94%), and *Health services, systems and policies* (e580) (92%); there were no categories as facilitators with prevalence below 5%. The frequency of barriers ranged from 1% to 24% (mean 10%). The most frequent barriers were *Products or substances for personal consumption* (e110) (24%), *Products and technology for personal use in daily living* (e115) (16%), and *Products and technology for personal indoor and outdoor mobility and transportation* (e120) (14%); two categories had prevalence as barriers below 5%.

Additional ICF categories

Thirty-eight aspects of functioning not previously covered by the comprehensive acute ICF Core Sets were identified as relevant. However, many of these aspects were only mentioned by one person, and so cannot be considered as representative. Aspects which were mentioned by at least 1% of the participants are presented in Table VI. All of these newly identified aspects could be translated into corresponding ICF categories. Ten aspects referred to categories and chapters of the component Body Functions, 17 to categories and chapters of the component Body Structures, 7 to categories and chapters of the component Activities and Participation and 3 to categories of the component Environmental Factors.

DISCUSSION

The results of the present multi-centre cohort study provide further insight into the course of functioning and health and its related contextual factors in patients with rehabilitation needs in acute hospital care. The results of our study generally confirm the first version of the comprehensive ICF Core Sets for patients in the acute hospital. We could show that a large number of the categories included in the comprehensive ICF Core Sets address relevant aspects of functioning and disability, and detected a few additional candidates for inclusion.

Irrespective of the health condition, there were high prevalences of impairment in *Sleep functions* (b134) and *Blood vessel functions* (b415), and also limitations in *Walking and moving* (d450–d469) and in all categories pertaining to *Self-care* (d510–d540). Sleep loss, sleep disruption and a disturbed circadian rhythm are reported frequently at acute and intensive care units, and have been attributed to several factors, such as interventions, diagnostic procedures, underlying disease or ambient noise (14–15). Impaired blood vessels functions frequently correspond to venous thromboembolism, which is a life-threatening and frequent complication of surgery, and also arising due to prolonged immobility and the use of central venous catheters (16–17).

Limitations in walking and moving, as well as self-care patterns are to be expected in critically ill patients in acute hospitals, in intensive care or in intermediate care units, such

Table VI. *Additional International Classification of Functioning, Disability and Health (ICF) categories not covered by the comprehensive ICF Core Sets*

		All conditions $n=391$		Neurological conditions $n=91$		Cardiopulmonary conditions $n=109$		Musculoskeletal conditions $n=191$	
ICF	ICF Code Description	n^a	%[b]	n^a	%[b]	n^a	%[b]	n^a	%[b]
Body Functions and Structures									
b810	Protective functions of the skin	122	31	–	–	4	4	118	62
b430	Haematological system functions	25	6	–	–	–	–	25	13
b265	Touch function	10	3	–	–	0	0	10	5
b535	Sensations associated with the digestive system	7	3	–	–	0	0	7	4
b525	Defecation functions	6	2	–	–	6	6	–	–
Body Structures									
s810	Structure of areas of skin	24	6	24	26	–	–	–	–
s560	Structure of liver	8	2	2	2	2	2	4	2
s750	Structure of lower extremity	5	1	2	2	2	2	1	1
s520	Structure of oesophagus	4	1	2	2	2	2	0	0
s760	Structure of trunk	4	1	4	4	–	–	–	–
Activities and Participation									
d455	Moving around	87	22	21	23	18	17	48	25
d450	Walking	30	8	30	33	–	–	–	–
d920	Recreation and leisure	9	2	0	0	0	0	9	5
d850	Remunerative employment	6	2	0	0	0	0	6	3
Environmental Factors									
e330	People in positions of authority	4	1	3	3	0	0	1	1

[a]Number of patients in whom the interviewers found the respective category relevant to describe the patient comprehensively.
[b]Proportion of patients in relation to all in whom the interviewers found the respective category relevant to describe the patient comprehensively.

as those in the present study. In general, the frequency of impairments and limitations in these categories reflects the seriousness of the underlying illness or disability (18). The present finding of frequently reported impairments in muscle functions and limitations in changing and maintaining body positions in patients with neurological and musculoskeletal conditions agrees with earlier reports on the need of rehabilitative interventions (18–19).

As expected, ICF categories related to brain and vascular systems were impaired in a high proportion of patients with neurological conditions, both at admission and discharge. The high prevalence of impairments related to perception and cognition is also in line with the literature (19–20).

Problems with *General metabolic functions* (b540), such as diabetes mellitus, were observed in only a small proportion of patients with neurological conditions, although approximately 50% had a cerebrovascular disease (Table I). This is surprising since diabetes is a risk factor for cerebrovascular diseases and should therefore be highly prevalent in patients with neurological conditions (21–23). Since disability after stroke is significantly higher in patients with diabetes (24), the category metabolic functions should be included in a final version of the comprehensive Set as a parameter to be monitored.

The most frequently observed improvements in patients with neurological conditions were in categories of the component Activities and Participation, namely in *Changing basic body position* (d410), *Moving around using equipment* (d465), *Toileting* (d530), and *Caring for body parts* (d520), which are all categories from mobility and self-care. These improvements reflect the major goals of rehabilitation and nursing care in the acute situation, which are primarily the ability to attain a sitting and standing position (included in *Changing basic body position*) and ultimately the obtaining of independent mobility with assistive devices such as wheelchairs, walking frames or crutches, as well as regaining independence in very personal activities such as toileting or brushing of teeth (included in *Caring for body parts*).

We identified some aspects as tending to deteriorate during hospitalization, namely *Attention functions* (b140) and *Stability of joint functions* (b715). Arguably, those functions are likely to be disregarded at the initiation of therapy, when survival and stabilization of vital functions are the main concerns. Additionally, joint problems such as subluxation of the shoulder joint, are common in patients with hemiplegia, and tend to exacerbate with time (25).

In patients with cardiopulmonary conditions, impairments in functions and structures connected with the cardiac and pulmonary system had the highest prevalence both at admission and discharge, especially *Exercise tolerance functions* (b455) and *Sensations associated with cardiovascular and respiratory function* (b460) (including dyspnoea and air hunger). Accordingly, limitations in a wide range of physical activities such as *Walking* (d450) and all self-care issues were reported most frequently in these patients. However, it was precisely these issues which improved most frequently during hospital stay, perhaps reflecting the importance of obtaining independence in daily activities as a major goal in cardiopulmonary rehabilitation. On the other hand, the frequent occurrence of limitations in *Handling stress and other psychological demands* (d240) underscores the relevance of psychosocial interventions in the early course of cardiopulmonary rehabilitation (26–27).

Improvements in *Mobility* and *Self-care* again refer to the typical goals of physical therapy and nursing in the acute hospital. Our observations of decline in ingestion and respiratory functions can be attributed to the effects of prolonged immobilization in some patients. In particular, it is unsurprising that patients with musculoskeletal conditions experienced impairment in functions of muscles, bones and joints, as well as limitations in the corresponding categories of the component A&P, such as *Walking* (d450), *Moving around* (d455), and, consequently, *Self-care*. In the course of their recovery and rehabilitation therapy, the degree of pain, mobility and stability of joints had improved at discharge. The deterioration of emotional functions seen in our study is in line with earlier reports, for example on the occurrence of depression after hip fracture (28–29).

The detection of additional topics not covered by the present version of the comprehensive ICF Core Sets were rather infrequent, with the exception of *Protective functions of the skin*, which came up in almost two-thirds of the patients with musculoskeletal conditions, *Moving around*, seen in almost 25% of the patients with musculoskeletal and neurological conditions, and *Walking*, which was noted in more than 25% of the patients with neurological conditions. Those categories seem intuitively reasonable and fit for inclusion in the revised ICF Core Sets. Indeed, they had initially been excluded during the consensus conferences only because the experts on the acute hospital situation sought to derive parsimonious sets, which were not so comprehensive as to be impractical in the clinical situation.

Even though prevalence of impairment, limitation or restriction was rather low in some of the categories, all of those categories showed change. Since assessing change over time arguably is one of the important properties of an assessment instrument (9), we propose to include categories into the comprehensive ICF Core Sets not only on the basis of frequency, but also conditional on their propensity to change.

Some limitations of our study may restrict the generalizability of the results. The sample included only patients from German-speaking countries with comparable healthcare systems. The collection of data elsewhere in Europe, or in other continents, might well have yielded different results. Therefore, additional validation studies with patients from other countries and cultures should be carried out. Impairments and limitations may also be a direct consequence of the underlying diagnoses encountered in the particular study. We are, however, confident that the current sample of older patients reflected the prototypical spectrum of diagnoses seen in Europe. Nevertheless, the best validation for comprehensive ICF Core Sets is to use them in practice as often as possible, and in many different settings.

In conclusion, the categories of the comprehensive ICF Core Sets for the acute hospital situation were confirmed. Due to their sensitivity to change no categories of the com-

prehensive ICF Core Sets should be excluded. The categories *Moving around* (d455) and *Walking* (d450) have to be included in the final version of the comprehensive ICF Core Set for neurological conditions in the acute hospital. The categories *Protective functions of the skin* (b810) and *Moving around* (d455) should be included in the final version of the comprehensive ICF Core Set for musculoskeletal conditions in the acute hospital.

ACKNOWLEDGEMENTS

The authors thank all the study participants for patience and collaboration, and thank Dr Paul Cumming for manuscript revisions. We further thank all participating hospitals involved in data collection, Kaiser-Franz-Josef-Hospital, Vienna (Austria), University Hospital Vienna, Vienna (Austria), University Hospital, Zurich (Switzerland), University Hospital, Heidelberg (Germany), and Hannover Medical School, Hannover (Germany). The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501 and by the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften, (TP 1).

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J Rehabil Med 2011; 43: 102–112

ORIGINAL REPORT

VALIDATION OF THE COMPREHENSIVE ICF CORE SETS FOR PATIENTS IN POST-ACUTE REHABILITATION FACILITIES

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Objectives: **To examine the relevance and completeness of the comprehensive International Classification of Functioning, Disability and Health (ICF) Core Sets for patients in post-acute rehabilitation facilities.**
Design: **Multi-centre cohort study.**
Patients: **A total of 165 patients (46% female; mean age 67.5 years) from post-acute rehabilitation facilities in 2 Austrian and 7 German hospitals.**
Methods: **Data on functioning were collected using the respective comprehensive post-acute ICF Core Sets. Data was extracted from patients' medical record sheets and interviews with health professionals and patients.**
Results: **Most of the categories of the comprehensive ICF Core Sets describing impairments, limitations or restrictions occurred in a considerable proportion of the study population. The most outstanding limitations and restrictions of the patients were problems with sleep and blood vessel functions, walking and moving and self-care. Twenty-six aspects of functioning not previously covered by the comprehensive ICF Core Sets were ranked as relevant.**
Conclusion: **Most categories of the comprehensive ICF Core Set for patients in post-acute rehabilitation facilities were confirmed. No significant gaps in the established set could be identified.**

Key words: ICF; cohort study; rehabilitation; outcome assessment; classification.

J Rehabil Med 2011; 43: 102–112

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Submitted May 25, 2010; accepted November 18, 2010

INTRODUCTION

Human functioning and its contrary notion, disability, are universal experiences, which must be understood in the context of an individual's personal resources, particular health conditions and expectations, and in interaction with the environment (1). Any acute injury or disease may have the consequence of bringing about transient or permanent disability. Thus, post-acute rehabilitation has the goal of optimizing functioning of people experiencing, or at risk of experiencing, disability. In situations entailing post-acute and long-term rehabilitation, professionals specialized in rehabilitation management should share a common understanding of functioning, and should utilize clinical assessment instruments that are based on a standard model of functioning.

The International Classification of Functioning, Disability and Health (ICF) (2), as a part of the World Health Organization's international family of classifications, is the contemporary framework to harmonize the assessment of functioning and disability at the individual and the societal level. The ICF covers all domains of human functioning and relating contextual factors. Since the ICF was developed as a multipurpose classification for various user groups it has to be comprehensive by its very nature. This comprehensiveness, which results in more than 1,400 categories, is the major challenge for implementing the ICF in daily practice. To foster the implementation of the ICF in clinical practice and research, the development of shorter practical tools is needed. The development of such tools for specific care situations or health conditions was the primary motivation behind the ICF Core Set project. The ICF Core Set project aimed to define so-called *comprehensive ICF Core Sets* which should define commonly acceptable standards for what aspects of functioning and disability should properly be measured and reported.

The development process of comprehensive ICF Core Sets involved evidence from different sources: the patients' perspective, the health professionals' perspective, the perspective of research and the actual prevalence in clinical practice. These perspectives were summarized and adopted in a formalized consensus process (3). Comprehensive ICF Core Sets for post-acute rehabilitation facilities have already been developed for patients with neurological, cardiopulmonary and musculoskeletal conditions (4–6).

Comprehensive ICF Core Sets can be used for the assessment of problems and needs, as well as for the estimation of prognosis and rehabilitation potential. Similarly, they can be used to coordinate rehabilitation interventions and strategies and to define rehabilitation goals. Finally, the Sets are envisioned to serve as a list of candidate categories for creating

new specific measurement instruments customized for the needs of the respective user.

The validation of comprehensive ICF Core Sets tailored for the use in particular contexts, needs an adequate methodological framework. The ICF Core Set project adopted the concept used in the Outcome Measures in Rheumatology (OMERACT) project. OMERACT identified 3 different properties relevant to the applicability of measures, namely truth, discrimination and feasibility (4). The criteria truth and discrimination can be applied to test the validity of the comprehensive sets. *Truth* refers to the question of what should properly be measured. As noted above, the original process for generating the comprehensive ICF Core Set had assured that all the relevant aspects of functioning were included, but the empirical validation of the choice of categories remains to be completed. The criterion *discrimination* refers to the ability of a measure to discriminate between different states of functioning or medical conditions. A discriminating measure must distinguish between different patient groups in a cross-sectional manner, and assess change of relevant aspects over time.

The objective of this study was to examine the relevance and completeness of the comprehensive ICF Core Sets for post-acute rehabilitation facilities. Specifically, we wanted to examine which aspects of functioning included in the comprehensive post-acute ICF Core Sets were frequent at admission to, and at discharge from, inpatient rehabilitation, and which aspects changed during hospital stay. We also searched for novel aspects that might be relevant for inclusion in the revised Set.

METHODS

Study design

A full description of the methods used in this study has been reported elsewhere (5). In brief, the study design was a prospective multicentre cohort study conducted from May 2005 to August 2008. The study population was recruited from post-acute rehabilitation facilities in 2 Austrian and 7 German hospitals, with approximately 9% of the patients being recruited from the Austrian centres. Patients were eligible if they were at least 18 years of age and experienced a recent acute episode of musculoskeletal, neurological, or cardiopulmonary injury or disease. Patients had to receive coordinated rehabilitation interventions by a multidisciplinary team and required ongoing need for nursing and medical care. Written informed consent was obtained from the patients or from the patient's care-giver in cases where the patient was unable to make an informed decision. Approval was obtained from institutional ethics committees from all involved institutions prior to starting the study.

Measures

For the assessment of functioning, we used the 3 comprehensive ICF Core Sets for patients in the post-acute rehabilitation situation, which were earlier developed to address the specific situations of patients with neurological, musculoskeletal, or cardiopulmonary conditions (4–6). For all patients, impairments in categories of the component Body Structures were graded as present or absent. Limitations or restrictions in categories of the components Body Functions and Activities and Participation were graded as "none", "slight/moderate/severe" or "complete" limitation or restriction. The categories of the component Environmental Factors were graded either as facilitator or barrier, or both. Change in the components Body Functions, Body Structures and Activities and Participation was defined as any change between the 3 recorded measures (none, slight/moderate/severe or complete), irrespective of the direction of the change.

We elected to report only those impairments, limitations and restrictions directly associated with the conditions causing the need for rehabilitation. The interviewers judged which of the impairments, limitations or restrictions resulted from the referring condition or principal diagnosis, and which occurred as a result of a specific co-morbidity. In order to validate the completeness of the comprehensive ICF Core Sets, the interviewers were furthermore asked to identify any aspects of functioning relevant to the patient, but not currently covered by the comprehensive ICF Core Sets. Additionally, socio-demographic (sex, age, education, living and occupation situation) and condition-specific data (underlying diagnosis, time until rehabilitation, number of co-morbidities and length of stay) were recorded.

Data collection procedures

Data were primarily collected from patients' medical record sheets, health professionals in charge of the patients, and from patients' interviews. Interviewers collecting data had been trained in the application and principles of the ICF, and provided with a manual. All interviewers were health professionals (physicians, medical students in clinical training, physical therapists, or nurses). During data collection interviewers obtained support and information from the ward staff in charge. Their ongoing supervision was ensured by periodic telephone calls.

Data collection took place within the first 24 h after admission to the hospital (baseline) and within the last 36 hours before discharge or, if length of stay was longer than 6 weeks, at 6 weeks after admission (end-point). ICF categories from the component Environmental Factors were assessed only at admission, since we did not expect any change in these categories during hospital stay.

Statistical analysis

For the categories of the ICF components Body Functions, Body Structures and Activities and Participation we calculated the absolute and relative frequencies (prevalences) of impairment, limitation or restriction at baseline and end-point. For the categories of the ICF component Environmental factors, we calculated the absolute and relative frequencies (prevalences) of persons who regarded a specific category as constituting either a barrier or facilitator. Relative frequencies of persons for whom the ICF category changed during the study period were calculated, along with their 95% confidence intervals (CI).

Aspects of functioning not covered by the comprehensive ICF Core Sets, but identified as relevant, were extracted and translated into the best corresponding ICF category. Absolute and relative frequencies of occurrence of those ICF categories were reported; any such category with prevalence below 5% was considered as not relevant.

RESULTS

Sociodemographic data

In total, 165 patients were included. Mean age at admission was 67.5 years (median 69.2; standard deviation (SD) 14.8 years). Mean length of stay was 14.9 days (median 10; SD 13.7 days). Forty-six percent of the patients were female (95% CI: 39–54). Sixty-seven had a neurological, 37 a cardiopulmonary and 61 a musculoskeletal condition. No patients were lost to follow-up. The most frequent admission diagnoses classified according ICD-10 in patients with neurological conditions were "Cerebrovascular diseases" ($n = 27$; 40.3%) and "Diseases of the nervous system", (most prominently inflammatory polyneuropathies) ($n = 22$, 32.8%). The most frequent admission diagnoses in patients with cardiopulmonary conditions

were "Diseases of the circulatory system ($n = 27$; 73.0%) and "Dyspnea" ($n = 7$, 18.9%) from "Symptoms and signs involving the circulatory and respiratory systems". The most frequent admission diagnoses in patients with musculoskeletal conditions were "Diseases of the musculoskeletal system and connective tissue" (mainly disc disorders) ($n = 14$; 23.0%) and fractures of the upper or lower extremities, or hip ($n = 19$, 31.1%). For further socio-demographic and condition-related variables see Table I.

Functioning and disability

Tables II–IV give the prevalence of impairment or restriction, both at admission and discharge, as well as the corresponding 95% CI:s for the frequency of change in impairment or restriction, for each category of underlying condition.

Of the categories of the components Body Functions and Structures and the Activities and Participation from the comprehensive ICF Core Sets, 86% were impaired or restricted for patients with neurological conditions in at least one-third of the patients, vs 63% from the cardiopulmonary patient group, and 67% from the musculoskeletal patient group.

Functioning and disability in patients with neurological conditions

The frequency of impairments or restrictions in patients with neurological conditions ranged from 5% to 99% (mean 56%) at admission and from 9% to 94% (mean 47%) at discharge. There was one category at admission with prevalence below or equal to 5%: *Structure of stomach* (s530).

The Body Functions and Body Structures most frequently impaired both at admission and at discharge were *Muscle endurance functions* (b740) (99% at admission/99% at discharge), *Muscle power functions* (b730) (97%/97%), *Gait pattern functions* (b770) (97%/93%), *Structure of cardiovascular system* (s410) (58%/60%), and *Structure of brain* (s110) (53%/51%).

The ICF categories from the component Activities and Participation (A&P) most frequently limited both at admission and at discharge were *Lifting and carrying objects* (d430) (99%/90%), *Moving around in different locations* (d460) (98%/94%), and *Walking* (d450) (97%/91%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 0% to 48% for the different ICF categories. The most frequent improvements were observed in A&P categories *Toileting* (d530) (48%), *Moving around using equipment* (d465) (47%), and *Dressing* (d410) (45%). The Body Functions which improved most frequently were *Gait pattern functions* (b770) (27%), *Respiration functions* (b440) (24%), *Ingestion functions* (b510) (24%), and *Defecation functions* (b760) (24%). The most frequent improvement in Body Structures was found in the *Structure of areas of skin* (s810) (16%).

The percentage of patients who reported deterioration on the different ICF categories ranged from 0% to 10%. The most frequent decline was observed in *Vestibular functions* (b235).

Functioning and disability in patients with cardiopulmonary conditions

In patients with cardiopulmonary conditions, information on the following categories were collected in only a minority of patients: *Voice functions* (b310), *Respiratory muscle functions* (b445), *Urinary excretory functions* (b610), *Muscle endurance functions* (b740), *Lifting and carrying objects* (d430), *Economic self-sufficiency* (d870), and *Community Life* (d910). For the sake of clarity we report the absolute frequencies of these categories in addition to the presented relative frequencies in the text.

The frequency of impairments or restrictions in patients with cardiopulmonary conditions ranged from 3% to 100% (mean 46%) at admission and from 0% to 100% (mean 33%) at discharge. There were two categories with prevalence below or equal 5% at admission: *Consciousness functions* (b110) with a prevalence of 5% *Family relationships* (d760) (3%). Categories

Table I. *Characteristics of participants*

Variable	All conditions	Neurological conditions	Cardiopulmonary conditions	Musculoskeletal conditions
Number of participants, *n*	165	67	37	61
Age, years, mean (SD)	67.5 (14.8)	63.9 (15.2)	78.3 (8.9)	64.8 (14.4)
Comorbidities, mean (SD)	3.1 (2.4)	2.5 (1.9)	4.9 (2.5)	2.8 (2.2)
Length of stay, days, mean (SD)	30.5 (18.1)	34.2 (19.9)	23.7 (14.5)	30.6 (17.1)
Time from event to rehabilitation onset, days, mean (median)	29.6 (17.0)	28.6 (14.5)	25.7 (13.0)	33.1 (22.5)
Female gender, %	46.1	35.8	54.1	52.5
Diagnosis, *n* (%)				
Diseases of the respiratory system (J00-J99)	1 (0.6)	1 (1.5)	0 (0)	0 (0)
Diseases of the circulatory system other than cerebrovascular diseases (I00-I52 and I70-I99)	34 (20.6)	2 (3.0)	27 (73.0)	5 (8.2)
Cerebrovascular diseases (I60-I69)	27 (16.4)	27 (40.3)	0 (0)	0 (0)
Diseases of the nervous system (G00-G99)	25 (15.2)	22 (32.8)	0 (0)	3 (4.9)
Diseases of the musculoskeletal system and connective tissue (M00-M99)	25 (15.2)	10 (14.9)	1 (2.7)	14 (23.0)
Injury, poisoning and certain other consequences of external causes (S00-T98)	24 (14.5)	0 (0)	0 (0)	24 (39.3)
Neoplasms (C00-D48)	6 (3.6)	2 (3.0)	1 (2.7)	3 (4.9)
Other diagnoses	23 (13.9)	3 (4.5)	8 (21.6)	12 (19.7)

SD: standard deviation.

Table II. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Functions – percentage of participants with impairment at admission/discharge and the extent of change over time*

		Neurological conditions $n=67$					Cardiopulmonary conditions $n=37$					Musculoskeletal conditions $n=61$				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
ICF	ICF Code Description	n^a	%[b]	n^a	%[b]	% (CI)[c]	n^a	%[b]	n^a	%[b]	% (CI)[c]	n^a	%[b]	n^a	%[b]	% (CI)[c]
b110	Consciousness functions	66	47	67	36	12 (5–22)	37	5	37	0	5 (1–18)					
b114	Orientation functions	65	45	67	33	15 (8–26)	37	19	37	14	8 (2–22)					
b126	Temperament and personality functions	61	56	66	44	15 (7–27)										
b130	Energy and drive functions	63	76	66	64	15 (7–26)	37	27	37	19	19 (8–35)	61	46	60	32	15 (7–27)
b134	Sleep functions	66	62	67	48	24 (15–36)	37	46	37	30	32 (18–50)	61	54	61	33	28 (17–41)
b140	Attention functions	66	56	67	42	24 (15–36)	37	16	37	11	16 (6–32)					
b144	Memory functions	63	54	66	48	11 (5–22)	37	14	37	16	3 (0–14)					
b147	Psychomotor functions	60	62	67	46	17 (8–29)										
b152	Emotional functions	63	63	66	52	22 (13–34)	37	16	36	8	11 (3–26)	58	47	61	31	21 (11–33)
b156	Perceptual functions	65	68	67	61	17 (9–28)										
b160	Thought functions	63	41	65	40	10 (4–20)										
b164	Higher-level cognitive functions	62	56	66	53	8 (3–18)										
b167	Mental functions of language	66	39	67	36	12 (5–22)										
b176	Mental function of sequencing complex movements	64	59	67	54	14 (7–25)										
b180	Experience of self and time functions	65	54	67	46	12 (5–23)										
b210	Seeing functions	63	16	67	15	3 (0–11)										
b215	Function of structures adjoining the eye	63	11	66	11	3 (0–11)										
b230	Hearing functions	65	9	67	12	3 (0–11)										
b235	Vestibular functions	63	24	67	24	19 (10–31)										
b240	Sensations associated with hearing and vestibular function	62	26	66	21	18 (9–30)										
b260	Proprioceptive function	67	90	67	85	19 (11–31)	36	14	37	11	6 (1–19)	61	67	61	52	25 (14–37)
b265	Touch function	66	64	67	58	15 (8–26)										
b270	Sensory functions related to temperature and other stimuli	63	57	67	54	25 (15–38)						52	40	52	27	21 (11–35)
b280	Sensation of pain	67	64	67	54	24 (14–36)	37	46	34	35	26 (13–44)	60	75	61	59	32 (20–45)
b310	Voice functions	65	51	66	38	18 (10–30)	6	67	6	17	67 (22–96)					
b320	Articulation functions	65	43	67	37	17 (9–28)										
b340	Alternative vocalization functions	65	38	66	27	15 (8–26)										
b410	Heart functions	60	35	67	36	5 (1–14)	37	81	36	81	25 (12–42)					
b415	Blood vessel functions	64	69	67	60	19 (10–30)	37	68	36	53	19 (8–36)	57	49	61	41	14 (6–26)
b420	Blood pressure functions	66	48	67	45	17 (9–28)	37	62	37	62	14 (5–29)					
b430	Haematological system functions	66	38	67	30	18 (10–30)	35	37	36	28	18 (7–35)					
b435	Immunological system functions	67	49	67	39	1 (7–26)	33	18	35	11	3 (0–16)	48	38	50	30	15 (6–28)
b440	Respiration functions	67	42	67	22	27 (17–39)	36	64	36	44	26 (12–43)	61	20	61	10	13 (6–24)
b445	Respiratory muscle functions						6	83	6	50	33 (4–78)					
b450	Additional respiratory functions	66	29	67	16	17 (9–28)	35	29	35	23	18 (7–35)					
b455	Exercise tolerance functions	66	77	67	75	8 (3–17)	37	92	37	86	22 (10–38)	58	64	60	52	21 (11–33)
b460	Sensations associated with cardiovascular and respiratory functions						35	77	36	67	21 (9–38)					
b510	Ingestion functions	66	47	67	33	29 (18–41)	37	19	37	14	14 (5–29)					
b515	Digestive functions	65	48	67	37	25 (15–37)										
b525	Defecation functions	66	61	67	45	26 (16–38)	37	14	36	8	11 (3–26)	61	18	61	13	13 (6–24)
b530	Weight maintenance functions	63	59	67	46	27 (17–40)	32	25	35	23	6 (1–21)	46	28	52	13	26 (14–41)
b535	Sensations associated with the digestive system	59	29	63	27	20 (11–33)										
b540	General metabolic functions	66	36	67	27	12 (5–22)										
b545	Water, mineral and electrolyte balance functions	66	59	67	49	20 (11–31)	34	26	34	12	24 (11–42)					
b550	Thermoregulatory functions	65	17	67	13	12 (5–23)										
b610	Urinary excretory functions						6	50	6	0	50 (12–88)					

Table II *contd.*

ICF	ICF Code Description	Neurological conditions $n=67$					Cardiopulmonary conditions $n=37$					Musculoskeletal conditions $n=61$				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
		n^1	%[2]	n^a	%[b]	% (CI)[c]	n^a	%[b]	n^a	%[b]	% (CI)[c]	n^a	%[b]	n^a	%[b]	% (CI)[c]
b620	Urination functions	67	57	67	46	27 (17–39)	37	19	37	5	16 (6–32)	60	20	60	13	10 (4–21)
b630	Sensations associated with urinary functions	59	51	61	36	25 (15–38)										
b710	Mobility of joint functions	67	81	67	73	16 (8–27)	37	49	37	32	19 (8–35)	61	92	61	92	13 (6–24)
b715	Stability of joint functions	67	64	67	49	24 (14–36)						61	69	61	66	23 (13–35)
b730	Muscle power functions	67	97	67	97	6 (2–15)	37	68	37	51	22 (10–38)	61	95	61	92	8 (3–18)
b735	Muscle tone functions	67	88	67	75	18 (10–29)						61	66	61	57	16 (8–28)
b740	Muscle endurance functions	67	99	67	99	9 (3–18)	6	100	6	83	33 (4–78)	52	94	52	88	10 (3–21)
b755	Involuntary movement reaction functions	67	73	67	60	27 (17–39)						48	21	52	12	17 (7–30)
b760	Control of voluntary movement functions	67	84	67	67	21 (12–33)	37	19	36	8	14 (5–29)	52	40	52	23	25 (14–39)
b770	Gait pattern functions	67	97	67	93	28 (18–41)						50	92	51	82	24 (13–38)
b780	Sensations related to muscles and movement functions						36	44	35	20	29 (15–46)	51	69	52	58	12 (4–24)
b810	Protective functions of the skin	66	52	67	34	24 (15–36)	37	41	37	30	14 (5–29)	52	77	52	48	31 (19–45)
b820	Repair functions of the skin						37	30	37	16	16 (6–32)					

[1]Number of valid answers.

[2]Proportion of impairments ("slight/moderate/severe" or "complete") in the category.

[3]Proportion of patients experiencing change (improvement or worsening) in the category. Numbers in parentheses represent upper and lower 95% confidence interval limits (CI).

of the component Body Functions had the highest prevalence of impairment both at admission and at discharge. As expected, impairments in *Functions of the cardiovascular system* (b410-b429), *Functions of the respiratory system* (b440-b449) and *Additional functions and sensations of the cardiovascular and respiratory systems* (b450-b499) were highly frequent in this patient group. Most frequently impaired at admission were *Muscle endurance functions* (b740, $n=6$) (100%), *Exercise tolerance functions* (b455) (92%), *Respiratory muscles functions* (b445) (83%, $n=5$), *Heart functions* (b410) (81%). The most frequently impaired at discharge were *Exercise tolerance functions* (b455) (86%), *Muscle endurance functions* (b740) (83%, $n=5$), *Heart functions* (b410) (81%).

The Body Structure most frequently impaired both at admission and at discharge was *Structure of cardiovascular system* (s410) (95% at admission/92% at discharge). The ICF categories from the component A&P most frequently limited at admission were *Lifting and carrying objects* (d430) (100%, $n=6$), *Carrying out the daily routine* (d230) (76%), *Walking* (d450) (76%) and *Moving around in different locations* (d460) (76%), the most frequently limited at discharge were *Lifting and carrying objects* (d430) (100%, $n=6$), *Economic self-sufficiency* (d870) (100%, $n=2$), *Moving around in different locations* (d460) (53%), *Caring for body parts* (d520) (51%), and *Walking* (d450) (49%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 0% to 100% for the different ICF categories. The most frequent improvements were observed in the categories *Economic self-sufficiency* (d870) (100%, $n=2$), *Voice functions* (b310) (67%, $n=4$), *Lifting and carrying objects* (d430, $n=4$) (67%), *Urinary excretory functions* (b610) (50%, $n=3$), *Muscle endurance functions* (b740) (33%, $n=2$), and *Respiratory muscle functions* (b445) (33%, $n=2$),

The percentage of patients reporting a deterioration in functioning at discharge ranged from 0% to 9% for the different ICF categories. The most frequent decline was observed in *Sensation of pain* (b280) (9%), *Sleep functions* (b134) (8%) and *Heart functions* (b410) (8%).

Functioning and disability in patients with musculoskeletal conditions

The frequency of impairments or restrictions in patients with musculoskeletal conditions ranged from 0% to 100% (mean 52%) at admission and from 0% to 92% (mean 40%) at discharge. There were 3 categories with prevalence below 5%: *Communicating with receiving spoken messages* (d310) with a prevalence of 2%, and *Religion and spirituality* (d930) (0%) and *Human rights* (d940) (0%).

The Body Functions most frequently impaired both at admission and at discharge were *Muscle power functions* (b730) (95% at admission/92% at discharge), *Muscle endurance functions* (b740) (94%/88%), *Mobility of joint functions* (b710) (92%/92%) and *Gait pattern functions* (s810) (92%/82%).

The Body Structures most frequently impaired were *Structure of lower extremity* (s750) (74%/68%) and *Structure of area of the skin* (s810) (69%/49%).

Table III. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Structures – percentage of participants with impairment at admission/discharge and the extent of change over time*

		Neurological conditions $n=67$					Cardiopulmonary conditions $n=37$					Musculoskeletal conditions $n=61$				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
ICF	ICF Code Description	n[a]	%[b]	n[a]	%[b]	% (CI)[c]	n[a]	%[b]	n[a]	%[b]	% (CI)[c]	n[a]	%[b]	n[a]	%[b]	% (CI)[c]
s110	Structure of brain	64	53	67	51	2 (0–8)										
s120	Spinal cord and related structures	66	29	67	22	6 (2–15)										
s130	Structures of meninges	65	11	67	9	6 (2–15)										
s410	Structure of cardiovascular system	65	58	67	60	11 (4–21)	37	95	37	92	8 (2–22)					
s430	Structure of respiratory system	65	28	67	24	12 (23)	37	41	36	31	11 (3–26)					
s530	Structure of stomach	65	5	67	12	5 (1–13)										
s710	Structure of head and neck region	67	22	67	16	6 (2–15)						61	11	61	8	3 (0–11)
s720	Structure of shoulder region	67	21	67	16	16 (8–27)						60	12	60	10	2 (0–9)
s730	Structure of upper extremity	67	31	67	28	9 (3–18)						61	21	61	18	3 (0–11)
s740	Structure of pelvic region											60	38	60	35	5 (1–14)
s750	Structure of lower extremity	67	42	67	37	7 (2–17)						61	74	60	68	8 (3–18)
s760	Structure of trunk						37	24	37	14	11 (3–25)	60	45	61	36	12 (5–23)
s810	Structure of areas of skin	67	52	67	37	18 (10–29)	37	38	37	30	8 (2–22)	61	69	61	46	23 (13–35)

[a]Number of valid answers.
[b]Proportion of impairments ("slight/moderate/severe" or "complete") in the category.
[c]Proportion of patients experiencing change (improvement or worsening) in the category. Numbers in parentheses represent upper and lower 95% confidence interval (CI) limits.

The ICF categories from the component A&P most frequently limited both at admission and at discharge were *Lifting and carrying objects* (d430) (100%/(0%), *Walking* (d450) (92%/84%), and *Moving around in different locations* (d460) (92%/87%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 2% to 42% for the different ICF categories. The most frequent improvements were observed in A&P categories *Toileting* (d530) (42%), *Dressing* (d540) (41%), and *Walking* (d450) (36%). The Body Functions which improved most frequently were *Protective functions of the skin* (b810) (31%), *Sensation of pain* (b280) (27%), and *Sleep functions* (b134) (25%). The most frequent improvement in Body Structures was found in the *Structure of areas of skin* (s810) (23%).

The percentage of patients reporting a deterioration in functioning at discharge ranged from 0% to 8% for the different ICF categories. The most frequent decline was observed in *Stability of joint functions* (b715) (8%).

Common aspects of functioning and disability in the 3 patient groups

A comparison of the 3 condition groups showed that there were several categories with highly frequent (> 50% of patients) impairment common to all patient groups at admission. These categories were *Exercise tolerance* (b455) (64–92%) and *Muscle power functions* (b730) (68–97%) and the A&P categories *Changing basic body position* (d410) (62–93%), *Lifting and carrying objects* (d430) (99–100%), *Walking and Moving* (d450-d469) (69–98%), and some of the *Self-care* categories (d510-d540) (65–96%).

Impairments in *Gait pattern* (b770) (92–97%) and *Proprioceptive functions* (b260) (67–90%) and limitations in *Transferring oneself* (d420) (74–90%) were highly prevalent in patients with neurological and musculoskeletal conditions at admission.

Contextual factors

Table V gives an overview of the occurrence of Environmental Factors serving as facilitators or barriers separated by conditions.

Environmental factors in patients with neurological conditions

The frequency of facilitators in patients with neurological conditions ranged from 78% to 100% (mean 93%). The frequency of barriers in these patients ranged from 0% to 34% (mean 12%). There were no categories identified as facilitators with prevalence below 5%. Eight categories identified as barriers had prevalence below 5%, as listed in Table V.

The Environmental Factors most frequently serving as facilitators in the patients with neurological conditions were *Immediate family* (e310), *Health professionals* (e355), *Individual attitudes of immediate family members* (e410), *Individual attitudes of friends* (e420), and *Health services, systems and policies* (e580). All 5 categories were mentioned as being facilitators by all neurological patients questioned.

The Environmental Factors most frequently serving as barriers in these patients were *Products and technology for personal indoor and outdoor mobility and transportation* (e115) (34%), *Products and technology for personal use in daily living* (e115) (25%), *Products and technology for communication* (e125) (25%), and *Products or substances for personal consumption* (e110) (24%).

Environmental factors in patients with cardiopulmonary conditions

In patients with cardiopulmonary conditions, information on the following categories was collected in only a minority of patients: *Design, construction and building products and*

Table IV. *International Classification of Functioning, Disability and Health (ICF) categories of the component Activities and Participation – percentage of participants with restrictions at admission/discharge and the extent of change over time*

		Neurological conditions $n=67$					Cardiopulmonary conditions $n=37$					Musculoskeletal conditions $n=61$				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
ICF	ICF Code Description	n[a]	%[b]	n[a]	%[b]	% (CI)[c]	n[a]	%%[b]	n[a]	%[b]	% (CI)[c]	n[a]	%[b]	n[a]	%[b]	% (CI)[c]
d110	Watching	66	39	67	33	8 (3–17)										
d115	Listening	66	32	67	22	11 (4–21)										
d120	Other purposeful sensing	64	52	66	36	18 (10–30)										
d130	Copying	64	48	67	39	14 (7–25)										
d135	Rehearsing	66	52	67	43	20 (11–31)										
d155	Acquiring skills	67	61	67	46	15 (7–26)	35	20	36	17	3 (0–15)	50	30	53	30	14 (6–27)
d160	Focusing attention	66	53	67	48	12 (5–22)										
d166	Reading	59	49	64	39	17 (8–29)										
d170	Writing	61	70	65	55	30 (19–43)										
d175	Solving problems	65	65	66	55	11 (5–21)										
d177	Making decisions	64	53	67	48	11 (5–21)	37	19	36	14	8 (2–22)	50	20	52	12	8 (2–19)
d230	Carrying out daily routine						37	76	36	47	42 (26–59)	50	64	52	42	34 (21–49)
d240	Handling stress and other psychological demands						35	46	36	33	24 (11–41)	56	54	61	43	18 (9–30)
d310	Communicating with – receiving – spoken messages	66	38	67	31	12 (5–22)						52	2	52	2	4 (0–13)
d315	Communicating with – receiving – nonverbal messages	65	40	67	36	9 (3–19)										
d330	Speaking	66	50	67	37	21 (12–33)										
d335	Producing nonverbal messages	66	47	67	36	15 (8–26)										
d350	Conversation	66	50	67	37	15 (8–26)										
d360	Using communication devices and techniques	64	53	66	39	16 (8–27)										
d410	Changing basic body position	67	93	67	60	46 (34–59)	37	62	37	38	35 (20–53)	61	80	61	62	28 (17–41)
d415	Maintaining a body position	67	85	67	66	31 (21–44)	37	32	37	11	22 (10–38)	61	59	61	36	26 (16–39)
d420	Transferring oneself	67	90	67	61	40 (28–53)	37	43	37	19	30 (16–47)	61	74	61	43	34 (23–48)
d430	Lifting and carrying objects	67	99	67	90	31 (21–44)	6	100	6	100	67 (22–96)	52	100	52	90	33 (20–47)
d440	Fine hand use (picking up, grasping)	67	88	67	70	24 (14–36)	37	27	36	22	11 (3–26)	52	23	52	17	8 (2–19)
d445	Hand and arm use	67	90	67	75	19 (11–31)	37	32	37	22	19 (8–35)	61	30	61	25	10 (4–20)
d450	Walking	67	97	67	91	39 (27–51)	37	76	37	49	46 (29–63)	61	92	61	84	36 (24–49)
d460	Moving around in different locations	66	98	67	94	32 (21–44)	37	76	36	53	47 (30–65)	52	92	52	87	29 (17–43)
d465	Moving around using equipment	67	96	66	76	48 (36–61)	35	69	35	29	49 (31–66)	52	83	51	61	35 (22–50)
d510	Washing oneself	67	96	67	72	42 (30–54)	37	70	37	49	30 (16–47)	60	87	61	57	33 (22–47)
d520	Caring for body parts	67	96	67	75	40 (28–53)	37	73	37	51	27 (14–44)	60	85	61	59	30 (19–43)
d530	Toileting	67	90	67	64	48 (35–60)	37	65	37	27	43 (27–61)	60	78	61	38	43 (31–57)
d540	Dressing	67	93	67	72	46 (34–59)	37	68	37	46	38 (22–55)	51	82	52	46	41 (28–56)
d550	Eating	66	76	67	52	33 (22–46)	37	41	37	8	32 (18–50)	61	26	61	15	11 (5–22)
d560	Drinking	66	70	67	46	38 (26–51)	37	32	37	5	27 (14–44)	52	17	52	8	10 (3–21)
d570	Looking after one`s health						34	26	34	18	9 (2–25)	45	40	52	23	22 (11–37)
d760	Family relationships	39	44	46	35	20 (8–37)	31	3	32	0	3 (0–18)	33	18	45	13	6 (1–21)
d870	Economic self-sufficiency						3	67	2	100	100 (16–100)					
d910	Community Life						3	67	3	67	100 (16–100)					
d930	Religion and spirituality	9	56	10	70	0 (0–41)						8	0	9	0	0 (0–41)
d940	Human rights											12	0	11	0	0 (0–31)

[a]Number of valid answers.

[b]Proportion of limitations/restrictions ("slight/moderate/severe" or "complete") in the category.

[c]Proportion of patients experiencing change (improvement or worsening) in the category. Numbers in parentheses represent upper and lower 95% confidence interval (CI) limits.

technology of buildings for private use (e155), *Air quality* (e260), *Associations and organizational services, systems and policies* (e555), and *General social support services, systems and policies* (e575). For the sake of clarity we provide absolute frequencies of these categories in addition to the relative frequencies presented in the text.

The frequency of facilitators reported by patients with cardiopulmonary conditions ranged from 31% to 100% (mean 73%), whereas the frequency of barriers ranged from 0% to 38% (mean 9%). There were no categories experienced as facilitating in less than 5% of the patients. Twelve categories (48%) were a barrier for less than 5% of the cardiopulmonary patients.

Table V. *International Classification of Functioning, Disability and Health (ICF) categories of the component Environmental Factors described as either facilitator or barrier at admission*

			Neurological conditions *n*=67		Cardiopulmonary conditions *n*=37		Musculoskeletal conditions *n*=61	
ICF	ICF Code Description	Specification	*n*[a]	%[b]	*n*[a]	%[b]	*n*[a]	%[c]
e110	Products or substances for personal consumption	Barrier	66	24	32	3	59	7
		Facilitator	66	98	32	91	59	95
e115	Products and technology for personal use in daily living	Barrier	65	25	35	6	56	11
		Facilitator	65	95	35	83	56	98
e120	Products and technology for personal indoor and outdoor mobility and transportation	Barrier	65	34	33	9	57	12
		Facilitator	65	94	33	100	57	96
e125	Products and technology for communication	Barrier	64	25	34	6	48	6
		Facilitator	64	83	34	82	48	94
e150	Design, construction and building products and technology of buildings for public use	Barrier			30	17	54	26
		Facilitator			30	73	54	83
e155	Design, construction and building products and technology of buildings for private use	Barrier			3	33		
		Facilitator			3	100		
e225	Climate	Barrier					33	12
		Facilitator					33	45
e245	Time-related changes	Barrier			29	34		
		Facilitator			29	31		
e250	Sound	Barrier			32	38		
		Facilitator			32	31		
e260	Air quality	Barrier			4	0		
		Facilitator			4	50		
e310	Immediate family	Barrier	47	4	32	3	34	9
		Facilitator	47	100	32	91	34	91
e315	Extended family	Barrier	17	12	25	4		
		Facilitator	17	82	25	72		
e320	Friends	Barrier	18	11	24	4	21	0
		Facilitator	18	89	24	75	21	100
e340	Personal care providers and personal assistants	Barrier					29	0
		Facilitator					29	97
e355	Health professionals	Barrier	67	4	34	0	60	2
		Facilitator	67	100	34	91	60	100
e360	Health related professionals	Barrier	36	8	24	0		
		Facilitator	36	97	24	83		
e410	Individual attitudes of immediate family members	Barrier	27	0	30	7	21	10
		Facilitator	27	100	30	87	21	90
e415	Individual attitudes of extended family members	Barrier	11	0	25	4		
		Facilitator	11	91	25	68		
e420	Individual attitudes of friends	Barrier	9	0	23	0	14	7
		Facilitator	9	100	23	65	14	100
e430	Individual attitudes of people in positions of authority	Barrier					11	0
		Facilitator					11	91
e440	Individual attitudes of personal care providers and personal assistants	Barrier					20	0
		Facilitator					20	95
e450	Individual attitudes of health professionals	Barrier	57	4	33	0	56	2
		Facilitator	57	98	33	79	56	98
e455	Individual attitudes of other professionals	Barrier			19	0		
		Facilitator			19	68		
e465	Social norms, practices and ideologies	Barrier	18	11	24	8		
		Facilitator	18	78	24	42		
e550	Legal services, systems and policies	Barrier	26	4				
		Facilitator	26	88				
e555	Associations and organizational services, systems and policies	Barrier			4	0	21	10
		Facilitator			4	50	21	90
e570	Social security, services, systems and policies	Barrier	44	5	29	3		
		Facilitator	44	98	29	66		
e575	General social support services, systems and policies	Barrier			5	0	31	10
		Facilitator			5	80	31	87
e580	Health services, systems and policies	Barrier	58	5	31	0	55	4
		Facilitator	58	100	31	74	55	100

[a]Number of patients in which the interviewers found the respective category relevant to describe the patient comprehensively.
[b]Proportion of patients in relation to all in which the interviewers found the respective category relevant to describe the patient comprehensively.

The Environmental Factors most frequently serving as facilitators in the patients with cardiopulmonary conditions were *Products and technology for personal indoor and outdoor mobility and transportation* (e115) (100%), *Design, construction and building products and technology of buildings for private use* (e155) (100%, $n=3$), *Products or substances for personal consumption* (e110) (91%), *Immediate family* (e310) (91%), and *Health professionals* (e355) (91%).

There were 5 (out of 24) Environmental Factors serving as barriers in more than 10% of the patients. These were *Sound* e250 (38%), *Time-related changes* (e245) (34%), and *Design, construction and building products and technology of buildings for private use* (e155) (33%, $n=1$), *Health services, systems and policies* (e580) (31%), and *Design, construction and building products and technology of buildings for public use* (e150) (17%).

Environmental factors in patients with musculoskeletal conditions

The frequency of facilitators among patients with musculoskeletal conditions ranged from 45% to 100% (mean 92%), whereas the frequency of barriers ranged from 0% to 26% (mean 7%). There were no categories as facilitators with prevalence below 5%. Seven categories as barriers had a prevalence below 5%.

The Environmental Factors most frequently serving as facilitators in the patients with musculoskeletal conditions were *Friends* (e320), *Health professionals* (e355), *Individual attitudes of friends* (e420), and *Health services, systems and policies* (e580), each of which was cited by all patients with musculoskeletal conditions. The Environmental Factors most frequently serving as barriers in musculoskeletal patients were *Design, construction and building products and technology of buildings for public use* (e150) (26%), *Products and technology for personal indoor and outdoor mobility and transportation* (e120) (12%), *Climate* (e225) (12%), and *Products and technology for personal use in daily living* (e115) (11%).

Additional ICF categories

Twenty-six aspects of functioning not previously covered by the comprehensive post-acute ICF Core Sets were identified as relevant by the interviewers. Aspects which were mentioned by at least 1% of the participants are presented in Table VI. All of the newly identified aspects could be translated into corresponding ICF categories. Twelve aspects were translated into categories of the component Body Functions, 12 to categories and chapters of the component Body Structures, and 2 to A&P categories.

DISCUSSION

The aim of the present study was to examine the relevance and completeness of the comprehensive ICF Core Sets for patients in post-acute rehabilitation facilities. The observed prevalence and change in functioning and disability and related contextual factors mainly confirms the first version of the comprehensive ICF Core Sets.

Table VI. *Additional International Classification of Functioning, Disability and Health (ICF) categories from the interviews*

ICF	ICF Code Description	All conditions $n=165$ n (%)	Neurological conditions $n=67$ n (%)	Cardiopulmonary conditions $n=37$ n (%)	Musculoskeletal conditions $n=61$ n (%)
Body Functions					
b610	Urinary excretory functions	6 (3.64)	0 (0)	–	6 (9.84)
b430	Haematological system functions	4 (2.42)	–	–	4 (6.56)
b540	General metabolic functions	3 (1.82)	–	0 (0)	3 (4.92)
b750	Motor reflex functions	3 (1.82)	3 (4.48)	0 (0)	0 (0)
b820	Repair functions of the skin	3 (1.82)	0 (0)	–	3 (4.92)
b210	Seeing functions	2 (1.21)	–	0 (0)	2 (3.28)
b310	Voice functions	2 (1.21)	–	2 (5.41)	0 (0)
b415	Blood vessel functions	2 (1.21)	–	–	2 (3.28)
b515	Digestive functions	2 (1.21)	–	0 (0)	2 (3.28)
Body Structures					
s540	Structure of intestine	19 (11.5)	17 (25.37)	0 (0)	2 (3.28)
s610	Structure of urinary system	7 (4.24)	0 (0)	2 (5.41)	5 (8.2)
s410	Structure of cardiovascular system	4 (2.42)	–	–	4(6.56)
s1	CHAPTER 1 STRUCTURES OF THE NERVOUS SYSTEM	3 (1.82)	1 (1.49)	0 (0)	2 (3.28)
s570	Structure of gall bladder and ducts	3 (1.82)	1 (1.49)	2 (5.41)	0 (0)
s730	Structure of upper extremity	3 (1.82)	–	3 (8.11)	–
s760	Structure of trunk	3 (1.82)	3 (4.48)	–	–
s560	Structure of liver	2 (1.21)	0 (0)	0 (0)	2 (3.28)
s580	Structure of endocrine glands	2 (1.21)	0 (0)	2 (5.41)	0 (0)
s630	Structure of reproductive system	2 (1.21)	2 (2.99)	0 (0)	0 (0)
Activities and Participation					
d650	Caring for household objects	2 (1.21)	0 (0)	2 (5.41)	(0)

–: not relevant, because the category has already been embodied in the corresponding comprehensive ICF Core Set.

All conditions

Patients in post-acute rehabilitation facilities mostly have a long history of hospital and intensive care unit (ICU) stays. Accordingly, patients from all 3 indication groups experienced high rates of impaired *Exercise tolerance* (b455) and *Muscle power functions* (b730), which reflects both impairments due to the underlying conditions as well as effects of prolonged immobilization (7–8). These deficits explain the frequent occurrence of limitations in self-care issues. Limitations in mobility issues, such as walking and moving around, lying down, sitting, or standing (included in *Changing basic body position* (d410)) are also frequently-reported consequences of prolonged immobilization, which underscores the need for additional rehabilitation care (6, 9).

Environmental factors related to personal support and relationships, such as family, friends or healthcare workers, were considered most frequently as facilitators, irrespective of the health condition. Indeed, support by family or friends or community services have previously been identified as relevant in the discharge decision of patients with acute musculoskeletal conditions (7).

Neurological conditions

As expected, impairments in cerebral structures, movement functions and mobility were frequent among patients with neurological conditions. It is notable that we observed significant improvement in self-care tasks during the follow-up interval, especially *Toileting* (d530) and *Dressing* (d540), and also improvement in functions related to mobility, both unassisted, and through use of assistive devices. This finding is in line with major rehabilitation goals in patients with neurological conditions such as stroke, namely the attainment of independence in self-care and mobility (8). Swallowing is a major issue in the rehabilitation of acquired brain injuries, and predicts functional outcome (10). The improvements we noted in categories related to respiration and ingestion may be attributed to successful swallowing therapy. We also found that improved mobility was associated with improved defecation functions and increased ability to toilet independently.

We identified some aspects as tending to deteriorate during rehabilitation of neurological patients, namely *Vestibular functions* (b235), which comprise the sensing of balance and position. Balance disorders and dizziness occurs frequently among patients with neurological disorders arising from cerebrovascular disease (11–12). Paradoxically, seeming deterioration in vestibular function might emerge along with improved mobility, which increases the burden on balance and coordination. It is highly possible that environmental factors, such as family and friends or health system's policy acting, may act as facilitators of or barriers to patients' functioning (13).

Seeing functions (b210) and *Functions of structures adjoining to the eye* (b215) showed low prevalence and hardly any change. Nevertheless, it should be discussed whether these categories should remain in the ICF Core Set because of their importance as basic sensory function.

Cardiopulmonary conditions

In patients with cardiopulmonary conditions the highest prevalence of impairments were observed in categories related to cardiovascular structures and functions, such as *Heart functions* (b410), *Exercise tolerance functions* (d455), or *Respiration functions* (b440). These impairments were associated with difficulties with self-care and mobility. We observed significant improvements during the rehabilitation process in functions related to the kidney (*Urinary excretory functions* (b610), *Muscle endurance functions* (b740) and *Respiratory muscle functions* (b445)). Normalization of diuretic functions is among the first signs of re-compensation after heart failure. Furthermore, the improvements in *Respiratory muscle function* (b445) may be attributed to lesser dyspnoea resulting from improved heart function.

Musculoskeletal conditions

The most frequently encountered musculoskeletal conditions entailing post-acute rehabilitation were fractures of the extremities, hip, or pelvis. Accordingly, the most frequent impairments were observed in categories related to movement, i.e. muscle and joint functions, and *Gait pattern functions* (b770). Most frequently, improvements were seen in *Walking* (d450) and Self-care, in agreement with an earlier report (14).

Approximately 25% of the patients in our study reported improvements in perceived pain, whereas 60% still experienced pain at the end of rehabilitation. In general, pain and sleep disturbance is common among patients after an acute injury, even after the acute phase (15–16).

We noted few additional topics not covered by the present version of the comprehensive ICF Core Sets, with the exception of *Structure of intestine* (s540), which occurred in 25% of the neurological patients. This association is in line with an earlier study, in which conditions such as peptic ulcer disease, gastrointestinal bleeding and *Clostridium difficile* proliferation were reported as relatively frequent medical complications following stroke (17). Gastrointestinal disorder should probably be considered as a topic for inclusion in the revised ICF Core Set.

Some limitations of our study may limit the generalizability of the results. The sample included only patients from German-speaking countries with comparable healthcare systems where post-acute rehabilitation facilities are well-established. The collection of data elsewhere in Europe, or on other continents, might well have yielded different results. Therefore, additional validation studies with patients from other countries and cultures should be carried out in the next phase of validation of the ICF. Impairments and limitations experienced by our patients may be a direct consequence of the underlying diagnoses encountered in the particular study. We are, however, confident that the current sample of older patients reflected the prototypical spectrum of diagnoses seen in Western Europe. However, this does not obviate the need to test the comprehensive ICF Core Sets as often as possible, and in many different settings. Another limitation pertains to

the fact that due to administrative problems not all categories could be applied to all patients. We are aware that this weakens evidence on those categories.

In conclusion, all categories of the comprehensive ICF Core Sets for the post-acute rehabilitation situation were confirmed due to their sensitivity to change. Categories that showed low prevalence or less change should be investigated particularly in further studies with respect to their significance for the patients. These future results should be put up for discussion among researchers and clinicians in the field of post-acute rehabilitation. All in all, we could not identify significant gaps in the established sets.

ACKNOWLEDGEMENTS

The authors thank all the study participants for their patience and collaboration, and Dr Paul Cumming for manuscript revisions. We further thank all participating hospitals involved in data collection, Kaiser-Franz-Josef-Hospital, Institute of Physical Medicine and Rehabilitation, Vienna (Austria), SMZ-Sophienspital, Ludwig Boltzmann Institute for Interdisciplinary Rehabilitation in Geriatrics, Vienna (Austria), University Hospital Munich, Department of Physical Medicine and Rehabilitation (Germany), General Hospital Munich Schwabing, Munich (Germany), Clinic and Institute for Physical and Rehabilitative Medicine, Nürnberg Süd Hospital (Germany), Institute for Physical and Rehabilitative Medicine, Ingolstadt Hospital (Germany), Malteser Krankenhaus, Department of Geriatrics, Bonn (Germany), Schön-Klinik Rosenheim (Germany) and Geriatric Rehabilitation Hospital Würzburg (Germany). The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501 and the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften, (TP 1).

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J Rehabil Med 2011; 43: 113–122

ORIGINAL REPORT

VALIDATION OF THE COMPREHENSIVE ICF CORE SET FOR PATIENTS IN GERIATRIC POST-ACUTE REHABILITATION FACILITIES

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Objective: **To examine the relevance and completeness of the comprehensive International Classification of Functioning, Disability and Health (ICF) Core Set for patients in geriatric post-acute rehabilitation facilities.**
Design: **Multi-centre cohort study.**
Patients: **A total of 209 patients (67% female, mean age 80.4 years) in geriatric wards of 2 Austrian and 3 German hospitals.**
Methods: **Data on functioning were collected using the respective comprehensive ICF Core Set. Data were extracted from patients' medical record sheets and interviews with health professionals and patients.**
Results: **Most of the categories of the comprehensive ICF Core Set describing impairments, limitations or restrictions occurred in a considerable proportion of the study population. The most outstanding limitations and restrictions of the patients were problems with walking and moving around, and difficulties with self-care. Fourteen aspects of functioning not previously covered by the comprehensive ICF Core Set were reported as relevant.**
Conclusion: **Most categories of the comprehensive ICF Core Set could be confirmed. Limitations in categories of intellectual and seeing functions appeared less frequently than might have been expected for a population of older hospitalized people. Some additional categories not covered by the present version of the comprehensive ICF Core Set emerged from the interviews and should be considered for inclusion in the final version.**

Key words: ICF; health services for the aged; cohort study; rehabilitation; outcome assessment; classification.

J Rehabil Med 2011; 43: 113–122

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Submitted May 25, 2010; accepted August 19, 2010

INTRODUCTION

Age is a predominant risk factor for many medical problems. In particular, older patients may be frail and present with a various range of conditions, co-morbidities, and impairments. Frailty is commonly defined as a state of declining ability of physiological systems to respond to external stressors, resulting in vulnerability to adverse outcomes (1). The medical conditions occurring in older patients are commonly chronic, multiple and multifactorial. Years ago, Bernard Isaacs described for geriatric syndromes 4 principal i's: immobility, instability, incontinence and intellectual impairment, calling them "the giants of geriatrics" (2). He argued that if one looks closely enough, all common medical problems with older adults are attributable to one of these central syndromes. The list of frequently encountered geriatric i's could be expanded to include iatrogenesis, isolation, insomnia, or immune deficiency. Older hospitalized patients are, furthermore, at high risk of developing functional decline arising from their immobility (3, 4). Geriatric medicine therefore requires a holistic approach offering therapy in a multidisciplinary team setting, with the aim of optimizing the patients' functional status and ameliorating their quality of life and autonomy (5). Geriatric care can be provided in a variety of settings, ranging from home to acute hospital care, rehabilitation settings and long-term care institutions. To summarize the scope of the problem, one can quote the Canadian geriatricians Rockwood & Hubbard: "We have complex patients (i.e. those with multiple needs, and a multifactorially determined state) on whom we apply a complex intervention (Comprehensive Geriatric Assessment and multidisciplinary care) to achieve a variety of ends." (6).

This multifactorial approach towards geriatric care requires a multidisciplinary team, in which a common understanding of functioning, disability and health is shared by all team members. In addition, the optimal approach needs to be complemented by a common agreement on concepts for the choice of appropriate assessment instruments and outcome measures for the applied interventions. The International Classification of Functioning, Disability and Health (ICF), which was created as a framework and language for describing and classifying functioning, health and disability (7), is considered to be an adequate reference system for this task (8). In order to enhance the applicability of the ICF in clinical practice and research and to overcome practical concerns relating to the great number of categories afforded within the ICF, the development of so-

called ICF Core Sets was initiated in recent years by the ICF Core Set project. Those comprehensive ICF Core Sets were created to provide standards for multi-professional comprehensive patient assessment, and should therefore include the typical spectrum of problems in functioning encountered in different patient populations. To this end, we generated comprehensive ICF Core Sets in which we aimed to select relevant ICF categories of particular validity for patients in the acute hospital and in post-acute rehabilitation facilities (9).

In general, the ICF Core Set project defines on an empirical basis a category as relevant when it describes a problem that is frequently encountered in typical patients, measured as an end-point in clinical trials, or was otherwise identified as being relevant following discussion among health professionals. The resultant information is then summarized and implemented as part of a formalized consensus process involving expert health professionals (9). One subset of the ICF has already been developed for use in patients at geriatric post-acute rehabilitation facilities (10).

As noted above, the ICF Core Set process assured that all the relevant aspects of functioning were included, but the empirical validation of the choice of categories remains to be completed. Thus, the objective of this study was to examine the relevance and completeness of the comprehensive ICF Core Set defined previously for patients in geriatric post-acute rehabilitation facilities. Specifically, we wanted to examine which aspects of functioning included in the comprehensive ICF Core Set

- were frequent at admission to and at discharge from post-acute rehabilitation facilities, and
- changed during stay in the post-acute rehabilitation facility, and
- also to identify new relevant aspects for inclusion in the revised Set.

METHODS

Study design

A full description of the methods used in this study has been reported elsewhere (11). In brief, the study design was a prospective multicentre cohort study conducted from May 2005 to August 2008. The study population was recruited from geriatric wards and units in 3 German hospitals, and 2 Austrian hospitals; approximately 62% of the patients were recruited from the German centres. Patients were eligible for inclusion if they were over 65 years of age, and fulfilled the criteria for post-acute geriatric rehabilitation, according to their need for ongoing medical and nursing care in addition to rehabilitation (12).

Measures

For the assessment of functioning, we used the comprehensive ICF Core Set for geriatric patients in post-acute rehabilitation facilities that was developed to cover the specific situation of older patients (10). For all patients, impairments in categories of the component Body Structures were graded as present or absent. Limitations or restrictions in categories of the components Body Functions and Activities and Participation were graded as "none", "slight/moderate/severe" or "complete" limitation or restriction. The categories of the component Environmental Factors were graded either as facilitator or barrier, or both.

We reported impairments, limitations and restrictions directly associated with the need for rehabilitation, regardless of the underlying health condition. In order to validate the completeness of the comprehensive ICF Core Set, the interviewers were furthermore asked to identify any aspects of functioning relevant to the patient, but not currently covered by the comprehensive ICF Core Set. Additionally, socio-demographic (sex, age, education, living and occupation situation) and condition-specific data (underlying diagnosis, time until rehabilitation, number of co-morbidities and length of stay) were recorded.

Data collection procedures

Data were primarily collected from patients' medical record sheets, health professionals in charge of the patients, and from patients' interviews. Interviewers collecting data were trained in the application and principles of the ICF and provided with a manual. Ongoing supervision of the interviewers was ensured by periodic telephone calls.

Data collection took place within the first 24 h after admission to the geriatric ward (baseline) and within the last 36 hours before discharge or, if length of stay was longer than 6 weeks, at 6 weeks after admission (end-point). ICF categories from the component Environmental Factors were assessed only at admission, since we did not expect any change in these categories during hospital stay.

Statistical analysis

For the categories of the ICF components Body Functions, Body Structures and Activities and Participation we calculated the absolute and relative frequencies (prevalences) of impairment, limitation or restriction at baseline and end-point. For the categories of the ICF component Environmental factors, we calculated the absolute and relative frequencies (prevalences) of persons who regarded a specific category as constituting either a barrier or facilitator. Relative frequencies of persons for whom the ICF category changed during the study period were calculated, along with their 95% confidence intervals (CI). Frequencies were calculated based on all available participants; change was calculated based on participants with data at baseline and at end-point. A difference between baseline and end-point was considered as change if the percentage of change was different from null and the confidence interval did not include the null.

Aspects of functioning not covered by the comprehensive ICF Core Set but identified as relevant were extracted and translated into the best corresponding ICF category (13). Absolute and relative frequencies of occurrence of those ICF categories were reported; any such category with prevalence below 5% was considered as not relevant.

RESULTS

Sociodemographics

In total, 209 patients were included. Mean age at admission was 80.4 years (median 80.9; standard deviation (SD) 7.3). Mean length of stay was 24.1 days (median 22.0; SD 13.1). Sixty-seven percent of the patients were female. Two patients (1%) were lost to follow-up because of unplanned discharges from hospital or death. The main admitting clinical problems were fractures ($n = 52$; 25%), among which 34 were fractures of the femur. Thirteen percent of the patients were admitted to hospital because of signs and symptoms that do not point definitely to a specific diagnosis, for example, dyspnoea, abnormalities of gait and mobility, dizziness and giddiness, or syncope and collapse. Further demographics and disease-related characteristics are presented in Table I.

Functioning and disability

Tables II–IV give the prevalence of impairment, limitation or restriction both at admission and discharge as well as the frequency of change and its 95% CI.

Table I. *Characteristics of participants*

Variable	
Participants, *n*	209
Age, mean (SD)	80.4 (7.3)
Comorbidities, mean (SD)	4.8 (2.6)
Length of stay, mean (SD)	24.1 (13.1)
Female gender, %	67.0
Medical diagnosis, *n* (%)	
Diseases of the respiratory system (J00–J99)	10 (4.8)
Diseases of the circulatory system other than cerebrovascular diseases (I00–I52 and I70–I99)	26 (12.4)
Cerebrovascular diseases (I60–I69)	19 (9.1)
Diseases of the nervous system (G00–G99)	13 (6.2)
Diseases of the musculoskeletal system and connective tissue (M00–M99)	16 (7.7)
Injury, poisoning and certain other consequences of external causes (S00–T98)	59 (28.2)
Neoplasms (C00–D48)	5 (2.4)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	28 (13.4)
Other diagnoses	33 (15.8)

SD: standard deviation.

Approximately 26% of the Body Functions and Structures and the Activities and Participation categories contained in the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities were reported as impaired, limited or restricted by at least one-third of the patients interviewed.

The most prevalent limitations and restrictions were found in the component Activities and Participation, specifically in *Walking and moving* (d450–d469) and *Self-care* (d510–d570), along with frequent impairments in associated categories of the component Body Functions such as *Gait pattern functions* (b770), *Muscle power functions* (b730), *Mobility of joint functions* (b710) and *Sensation of pain* (b280). Although many of the impairments, limitations and restrictions reported in these ICF categories at admission were substantially reduced at discharge, we found residual limitations and restrictions in approximately one- to two-thirds of all patients. At least 60% of the patients reported impairments at discharge in the categories *Muscle power functions* (b730) and *Gait pattern functions* (b770) and in *Walking and moving* categories.

The frequency of impairments or restrictions in geriatric patients ranged from 1% to 80% (mean 25%) at admission and from 0% to 66% (mean 18%) at discharge. There were 11 categories with prevalence below 5% at admission. The Body Functions (Table II) and Body Structures (Table III) most frequently impaired both at admission and at discharge were *Gait pattern functions* (b770) (73% at admission/66% at discharge), *Muscle power functions* (b730) (73%/60%), *Mobility of joint functions* (b710) (59%/48%), *Structure of cardiovascular system* (s410) (41%/35%), *Structure of areas of skin* (s810) (40%/33%), and *Structure of lower extremity* (s750) (35%/33%).

The ICF categories from the component Activities and Participation (Table IV) most frequently limited or restricted both at admission and at discharge were the *Walking and moving* categories *Moving around in different locations* (d460) (80% at admission/66% at discharge) and *Walking* (d450) (79%/61%) and the *Self-care* categories *Washing oneself* (d510) (75%/53%) and *Caring for body parts* (d520) (74%/55%).

The percentage of patients reporting an improvement in functioning at discharge ranged from 0% to 41% for the different ICF categories. The most frequent improvements were observed in Activities and Participation categories *Moving around using equipment* (d465) (41%), *Changing basic body position* (d410) (36%), and *Toileting* (d530) (33%). The Body Functions which improved most frequently were *Sensation of pain* (b415) (28%), *Sleep functions* (b134) (22%), and *Sensations related to muscles and movement functions* (b780) (22%). The most frequent improvement in Body Structures was found in the *Structure of areas of skin* (s810) (9%).

The percentage of patients who reported functional deterioration on the different ICF categories ranged from 0% to 5%. The most frequent decline was observed in *Handling stress and other psychological demands* (d240).

Contextual factors

Table V gives an overview of the occurrence of Environmental Factors serving as facilitators or barriers. The frequency of facilitators ranged from 21% to 92% (mean of 62%). The Environmental Factors most frequently serving as facilitators in the geriatric patients were *Health professionals* (e355) (92%), *Products and technology for personal indoor and outdoor mobility and transportation* (e120) (91%), and *Immediate family* (e310) (85%). There were no categories as facilitators with prevalence below 5%. The frequency of barriers ranged from 0% to 26% (mean of 7%). The Environmental Factors most frequently presenting barriers in these patients were *Time-related changes* (e245) (26%), *Sound* (e250) (26%), *Products and technology for culture, recreation and sport* (e140) (19%), and *Design, construction and building products and technology of buildings for public use* (e150) (17%).

Additional ICF categories

Fourteen aspects of functioning not previously covered by the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities were identified as relevant. Some of these aspects were mentioned only once or twice and are therefore not representative for the whole group and the corresponding ICF Core Set. Aspects which were mentioned by at least 1% of the participants are presented in Table VI.

All newly identified aspects could be translated into corresponding ICF categories. Four aspects referred to categories of the component Body Functions, 8 to categories and chapters of the component Body Structures, and 2 to categories of the component Activities and Participation. There were no categories from the component Environmental Factors that were identified as relevant, but not covered.

DISCUSSION

The results of the present multi-centre cohort study provide further insight into the course of functioning and health and its related

Table II. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Functions – percentage of participants with impairment at admission/discharge and the extent of change over time (*n = *209)*

ICF	ICF Code Description	Admission *n* (%)	Discharge *n* (%)	Change % [95% CI]
b110	Consciousness functions	209 (6)	207 (4)	4 [2–7]
b114	Orientation functions	208 (15)	206 (14)	6 [3–10]
b117	Intellectual functions	208 (3)	205 (3)	1 [0–3]
b130	Energy and drive functions	209 (24)	204 (17)	16 [11–22]
b134	Sleep functions	208 (40)	201 (22)	26 [20–32]
b140	Attention functions	209 (18)	207 (13)	12 [8–17]
b144	Memory functions	209 (22)	207 (18)	5 [2–9]
b147	Psychomotor functions	208 (14)	206 (9)	6 [3–11]
b152	Emotional functions	208 (15)	204 (11)	7 [4–12]
b156	Perceptual functions	209 (11)	205 (10)	3 [1–6]
b167	Mental functions of language	209 (8)	204 (6)	1 [0–4]
b176	Mental function of sequencing complex movements	209 (15)	206 (12)	6 [3–11]
b180	Experience of self and time functions	208 (12)	204 (10)	4 [2–8]
b210	Seeing functions	208 (3)	207 (1)	1 [0–3]
b215	Function of structures adjoining the eye	206 (2)	206 (2)	1 [0–4]
b230	Hearing functions	209 (1)	206 (0)	1 [0–3]
b240	Sensations associated with hearing and vestibular function	207 (15)	202 (5)	10 [6–15]
b260	Proprioceptive function	207 (14)	204 (9)	6 [3–11]
b265	Touch function	208 (15)	204 (12)	3 [1–6]
b270	Sensory functions related to temperature and other stimuli	205 (13)	199 (11)	6 [3–10]
b280	Sensation of pain	209 (57)	192 (33)	32 [25–39]
b320	Articulation functions	209 (8)	205 (5)	2 [1–6]
b410	Heart functions	209 (21)	206 (19)	8 [5–12]
b415	Blood vessel functions	209 (35)	205 (28)	11 [7–16]
b420	Blood pressure functions	209 (21)	207 (16)	10 [6–15]
b430	Haematological system functions	202 (13)	202 (8)	7 [4–11]
b435	Immunological system functions	196 (13)	198 (8)	9 [6–14]
b440	Respiration functions	207 (19)	205 (14)	9 [6–14]
b450	Additional respiratory functions	207 (10)	203 (8)	6 [3– 11]
b455	Exercise tolerance functions	207 (35)	204 (30)	12 [8–17]
b460	Sensations associated with cardiovascular and respiratory functions	206 (21)	203 (18)	10 [6–14]
b510	Ingestion functions	209 (13)	205 (9)	7 [4–11]
b525	Defecation functions	209 (21)	205 (13)	11 [7–16]
b530	Weight maintenance functions	201 (15)	201 (14)	9 [5–14]
b535	Sensations associated with the digestive system	207 (12)	205 (6)	8 [5–12]
b540	General metabolic functions	205 (9)	203 (7)	3 [1–6]
b545	Water, mineral and electrolyte balance functions	199 (20)	199 (9)	14 [9–20]
b620	Urination functions	209 (20)	205 (12)	10 [6–15]
b630	Sensations associated with urinary functions	208 (11)	205 (11)	5 [2–9]
b710	Mobility of joint functions	209 (59)	206 (48)	13 [9–18]
b715	Stability of joint functions	205 (47)	203 (37)	14 [9–19]
b730	Muscle power functions	209 (73)	206 (60)	19 [14–25]
b735	Muscle tone functions	209 (36)	206 (25)	17 [13–23]
b755	Involuntary movement reaction functions	208 (30)	204 (23)	9 [6–14]
b760	Control of voluntary movement functions	208 (20)	203 (15)	10 [7–15]
b765	Involuntary movement functions	208 (12)	203 (15)	3 [1–6]
b770	Gait pattern functions	207 (73)	202 (66)	18 [13–24]
b780	Sensations related to muscles and movement functions	205 (49)	198 (32)	26 [20–33]
b810	Protective functions of the skin	209 (30)	204 (14)	21 [15–27]
b820	Repair functions of the skin	206 (13)	204 (8)	10 [7–15]
b840	Sensation related to the skin	207 (15)	200 (10)	10 [6–15]

CI: confidence interval.

contextual factors in representative older patients being treated in post-acute rehabilitation settings. The present findings mainly confirm the validity of the first version of the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities. We found that a large number of the categories included in the comprehensive ICF Core Set address issues considered to be important to patients in geriatric post-acute rehabilitation facilities. Generally speaking, our cohort presented with a wide range of diagnoses, severity of illness, co-morbidities and cognitive and physical functional abilities, as is typical of this age group.

Table III. *International Classification of Functioning, Disability and Health (ICF) categories of the component Body Structures – percentage of participants with impairment at admission/discharge and the extent of change over time (*n = *209)*

ICF	ICF Code Description	Admission *n* (%)	Discharge *n* (%)	Change % [95% CI]
s110	Structure of brain	200 (24)	200 (24)	3 [1–6]
s120	Spinal cord and related structures	200 (2)	199 (2)	0 [0–2]
s320	Structure of mouth	206 (1)	205 (0)	1 [0–4]
s410	Structure of cardiovascular system	209 (41)	206 (35)	8 [5–12]
s430	Structure of respiratory system	208 (10)	206 (10)	2 [1–5]
s610	Structure of urinary system	204 (4)	203 (4)	1 [0–4]
s620	Structure of pelvic floor	201 (2)	202 (2)	1 [0–3]
s710	Structure of head and neck region	208 (4)	207 (3)	1 [0–3]
s720	Structure of shoulder region	209 (3)	207 (3)	2 [1–5]
s740	Structure of pelvic region	205 (13)	206 (12)	3 [1–6]
s750	Structure of lower extremity	209 (35)	207 (33)	2 [1–6]
s760	Structure of trunk	209 (11)	207 (10)	2 [1–5]
s770	Additional musculoskeletal structures related to movement	208 (24)	206 (19)	10 [6–15]
s810	Structure of areas of skin	209 (40)	207 (33)	11 [7–16]

CI: confidence interval.

Most common limitations and restrictions at admission and at discharge

The most outstanding limitations and restrictions of the patients, which were reported by more than half of the participants at admission, were problems with walking and moving around, difficulties with self-care activities, difficulties carrying out a daily routine, difficulties changing body position, lack of muscle power, limited joint mobility and pain. Thus, mobility limitations emerged as a key for these patients. This finding is in accordance with numerous previous studies concerning the

Table IV. *International Classification of Functioning, Disability and Health (ICF) categories of the component Activities and Participation – percentage of participants with limitations or restrictions at admission/discharge and the extent of change over time (*n = *209)*

ICF	ICF Code Description	Admission *n* (%)	Discharge *n* (%)	Change % [95% CI]
d130	Copying	208 (11)	204 (9)	3 [1–6]
d155	Acquiring skills	203 (20)	202 (16)	8 [4–12]
d177	Making decisions	207 (13)	202 (10)	6 [3–10]
d230	Carrying out daily routine	208 (70)	204 (50)	34 [27–41]
d240	Handling stress and other psychological demands	198 (34)	195 (29)	15 [10–21]
d310	Communicating with (receiving) spoken messages	208 (7)	203 (5)	0 [0–3]
d315	Communicating with (receiving) nonverbal messages	205 (5)	203 (5)	3 [1–6]
d330	Speaking	208 (9)	207 (7)	2 [1–6]
d335	Producing nonverbal messages	208 (8)	205 (5)	3 [1–6]
d360	Using communication devices and techniques	199 (16)	200 (16)	6 [3–11]
d410	Changing basic body position	208 (68)	205 (39)	37 [30–44]
d415	Maintaining a body position	208 (43)	206 (23)	25 [19–31]
d420	Transferring oneself	208 (40)	206 (16)	31 [24–37]
d440	Fine hand use (picking up, grasping)	208 (22)	203 (16)	8 [5–12]
d445	Hand and arm use	208 (20)	205 (13)	9 [6–14]
d450	Walking	206 (79)	205 (61)	31 [24–38]
d460	Moving around in different locations	206 (80)	204 (66)	27 [21–34]
d465	Moving around using equipment	195 (69)	199 (35)	44 [37–51]
d510	Washing oneself	208 (75)	206 (53)	25 [19–31]
d520	Caring for body parts	208 (74)	207 (55)	23 [17–29]
d530	Toileting	208 (61)	205 (30)	35 [28–42]
d540	Dressing	208 (73)	206 (47)	31 [25–38]
d550	Eating	208 (25)	206 (12)	16 [11–21]
d560	Drinking	208 (19)	206 (9)	12 [8–17]
d570	Looking after one's health	201 (23)	199 (18)	12 [8–18]
d760	Family relationships	192 (8)	194 (6)	4 [2–8]
d770	Intimate relationships	70 (9)	64 (6)	3 [0–11]
d860	Basic economic transactions	185 (21)	186 (17)	6 [3–11]
d930	Religion and spirituality	162 (21)	146 (8)	11 [6–17]
d940	Human rights	183 (5)	166 (5)	6 [3–10]

CI: confidence interval.

Table V. *International Classification of Functioning, Disability and Health (ICF) categories of the component Environmental Factors described as either facilitator or barrier at admission (*n = 209)

ICF	ICF Code Description	Specification	*n* (%)
e110	Products or substances for personal consumption	Barrier	194 (9)
		Facilitator	194 (82)
e115	Products and technology for personal use in daily living	Barrier	199 (9)
		Facilitator	199 (71)
e120	Products and technology for personal indoor and outdoor mobility and transportation	Barrier	193 (10)
		Facilitator	193 (91)
e125	Products and technology for communication	Barrier	202 (11)
		Facilitator	202 (72)
e140	Products and technology for culture, recreation and sport	Barrier	146 (19)
		Facilitator	146 (55)
e145	Products and technology for the practice of religion or spirituality	Barrier	131 (5)
		Facilitator	131 (37)
e150	Design, construction and building products and technology of buildings for public use	Barrier	181 (17)
		Facilitator	181 (71)
e240	Light	Barrier	196 (9)
		Facilitator	196 (47)
e245	Time-related changes	Barrier	188 (26)
		Facilitator	188 (21)
e250	Sound	Barrier	200 (26)
		Facilitator	200 (22)
e310	Immediate family	Barrier	190 (5)
		Facilitator	190 (85)
e315	Extended family	Barrier	153 (3)
		Facilitator	153 (67)
e320	Friends	Barrier	148 (1)
		Facilitator	148 (64)
e325	Acquaintances, peers, colleagues, neighbours and community members	Barrier	174 (3)
		Facilitator	174 (57)
e330	People in position of authority	Barrier	126 (4)
		Facilitator	126 (55)
e355	Health professionals	Barrier	201 (1)
		Facilitator	201 (92)
e360	Health-related professionals	Barrier	145 (1)
		Facilitator	145 (81)
e410	Individual attitudes of immediate family members	Barrier	182 (4)
		Facilitator	182 (81)
e415	Individual attitudes of extended family members	Barrier	147 (3)
		Facilitator	147 (59)
e420	Individual attitudes of friends	Barrier	136 (0)
		Facilitator	136 (57)
e425	Individual attitudes of acquaintances, peers, colleagues, neighbours and community members	Barrier	165 (4)
		Facilitator	165 (53)
e430	Individual attitudes of people in positions of authority	Barrier	119 (5)
		Facilitator	119 (55)
e450	Individual attitudes of health professionals	Barrier	198 (0)
		Facilitator	198 (75)
e455	Individual attitudes of other professionals	Barrier	136 (1)
		Facilitator	136 (74)
e460	Societal attitudes	Barrier	165 (11)
		Facilitator	165 (28)
e465	Social norms, practices and ideologies	Barrier	156 (13)
		Facilitator	156 (29)
e570	Social security, services, systems and policies	Barrier	182 (4)
		Facilitator	182 (69)
e580	Health services, systems and policies	Barrier	193 (2)
		Facilitator	193(81)

Table VI. *Additional International Classification of Functioning, Disability and Health (ICF) categories emerging as not yet included in the Comprehensive ICF Core Sets (*n = *209)*

ICF	ICF Code Description	*n* (%)
Body Functions		
b555	Endocrine gland functions	10 (4.8)
b310	Voice functions	4 (1.9)
b130	Energy and drive functions	2 (1.0)
b610	Urinary excretory functions	1 (0.5)
Body Structures		
s540	Structure of intestine	19 (9.0)
s730	Structure of upper extremity	19 (9.0)
s630	Structure of reproductive system	6 (2.9)
s530	Structure of stomach	4 (1.9)
s570	Structure of gall bladder and ducts	4 (1.9)
s7	CHAPTER 7 STRUCTURES RELATED TO MOVEMENT	4 (1.9)
s560	Structure of liver	2 (1.0)
s580	Structure of endocrine glands	2 (1.0)
Activities and Participation		
d455	Moving around	24 (11.5)
d650	Caring for household objects	2 (1.0)

prevalence of impairments and disability in older adults (14, 15). Physical functioning, which encompasses mobility and basic activities of daily living, is, furthermore, a main area of any geriatric assessment, and of assessments in outcome studies concerning health and disability in aged people (16, 17). Mobility and basic activities of daily living are critical aspects of functioning for older people aspiring to maintain independent living and a satisfactory quality of life.

All highly frequent restricted categories showed improvement at the end of the hospital stay. Nonetheless, problems with walking and moving around, difficulties with self-care activities, and difficulties carrying out a daily routine, were found to be the most common limitations and restrictions also at discharge being reported. These limitations and restrictions were all reported, with few exceptions, by more than one-half of the patients, along with associated Body Function impairments such as lack of muscle power and impaired gait pattern functions. Gait disorders are common in aged populations, and often prove not completely amenable to rehabilitation or treatment. While there is a tendency towards increasing prevalence of gait disorders with advancing age (15), it has been pointed out that disordered gait is not an inevitable consequence of ageing, but rather a reflection of the increased prevalence and severity of age-related diseases and disorders such as degenerative joint disease, cardiovascular disease, or impairment following orthopaedic surgery (18). Moreover, it is well known that hospitalized older persons are at high risk for functional decline as a consequence of their acute medical illness, the medical or surgical therapies initiated, or deconditioning due to forced immobility (3, 4).

Moving around using equipment (d465) and *Toileting* (d530) were the sole exceptions among *Walking and Moving* and *Self-care* categories, with notably better performance than the other categories. Both were restricted in approximately one-third of the patients at discharge. *Moving around using equipment* (d465) was, furthermore, the category with the most frequent improvement (41%) of all categories of the ICF Core Set for geriatric patients, whereas *Toileting* (d530) was the category with the most frequent improvement (33%) among all *Self-care* categories.

Hand-held walking aids, such as canes and walkers are indispensible for improving stability in older adults with gait and balance disorders, allowing them to live more independently and participate in community life. For persons who cannot walk, or who tire very easily, a wheelchair may be required. The results of our study indicate that many of the participants were provided with (more) appropriate mobility aids and equipment, including fitting and instruction, during the course of their hospital stay.

To encourage patients to improve their ability to self-care, especially with respect to toileting, is a major focus of geriatric care and rehabilitation. The capacity for independent toileting without assistance requires mobility and toileting skills, including the ability to sit down and rise from the seated to a standing position, as well as cleaning oneself. In comparison with other self-care activities, such as, for example, washing (including all body parts), improved toileting can be achieved in a shorter time. Toileting appears to be a less complex activity in terms of the number and the intricacy of demanding skills that it entails. Additionally, the availability of devices such as raised toilet seats or toilet frames enable people with rather severe disabilities to manage their toileting without assistance, plausibly accounting for the comparatively high percentage of patients with improvement in this category observed at discharge.

Residual limitation at discharge

Despite a high degree of overall functional improvement, there were several categories with residual limitation, as was noted in approximately two-thirds of patients at discharge. In particular, *Muscle power functions* (b730) and *Walking* (d450) were restricted in 60%/61% and *Gait pattern functions* (b770) and *Moving around in different locations* (d460) were limited or restricted in 66% of the participants at discharge.

With advancing age, muscle power declines, sometimes precipitously (19), which causes weakness and frailty. Loss of muscle power is linked to poor balance, gait speed, falls, and fractures, consequently contributing importantly to the decline in functional ability and independence in old age (20). Although there is evidence that exercise and muscle power-specific training can increase muscle power and improve function even in very old people, recovery of muscle power after hospitalization can be a lengthy process (21, 22). Given the brief mean length of stay in our study, substantial recovery of muscle power was not to be expected in all patients.

Contextual factors

All Environmental Factors contained in the comprehensive geriatric ICF Core Set were reported either as a barrier or as a facilitator. Notably, patients were more apt to identify these factors as facilitator than as a barrier. The most frequent facilita-

tors, which were specified by more than 85% of these patients, were *Health professionals* (e355), *Products and technology for personal indoor and outdoor mobility and transportation* (e120), and *Immediate family* (e310). The most frequently reported barriers were *Time-related changes* (e245) and *Sound* (e250), which were mentioned by one-quarter of respondents. We presume that these barriers arose from environmental changes due to hospitalization, resulting in exposure to an unfamiliar, noisy environment, which is potentially disruptive of patients' habitual circadian patterns.

The lack of family members' presence and support can be a major factor affecting the hospitalized older patients' social relationships and personal well-being. Based on a review of studies concerning family care for hospitalized aged, Li et al. (23) summarize that family care actions usually consist of provision of emotional support, or visiting and helping with daily activities. Other researchers have differentiated between directive behaviours, in which the family member acts on behalf of the older adult or as an advisor, and supportive behaviours, in which the family member motivates and stimulates the older patient (24).

The ICF defines the category e120 as "equipment… used by people in activities of moving inside and outside buildings…" (7: 174). This category received the most frequent mention as facilitator, being cited by 91% patients, thus emphasizing the importance of assistive mobility for older patients, noted above.

Infrequent notations

There were 11 categories, mostly from the component Body Structures, with prevalence below 5% at admission and discharge.

Intellectual functions

Cognitive impairment occurs frequently in older adults, but its early stages are often undiagnosed, despite the high risk of progression to dementia. Recent epidemiological studies from European countries cited prevalence rates of 10–25% for mild cognitive impairment (MCI) in patients aged 65 years and older in western industrialized nations, with a mean prevalence of approximately 16%. The incidence rates of all prodromal dementia syndromes were found to increase with age (25). Nonetheless, the percentage of patients with impaired *Intellectual functions* (b117) was relatively low in our study (3%). However, our survey did not include standardized diagnostic tests for the detection of cognitive impairment, such that it seems likely that the true prevalence of cognitive impairment was underestimated in our study population.

Seeing and Hearing functions

Although hearing and vision impairments are common in older adults (26) and of increasing incidence with age (27), few patients in our sample population reported these impairments. Appropriate use of properly adjusted glasses and/or hearing aids might well explain this discrepancy, such that the patients do not perceive themselves to be impaired with respect to these senses. Nonetheless, Wallhagen et al. (28) have shown that hearing and vision impairments have strong independent impacts on subsequent physical, mental and social functioning. Impairments in either of these senses have the potential to disrupt interpersonal relations and severely constrain social participation of the persons affected. Thus, Lupsakko et al. (29) found an association between combined hearing and visual impairment and depressive symptoms in an aged population. Visual impairment is, furthermore, a risk factor for falls and fall injuries in older adults (30). For these reasons, *Seeing functions* (b210) and *Hearing functions* (b230) are an essential part of an ICF Core Set, with particular relevance to the clinical framework for comprehensive assessment of functioning in elderly persons.

Body Structures

In comparison with the other comprehensive ICF Core Sets for patients in post-acute rehabilitation facilities (31–33), the ICF Core Set for older patients contains relatively many Body Structure categories. This reflects the wide range of medical diagnoses and comorbidities commonly found among older patients, even though not equal importance is attributed to every category. While impairments of the cardiovascular system, structure of lower extremity and structure of areas of skin were present in more than one-third of the aged patients participating in our study, several Body Structure categories were mentioned as being impaired by only few patients. Arguably, the particular categories must depend on the case mix of patients being investigated, such that Body Structure categories might be not be optimal candidates for an ICF Core Set.

Human rights

The Activities and Participation category *Human rights* (d940) implies, among other things, the right to self-determination or autonomy and the right to control over one's destiny (7). In the present context, it refers to the potential for restriction of privacy and dignity of geriatric inpatients. Indeed, a key component of human rights in the hospital setting is the maintenance of patient integrity and dignity, which implicates that patients are treated and cared for with respect. Human rights issues can arise in diverse contexts in the hospital setting, potentially encompassing, for example, the right to protect one's personal information as confidential, the right to expect treatment which respects one's dignity, or the right to control one's personal sphere and territory (34). During the 2003 ICF Core Set Consensus Conference, the category *Human rights* (d940) provoked extensive discussions between the participating experts. The question whether or not *Human rights* (d940) should actually be included in the ICF Core Set for aged patients was decided only after the third and last vote (10). Among the patients participating in our current study, only 5% complained of disregard for their human rights. However, consideration of ethical issues must always be a central aspect of clinical practice, especially for older persons, whose

autonomy may be particularly vulnerable. Recent studies have shown that enhancing dignified care in hospital practice is still an essential concern for older patients (35, 36).

Additional topics

While some particular categories were of lesser importance, other issues emerged from the interviews that are so far not covered by the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities. These aspects of functioning comprised 14 additional ICF categories, most of which were mentioned by less than 5% of the participants. Of the additional ICF categories, more than one-half belong to the component Body Structures, of which *Structure of intestine* (s540) and *Structure of upper extremity* (s730) were the most frequently named, each with 19 mentions (9%). *Structure of upper extremity* (s730) is the only *Structure related to movement* identified in the present study that is not yet been contained in the comprehensive ICF Core Set for aged patients.

While the categories *Walking* (d450), *Moving around in different locations* (d460), and *Moving around using equipment* (d465) are already part of the comprehensive ICF Core Set for aged patients, climbing stairs came up so frequently in our interviews as to be a candidate for inclusion. Climbing stairs can be linked to the Activities and Participation category *Moving around* (d455), which is the only *Walking and moving* (d450–d469) category not yet covered by the ICF Core Set for aged patients. In general, these findings once again demonstrate the importance of mobility-related Body Structures, Body Functions and Activities and Participation in the study of functioning of older adults.

Some limitations of our study need mentioning. The sample included only patients from two German-speaking countries, with comparable healthcare systems, and may not be generalizable. Novel results might be obtained with data collection elsewhere in Europe, or around the world. This raises the need for additional validation studies with patients from other countries and cultures. In general, impairments, limitations and restrictions may be a direct consequence of the underlying diagnoses leading to hospitalization. We are, however, confident that the current sample of older patients is representative of the spectrum of diagnoses typical for a geriatric population. Nevertheless, complete validation for comprehensive ICF Core Set requires the implementation in as many different settings as possible.

The relatively low prevalence of cognitive and sensory impairment in our study indicates that there has been a selection of participants. Potentially this is another drawback for generalizability. However, it has to be kept in mind that it is difficult to elicit information from non-responsive patients, thus studies relying on the patient perspective, like our study will usually have to face this problem.

In conclusion, most categories of the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities were confirmed. Some additional categories not covered by the Set in its present version emerged from the interviews and should be considered for inclusion in a finalized version.

ACKNOWLEDGEMENTS

The authors thank all the study participants for their patience and collaboration. We furthermore thank all participating clinics and rehabilitation centres involved in data collection: Ludwig Boltzmann Institute for Interdisciplinary Rehabilitation in Geriatrics, SMZ-Sophienspital, Vienna (Austria), Malteser Krankenhaus, Department of Geriatrics, Bonn (Germany), Schön Klinik Rosenheim (Germany), Geriatric Rehabilitation Hospital Würzburg (Germany), Kaiser-Franz-Josef-Hospital, Institute of Physical Medicine and Rehabilitation, Vienna (Austria). The authors thank Dr Paul Cumming for textual revisions. The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501 and by the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften (TP 1).

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J Rehabil Med 2011; 43: 123–130

ORIGINAL REPORT

BRIEF ICF CORE SETS FOR THE ACUTE HOSPITAL

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Objective: **To identify candidate categories for brief International Classification of Functioning, Disability and Health (ICF) Core Sets for the reporting and measurement of functioning in patients in the acute hospital.**
Design: **Prospective multi-centre cohort study.**
Patients: **Patients receiving rehabilitation interventions for musculoskeletal, neurological or cardiopulmonary injury or disease in acute hospitals.**
Methods: **Functioning and contextual factors were coded using the ICF. The criterion for selecting candidate categories for the brief ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, the independent variables being all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables.**
Results: **A total of 391 patients were included in the study (91 neurological, 109 cardiopulmonary, 191 musculoskeletal), mean age 63.4 years, 50.1% female. Selection yielded 33 categories for neurological, 31 for cardiopulmonary, and 30 for musculoskeletal.**
Conclusion: **The present selection of categories can be considered an initial proposal, serving to identify the ICF categories most relevant for the practical assessment and monitoring of functioning in patients with acute neurological, cardiopulmonary, and musculoskeletal conditions.**

Key words: ICF; health status measurements; outcome assessment; classification; regression analysis; intensive care.

J Rehabil Med 2011; 43: 123–130

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Submitted May 25, 2010; accepted September 30, 2010

INTRODUCTION

Patients in developed countries now have a higher likelihood of surviving acute injury or illness (1–2). However, recovery may be marred by significant loss of functioning. Several factors are increasing the risk for future disability in patients in the acute hospital, e.g. prolonged stay at intensive care, old age, or frailty. Therefore, the risk for disability has to be identified, and appropriate interventions should be provided at the earliest possible stage in acute treatment (3), e.g. after acute stroke (4). It is held that healthcare professionals in the acute hospital should be able to make a brief assessment of their patients' functioning, so as to identify those patients who are especially vulnerable to future disability, and set in motion timely strategies for meeting their subsequent rehabilitation needs. In order to communicate their patients' particular needs to all other professionals involved in the provision of rehabilitation care, healthcare professionals must have recourse to a standard system for describing human functioning and rating disability. To this end, there must be defined standards for what to report and how to measure functioning and disability. However, instruments recommended for the use in the acute situation, such as the Functional Independence Measure (FIM™) (5), measure selected aspects of self care and are not commonly used in all acute care settings. For example, the FIM is used most frequently in neurological care, but displays ceiling effects in other care situations (6).

The International Classification of Functioning, Disability and Health (ICF), a part of the family of international classifications of the World Health Organization (WHO), provides a common framework for describing and classifying health and disability. The ICF classifies domains of functioning, along with their contextual factors, which are encountered in human life. As such, the ICF may arguably constitute a comprehensive framework and a guide for healthcare planning and for measuring the changes brought by interventions across a multitude of dimensions from body functions to personal activities, societal participation and environmental factors. It also provides the potential framework for transition along the continuum of care. For example, assessment of functioning in acute care cannot be carried over to other episodes of care, such as rehabilitation, unless there is a common assessment scheme. A classification must be exhaustive by its very nature and becomes very complex in daily use unless it is transformed into practice-friendly tools. Comprising over 1400 categories,

the entire volume of the ICF cannot be applied by the clinicians to all their patients. In daily practice clinicians will need only a fraction of the categories found in the ICF. Although there are generic instruments based on the ICF that are designed as practical translations of the ICF and are usable across a wide range of applications, the generic character may be a drawback in specific settings. Thus, in this trade-off between generalizability and the need to capture the detail, the ICF must be adapted to the perspectives and needs of different users. The need to tailor ICF to the needs of particular contexts is the primary motivation behind the ICF Core Set project, which aims to extract selections of ICF categories from the entire classification that are relevant to specific health conditions or care situations. This on-going project of selection of the so-called comprehensive ICF Core Sets will define common standards for what should properly be measured and reported.

In general, the ICF Core Set project seeks to define on an empirical basis the ICF categories relevant for the condition and rehabilitation of typical patients in acute care, especially when applied as an endpoint in clinical trials, or if identified as being relevant following discussion among health professionals (7). By including all potentially relevant categories, the Core Set selection process is comprehensive, omitting only those factors that proved to be irrelevant to designing treatment strategy or assessing outcome. Due to the consensus process, the ICF Core Sets in their present version are comprehensive, and applicable for the assessment of individual problems and needs. As such, they permit the estimation of prognosis and the potential for rehabilitation, with general applicability for assessment of functioning in the acute situation, e.g. at the intensive care unit. Comprehensive acute ICF Core Sets were developed for patients with conditions falling into 3 main categories: neurological, cardiopulmonary and musculoskeletal (8–10). This stratification was based on practical considerations related to healthcare provision being organized according to organ system and the varying spectrum of problems experienced in patients with neurological, musculoskeletal and cardiopulmonary conditions. This approach was used in prior studies on functioning in the acute care situation (11) and verified by focus groups (12). The comprehensive Core Sets have been validated from the perspectives of patients and healthcare professionals (13–15). The 3 comprehensive acute ICF Core Sets include second-level ICF categories, encompassing 85 neurological conditions, 48 cardiopulmonary conditions, and 47 musculoskeletal conditions. While the ICF is comprehensive, it is usually necessary to obtain a minimally sufficient data-set: In clinical practice, this may encompass only 20 different concepts or topics, selected from the comprehensive ICF Core Sets. Thus, subsets from the comprehensive Core Sets must be created, also on an empirical basis, and according to specific needs of the individual user. Methods have been proposed for identifying candidate categories for brief ICF Core Sets, selected from the comprehensive acute ICF Core Sets (16). The objective of this study was to employ these methods for identifying candidate categories for brief ICF Core Sets for the reporting and measurement of functioning in patients in the acute hospital.

METHODS

Detailed methods of the ICF Core Set development have been described elsewhere (16). In brief, a prospective multi-centre cohort study was conducted from May 2005 to August 2008 in 5 acute hospitals in Germany, Austria and Switzerland. The participating facilities were University Hospital Vienna (Department of Physical Medicine and Rehabilitation, Vienna, Austria), Kaiser-Franz-Josef-Spital (Institute for Physical Medicine and Rehabilitation, Vienna, Austria), University Hospital Zurich (Department of Rheumatology and Institute for Physical Medicine, Zurich, Switzerland), Hannover Medical School (Department of Rehabilitation Medicine, Hannover, Germany), and Orthopaedic University Hospital (Heidelberg, Germany). Selection of study centres was based on size of the respective wards and on previous experience of the facility with the ICF. Precondition for inclusion of the facility was a multi-disciplinary team-oriented approach to rehabilitation. Patients were eligible if they were at least 18 years of age and received team integrated multiprofessional rehabilitation interventions for acute musculoskeletal, neurological, or cardiopulmonary injury or disease. As such, rehabilitation interventions could be provided either at a dedicated rehabilitation ward situated in the acute hospital or by mobile rehabilitation teams caring for patients on medical or surgical wards or at an intensive care unit. Informed consent was obtained from the patients or from the patient's care-giver in cases where the patient was unable to make an informed decision. Approval was obtained from institutional ethics committees from all involved institutions prior to starting the study.

As noted above, we have developed the comprehensive ICF Core Sets in order to facilitate and promote the use of the ICF in clinical practice and research. The comprehensive ICF Core Sets are selections from the entire list of ICF categories, which emerged from a multi-stage consensus process seeking to identify those aspects of functioning most relevant for patients in specific settings or with specific health conditions. Three comprehensive ICF Core Sets were developed for patients receiving acute treatment for neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in the acute situation (8–10). The current study made use of a combination of these 3 comprehensive ICF Core Sets for patient assessment.

For scoring of the Core Sets, the ICF suggests assigning qualifiers ranging from 0 to 4 for each category. Because the properties of all qualifiers are not yet sufficiently evaluated, in the present study we used a simplified qualifier, defined as follows. Each category of the components Body Functions and Activities and Participation was graded with the qualifiers 0 for "no impairment/limitation", 1 for "moderate impairment/limitation" and 2 for "severe impairment/limitation". The categories of the component Body Structures were graded with the qualifiers 0 for "no impairment" and 1 for "impairment". The categories of the component Environmental Factors were graded with 0 for "no barrier/facilitator" and 1 for "barrier/facilitator". Impairments of body functions or structures, and limitations or restrictions of activities and participation were recorded if they were directly associated with the condition necessitating rehabilitation.

To provide a global overview of functioning, the patients were asked to report their difficulties in overall functioning using a horizontal visual analogue scale, ranging from zero, for complete difficulty in all aspects of functioning to 10, for no difficulty in functioning). "Overall functioning" was defined as encompassing all aspects of physical or mental state, of daily living, mobility and interaction with the environment and with others. Patients were asked to relate to their current health condition and their present state. Independently, and blinded to the patients' responses, the health professionals were asked to appraise their patients' functioning on the same analogue scale.

Patients were recruited and interviewed by health professionals who were trained in the application and principles of the ICF. Interviewers were trained during a structured 1-day meeting, and were provided with a comprehensive manual. Ongoing supervision of interviewers was ensured by periodic telephone calls between each interviewer and the responsible member of their research team. Data was primarily collected from patients' medical record sheets, by interview of health

professionals in charge of the patients, and by patient interviews. ICF Core Set categories were assessed within the first 24 h after admission (baseline).

The criterion for selecting candidate categories for the brief ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, in which the independent variables were all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables. To improve prediction accuracy, and to derive small subsets of independent variables having the strongest effects on the dependent variable, we used the least absolute shrinkage and selection operator (LASSO) (17). This procedure minimizes the residual sum of squared errors with a bound on the sum of the absolute values of the coefficients. To avoid large variance, as often occurs in ordinary least square regression, the LASSO sets some regression coefficients to zero and shrinks others based on a pre-set regularization parameter, the so-called penalty. Thus, the method acts recursively to select valid subsets with adequate discrimination.

To validate the approach for selection of brief ICF Core Sets described above, we additionally used the Random Forest algorithm, which is based on Classification and Regression Trees (CART) non-parametric regression techniques. CART divides a population into several subpopulations depending on provisional characteristics defined by successive binary splits in predictor variables. In the course of the iterations, successive subpopulations emerge as increasingly homogenous with respect to the outcome variable, which in this case is the overall functioning as reported by patients and health professionals. Of the many different ways to construct CART, we employed the technique proposed by Breiman et al. (18–19).

If the 2 regression techniques yielded differing sets of categories results, the union of the 2 resulting sets would be reported.

All data analyses were carried out with R 2.9.0 (20).

RESULTS

A total of 391 patients were included in the study; 91 with neurological, 109 with cardiopulmonary and 191 with musculoskeletal conditions. Mean age was 63.4 years (neurological: 64.6 years, cardiopulmonary: 68.9 years, musculoskeletal: 59.7 years), 50.1% were female (neurological: 50.5%, cardiopulmonary: 45.9%, musculoskeletal: 52.4%). Mean length of hospital stay in acute care was 14.9 days (neurological: 17.7 days, cardiopulmonary: 14.4 days, musculoskeletal: 13.9 days). The most frequent diagnoses are shown in Table I. Patients with neurological conditions reported a mean functioning score of 4.9 (95% CI 4.4–5.4) at admission and of 6.6 (95% confidence interval (CI) 6.1–7.0) at discharge. Patients with cardiopulmonary conditions reported a mean functioning score of 4.9 (95% CI 4.4–5.3) at admission and of 6.9 (95% CI 6.6–7.3) at discharge. Patients with musculoskeletal conditions reported a mean functioning score of 4.1 (95% CI 3.8 to 4.4) at admission and of 6.5 (95% CI 6.2–6.8) at discharge.

For patients with neurological conditions, statistical selection of ICF categories by LASSO and CART yielded 13 categories for the component Body Functions, 12 categories for the component Activities and Participation, 3 categories for the component Body Structures and 5 categories for the component Environmental Factors, i.e. a total of 28 categories for the functioning part and 5 categories for the contextual part of the ICF.

For patients with cardiopulmonary conditions, statistical selection of ICF categories by LASSO and CART yielded 12 categories for the component Body Functions, 9 categories for the component Activities and Participation, 2 categories for the component Body Structures and 8 categories for the component Environmental Factors, i.e. a total of 23 categories for the functioning part and 8 categories for the contextual part of the ICF.

For patients with musculoskeletal conditions, statistical selection of ICF categories by LASSO and CART yielded 9 categories for the component Body Functions, 12 categories for the component Activities and Participation, 6 categories for the component Body Structures and 3 categories for the component Environmental Factors, i.e. a total of 27 categories for the functioning part and 3 categories for the contextual part of the ICF.

The particulars of the selected categories for patients with neurological, cardiopulmonary and musculoskeletal conditions, along with information on the corresponding comprehensive ICF Core Sets are shown in Tables II–V.

DISCUSSION

From a sample of 391 patients in the acute hospital we identified candidate categories for brief ICF Core Sets extracted from the comprehensive acute ICF Core Sets. These candidate categories

Table I. *Most frequent diagnoses responsible for inpatient stay (International Classification of Diseases (ICD-10))*

	All conditions *n* = 391 *n* (%)	Neurological conditions *n* = 91 *n* (%)	Cardiopulmonary conditions *n* = 109 *n* (%)	Musculoskeletal conditions *n* = 191 *n* (%)
Diseases of the respiratory system (J00-J99)	28 (7.2)	2 (2.2)	26 (23.9)	0 (0)
Diseases of the circulatory system other than cerebrovascular diseases (I00-I52 and I70-I99)	69 (17.6)	3 (3.3)	66 (60.6)	0 (0)
Cerebrovascular diseases (I60-I69)	46 (11.8)	46 (50.5)	0 (0)	0 (0)
Diseases of the nervous system (G00-G99)	18 (4.6)	18 (19.8)	0 (0)	0 (0)
Diseases of the musculoskeletal system and connective tissue (M00-M99)	87 (22.3)	3 (3.3)	1 (0.9)	83 (43.5)
Injury, poisoning and certain other consequences of external causes (S00-T98)	80 (20.5)	4 (4.4)	0 (0)	76 (39.8)
Neoplasms (C00-D48)	37 (9.5)	11 (12.1)	7 (6.4)	19 (9.9)
Symptoms, signs, etc. (R00-R99)	6 (1.5)	2 (2.2)	3 (2.8)	1 (0.5)
Other diagnoses	20 (5.1)	2 (2.2)	6 (5.5)	12 (6.3)

Table II. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Functions contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in the acute hospital*

ICF code	and category description	NEUR comp Core Set	NEUR brief Core Set	CP comp Core Set	CP brief Core Set	MSK comp Core Set	MSK brief Core Set
b110	Consciousness functions	×	×	×	×	×	
b114	Orientation functions	×		×			
b130	Energy and drive functions	×		×	×	×	x
b134	Sleep functions	×		×		×	
b140	Attention functions	×	×				
b147	Psychomotor functions	×					
b152	Emotional functions	×				×	x
b156	Perceptual functions	×					
b167	Mental functions of language	×	×				
b180	Experience of self and time functions	×				×	
b210	Seeing functions	×					
b215	Functions of structures adjoining the eye	×	×				
b230	Hearing functions	×					
b235	Vestibular functions	×	×				
b240	Sensations associated with hearing and vestibular functions	×	×				
b260	Proprioceptive functions	×				×	
b265	Touch functions	×					
b270	Sensory functions related to temperature and other stimuli	×	×				
b280	Sensation of pain	×		×	×	×	
b310	Voice functions	×					
b410	Heart functions	×		×			
b415	Blood vessel functions	×	×	×	×	×	×
b420	Blood pressure functions	×		×	×		
b430	Haematological system functions	×	×	×			
b435	Immunological system functions	×		×	×		
b440	Respiration functions	×	×	×	×	×	×
b445	Respiratory muscle functions			×	×		
b450	Additional respiratory functions	×		×	×		
b455	Exercise tolerance functions	×		×	×	×	×
b460	Sensations associated with cardiovascular and respiratory functions			×	×		
b510	Ingestion functions	×		×	×		
b525	Defecation functions	×	×			×	×
b535	Sensations associated with the digestive system	×	×				
b540	General metabolic functions	×					
b545	Water, mineral and electrolyte balance functions	×		×			
b610	Urinary excretory functions			×			
b620	Urination functions	×				×	×
b710	Mobility of joint functions	×	×	×		×	×
b715	Stability of joint functions	×				×	
b730	Muscle power functions	×		×		×	
b735	Muscle tone functions	×				×	×
b755	Involuntary movement reaction functions	×					
b760	Control of voluntary movement functions	×					
b810	Protective functions of the skin	×					
b820	Repair functions of the skin			×		×	

represent a practical alternative to the lengthy comprehensive sets, in providing a minimal standard for measuring and communicating patients' functioning in the acute care setting. Our approach considers the specific methods that have been proposed for the definition of brief ICF Core Sets, especially with respect to the properties of feasibility and discrimination of measures (21) and their usefulness for the specific setting. In general, the criterion *feasibility* is satisfied when a measure can in practical terms be applied by health professionals, given circumstances of restricted time and resources, which may be especially limited in the acute hospital setting. With this in mind, in the present study we sought to define practical and applicable brief ICF Core Sets with no more than 20 items or ICF categories. This upper limit was based on the precedent set by generic health status measures, and the practical requirement for a measure to be completed in a 20-min interview. The brief ICF Core Sets emerging in the present study are generally feasible in the acute situation, albeit containing slightly more than 20 categories to assess functioning. We proposed assessing a total of 21–25 categories from the components Body Functions and Activities and Participation, electively supplemented with an additional 8–10 categories from Environmental Factors. Use of categories from Body Structures would depend on the underlying health condition, as required by the routine medical assessment.

Table III. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Activities and Participation contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in the acute hospital*

ICF code	and category description	NEUR comp Core Set	NEUR brief Core Set	CP comp Core Set	CP brief Core Set	MSK comp Core Set	MSK brief Core Set
d240	Handling stress and other psychological demands			×		×	×
d315	Communicating with – receiving – nonverbal messages	×					
d330	Speaking	×		×	×		
d335	Producing nonverbal messages	×					
d360	Using communication devices and techniques	×	×				
d410	Changing basic body position	×	×	×	×	×	×
d415	Maintaining a body position	×	×	×	×	×	×
d420	Transferring oneself	×	×	×	×	×	×
d440	Fine hand use (picking up, grasping)	×					
d445	Hand and arm use	×				×	
d450	Walking			×	×	×	×
d465	Moving around using equipment	×	×				
d510	Washing oneself	×	×	×	×	×	×
d520	Caring for body parts	×	×	×	×	×	×
d530	Toileting	×	×	×	×	×	×
d540	Dressing	×	×	×	×		
d550	Eating	×	×			×	×
d560	Drinking	×	×				
d760	Family relationships	×	×			×	
d930	Religion and spirituality					×	
d940	Human rights	×				×	

The second essential criterion, *discrimination,* refers to the ability of a measure to discriminate between different states of functioning or medical conditions. A discriminating measure must enable the distinguishing between different patient groups in a cross-sectional manner. In order to ensure discrimination of our brief Core Sets, we applied modern regression techniques, which accommodate collinearities of many variables, thus ensuring that the minimally sufficient predictors of functioning, as reported from the perspectives of both patient and healthcare professional, were included in the final selection. By design, we ensured that categories from all components of the ICF remained in the selection. By using two different statistical techniques, the validity of the choice was increased. The results of the selection processes have high face validity, as the selected categories seem accurately to represent the relevant issues in the acute situation.

For patients with neurological conditions, the selected categories mainly represented impairment of consciousness, attention and mental functions of language. Indeed, these are the most disabling consequences of neurological injury or disease impinging on functioning, which furthermore have immediate significance for therapy, e.g. after an acute stroke (22–23). Similarly, vascular, respiratory and elimination functions also emerged as categories to be monitored in acute neurological conditions. Aspects of activities of daily living and mobility from the component Activities and Participation that were included in the final selection are also highly relevant in the acute situation (24). Indeed, precisely these aspects are also covered by existing measurement instruments, which are commonly recommended for acute care of neurological conditions such as stroke (25), for example the FIM™ (5). Additionally,

Table IV. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Structures contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in the acute hospital*

ICF category		NEUR comp Core Set	NEUR brief Core Set	CP comp Core Set	CP brief Core Set	MSK comp Core Set	MSK brief Core Set
s110	Structure of brain	×	×				
s120	Spinal cord and related structures	×	×				
s410	Structure of cardiovascular system	×		×		×	×
s430	Structure of respiratory system	×		×		×	
s710	Structure of head and neck region	×	×			×	×
s720	Structure of shoulder region					×	
s730	Structure of upper extremity					×	×
s740	Structure of pelvic region					×	×
s750	Structure of lower extremity					×	
s760	Structure of trunk			×	×	×	×
s810	Structure of areas of skin			×	×	×	×

Table V. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Environmental Factors contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in the acute hospital*

ICF category		NEUR comp Core Set	NEUR brief Core Set	CP comp Core Set	CP brief Core Set	MSK comp Core Set	MSK brief Core Set
e110	Products or substances for personal consumption	×		×	×	×	×
e115	Products and technology for personal use in daily living	×		×	×	×	
e120	Products and technology for personal indoor and outdoor mobility and transportation	×	×	×	×	×	
e125	Products and technology for communication	×					
e150	Design, construction and building products and technology of buildings for public use	×				×	
e240	Light	×					
e250	Sound	×		×	×		
e260	Air quality			×	×		
e310	Immediate family	×		×	×	×	
e315	Extended family	×	×				
e320	Friends	×		×		×	
e355	Health professionals	×		×		×	×
e360	Health related professionals	×					
e410	Individual attitudes of immediate family members	×		×		×	
e415	Individual attitudes of extended family members	×					
e420	Individual attitudes of friends	×		×		×	×
e450	Individual attitudes of health professionals	×		×		×	
e455	Individual attitudes of other professionals	×					
e465	Social norms, practices and ideologies	×	×				
e550	Legal services, systems and policies	×	×				
e570	Social security, services, systems and policies	×	×	×	×		
e580	Health services, systems and policies	×		×	×	×	

family relationships from Activities and Participation and the Environmental Factor component of extended family came up as candidate categories, which is concordant with the current literature on acute neurological care, e.g. after traumatic brain injury (26).

For patients with cardiopulmonary conditions, heart functions, blood functions, blood pressure functions and respiratory functions along with exercise tolerance were included in the candidate selection. These factors certainly represent the most important issues that should be assessed and monitored in cardiopulmonary patients (27). In addition, it must be considered that activities of daily living are frequently limited in patients with cardiac or pulmonary disease (28). Categories from the component Environmental Factors, namely *Social security* (e570) and *Health services* (e580), were also included in the selection, which is consistent with current literature showing that the survival of patients with acute cardiorespiratory conditions largely depends on the availability of healthcare and the quality of treatment (29). Interestingly, the categories *Sound* (e250) and *Air quality* (e260) also entered the selection. These environmental issues might reflect the subjectively "hostile environment" of the acute ward or intensive care unit, which has been described previously and illustrates the particular vulnerability of patients to this kind of stress (30).

For patients with musculoskeletal conditions, some very basic categories from the component Body Functions were included into the selection of candidate categories, specifically blood vessel functions, respiration, exercise tolerance, defecation, urination, mobility of joints and muscle tone. These reflect key issues arising in the context of medical or surgical interventions in musculoskeletal diseases or injuries (31–32). Emotional functions and energy and drive functions also emerged as issues to be monitored, consistent with findings that early psychosocial support is essential for neuromuscular rehabilitation (33). Accordingly, limitations in mobility and self care from the component Activities and Participation entered the selection.

In general, patients with neurological, cardiopulmonary or musculoskeletal conditions largely differ as regarding their specific impairments, activity limitations and participation restrictions. Several communalities, however, deserve mention. Notably, aspects of basic transfer, mobility and self-care are common to all patients in acute care.

Among the limitations of this study, it must be considered that selection bias may have occurred due to the use of a convenience sample of patients and participating facilities. Team-integrated multiprofessional rehabilitation intervention may have contributed to the selection reducing the representativeness of the results. Still, the spectrum of impairments and limitations encountered in our group of 391 patients was consistent with the results from similar studies (11–12). Another limitation might arise from the statistical selection process. Although we used 2 established methods, a split-sample approach might have proved superior validation of the results. However, this approach was not possible because of the limited sample size. Further studies of sufficient size would establish the validity of the proposed selection more firmly, and would yield more insights into the association structures (34) and potential scale attributes (35) of the categories.

Defining brief ICF Core Sets for the acute care situation has distinct advantages. Standardized health status measures are of interest for the acute situation because there is growing concern over costs and because patients are to return to a high level of functioning as soon as possible (36). Measuring functioning thus is an issue for health professionals and healthcare providers. The ICF provides the potential framework for standardized reporting and measurement in the acute situation and the framework along the continuum of care. Brief ICF Core Sets are a focused approach to measuring health status from a patient-centred and multi-professional perspective.

In conclusion, the present selection of categories can be considered an initial proposal, serving to identify the issues most relevant for the assessment and monitoring of functioning in patients with acute neurological, cardiopulmonary, and musculoskeletal conditions. The main strength of the study lies in the selection of a restricted set of categories, facilitating the inclusion of brief ICF Core Sets into daily clinical routine. If it should occur that important categories are missing from the brief Core Sets, the comprehensive ICF Core Sets could easily be used to reconfigure the assessment. Also, for patients with multiple diagnoses or for aged patients, a more generic Set could be constructed, containing all categories from the 3 acute brief ICF Core Sets. Another advantage of the proposed selection is derived from its participatory approach, taking into consideration the perspectives both of patients and healthcare professionals. Thus, the brief ICF Core Sets for the acute hospital can contribute substantially to the optimal management of patients, the teaching of health professionals, the planning of studies and the development of new assessment instruments.

ACKNOWLEDGEMENTS

This project was supported by the LMU innovativ project Münchner Zentrum für Gesundheitswissenschaften, (TP 1). The authors thank Dr Paul Cumming for revising the manuscript.

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J Rehabil Med 2011; 43: 131–138

ORIGINAL REPORT

ICF CORE SETS FOR EARLY POST-ACUTE REHABILITATION FACILITIES

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Objective: **To identify candidate categories for International Classification of Functioning, Disability and Health (ICF) Core Sets for the reporting and measurement of functioning in patients in early post-acute rehabilitation facilities.**
Design: **Prospective multi-centre cohort study.**
Patients: **Patients receiving rehabilitation interventions for musculoskeletal, neurological or cardiopulmonary injury or disease in early post-acute rehabilitation facilities.**
Methods: **Functioning was coded using the ICF. The criterion for selecting candidate categories for the ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, the independent variables being all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables.**
Results: **A total of 165 patients were included in the study (67 neurological, 37 cardiopulmonary, 61 musculoskeletal), mean age 67.5 years, 46.1% female. Selection yielded 38 categories for neurological, 32 for cardiopulmonary, and 31 for musculoskeletal.**
Conclusion: **The present selection of categories can be considered an initial proposal, serving to identify the issues most relevant for the assessment and monitoring of functioning in patients undergoing early post-acute rehabilitation for neurological, cardiopulmonary, and musculoskeletal conditions.**

Key words: ICF; health status measurements; outcome assessment; classification; regression analysis; rehabilitation.

J Rehabil Med 2011; 43: 131–138

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Submitted May 25, 2010; accepted September 20, 2010

INTRODUCTION

Following an acute episode of disease or an acute injury patients are at risk of experiencing a significant loss of functioning. Inactivity, immobility, complications and prevalent chronic conditions may have a wide range of adverse effects. Thus, many patients require specialized rehabilitation care. In addition to their rehabilitation needs, these patients may also have needs for ongoing extensive medical and nursing care. Early post-acute rehabilitation may be provided either in dedicated units of an acute care hospital or in specialized rehabilitation facilities. In some countries, such as Germany, there are early post-acute rehabilitation units for patients with any diagnosis, and units caring exclusively for patients with neurological conditions or for aged patients (1).

In situations entailing post-acute and long-term rehabilitation, professionals specialized in rehabilitation care provision should share a common understanding of functioning, and utilize clinical assessment instruments that are based on a standard model of functioning in order to optimize the management of the rehabilitation process. While a multitude of measuring instruments has been used in post-acute rehabilitation settings, typical instruments vary with respect to their underlying models and scales, and are tailored for specific populations or diagnoses. Accordingly, the methods differ in their sensitivity to discover incremental gains in recovery of functioning (2). Thus, there is urgent need for implementing improved and standardized outcome measurement in rehabilitation (3–4).

The International Classification of Functioning, Disability and Health (ICF), a part of the family of international classifications of the World Health Organization (WHO), provides a common framework for describing and classifying health and disability. The ICF classifies domains of functioning, along with their contextual factors, which are encountered in human life. As such, the ICF may arguably constitute a comprehensive framework and a guide for healthcare planning and for measuring the changes brought by interventions across a multitude of dimensions, from body functions to personal activities, societal participation and environmental factors. It also provides the potential framework for transition along the continuum of care. A classification must be exhaustive by its very nature and becomes very complex in daily use unless it is transformed into practice-friendly tools. Comprising over 1,400 categories, the entire volume of the ICF cannot be applied by the clinicians to all their patients. In daily practice clinicians will need only a fraction of the categories found in the ICF. Although there are generic instruments based on the

ICF, which are designed as practical translations of the ICF and are usable across a wide range of applications, the generic character may be a drawback in specific settings. Thus, in this trade-off between generalizability and the need to capture the detail, the ICF must be adapted to the perspectives and needs of different users. The need to tailor ICF to the needs of particular contexts is the primary motivation behind the ICF Core Set project, which aims to extract selections of ICF categories from the entire classification that are relevant to specific health conditions or care situations. This on-going project of selection of the so-called ICF Core Sets will define common standards for what should properly be measured and reported.

In general, the ICF Core Set project seeks to define, on an empirical basis, the ICF categories relevant for the condition and rehabilitation of typical patients after an acute episode, especially when applied as an endpoint in clinical trials, or if it was identified as being relevant following discussion among health professionals (5). By including all theoretically relevant categories, the selection process is comprehensive, omitting only those factors that proved to be irrelevant to designing treatment strategy or assessing outcome. Due to the consensus process, the ICF Core Sets in their present version are comprehensive, with applicability for the assessment of individual problems and needs. As such, they permit the estimation of prognosis and the potential for rehabilitation, with general applicability for assessment of functioning in any rehabilitation situation. ICF Core Sets for early post-acute rehabilitation facilities were developed for patients with neurological, cardiopulmonary and musculoskeletal conditions (6–8). This stratification was based on practical considerations related to healthcare provision being organized according to organ system and the varying spectrum of problems experienced in patients with neurological, musculoskeletal and cardiopulmonary conditions. This approach was used in prior studies on functioning in the acute care situation (9) and verified by focus groups (10). They were validated in the patients' and healthcare professionals' perspective (11–13). They are intended to be practical and useful for healthcare professionals specialized in rehabilitation and involved in interdisciplinary rehabilitation teams. They are based on the experience of patients in need of medical, nursing and therapeutic management.

The comprehensive post-acute ICF Core Sets include 116 (neurological conditions), 84 (cardiopulmonary conditions) and 70 (musculoskeletal conditions) second-level ICF categories, respectively. However, a minimally sufficient data set, which is feasible in clinical practice, may encompass only 20 different concepts or topics, but not much more as contained in the comprehensive ICF Core Sets. Thus, subsets can be created from the comprehensive Core Sets, according to specific needs of the individual user. Specific methods have been proposed for identifying candidate categories for ICF Core Sets, selected from the comprehensive post-acute ICF Core Sets (14).

The objective of this study was to employ these methods for identifying candidate categories for ICF Core Sets out of the comprehensive post-acute ICF Core Sets for the reporting and measurement of functioning in patients in early post-acute rehabilitation facilities.

METHODS

Detailed methods involved in the ICF Core Set development have been described elsewhere (14). In brief, a prospective multi-centre cohort study was conducted from May 2005 to August 2008 in 9 early post-acute rehabilitation facilities in Austria and Germany, including 5 facilities specialized in geriatric rehabilitation. Patients were eligible for inclusion in the study if they were at least 18 years of age and were receiving rehabilitation interventions for musculoskeletal, neurological or cardiopulmonary injury or disease.

As described above, we have developed the ICF Core Sets in order to facilitate and encourage the use of the ICF in clinical practice and research. The ICF Core Sets are selections from the entire list of ICF categories, which emerged from a multi-stage consensus process seeking to identify those aspects of functioning most relevant for patients in specific settings or with specific health conditions. Three comprehensive ICF Core Sets were developed for patients with neurological, cardiopulmonary and musculoskeletal conditions in early post-acute rehabilitation facilities (6–8). The current study made use of these 3 comprehensive Core Sets for patient assessment.

For scoring of the Core Sets, the ICF suggests assigning qualifiers ranging from 0 to 4 for each category. Since the properties of all qualifiers are not yet sufficiently evaluated, in the present study we used a simplified qualifier, defined as follows. Each category of the components Body Functions and Activities and Participation was graded with the qualifiers 0 for "no impairment/limitation", 1 for "moderate impairment/limitation" and 2 for "severe impairment/limitation". The categories of the component Body Structures were graded with the qualifiers 0 for "no impairment" and 1 for "impairment". The categories of the component Environmental Factors were graded with 0 for "no barrier/facilitator" and 1 for "barrier/facilitator". Impairments of body functions or structures, and limitations or restrictions of activities and participation were recorded if they were directly associated with the condition necessitating rehabilitation.

To describe an overall view of functioning, the patients were asked to appraise their personal limitations in overall functioning using a horizontal visual analogue scale, ranging from zero, for complete limitation in all aspects of functioning to 10, for no limitation in functioning). Independently, and blinded to the patients' responses, the health professionals were asked to appraise their patients' functioning on the same analogue scale.

Patients were recruited and interviewed by health professionals trained in the application and principles of the ICF. Data was primarily collected from patients' medical record sheets, by interview of health professionals in charge of the patients, and by patient interviews. ICF Core Set categories were assessed within the first 24 h after admission (baseline).

The criterion for selecting candidate categories for the ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, in which the independent variables were all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables. To improve prediction accuracy, and to derive small subsets of independent variables having the strongest effects on the dependent variable, we used the least absolute shrinkage and selection operator (LASSO) (15). This procedure minimizes the residual sum of squared errors with a bound on the sum of the absolute values of the coefficients. To avoid large variance, as often occurs in ordinary least square regression, the LASSO sets some regression coefficients to zero and shrinks others based on a preset regularization parameter, the so-called penalty. Thus, the method acts recursively to select valid subsets with adequate discrimination.

To validate the approach for selection of ICF Core Sets described above, we additionally used the Random Forest algorithm, which is based on Classification and Regression Trees (CART) non-parametric regression techniques. CART divides a population into several subpopulations depending on certain characteristics defined by successive

binary splits in predictor variables. In the course of the iterations, successive subpopulations emerge as increasingly homogenous with respect to the outcome variable, which in this case is the overall functioning as reported by patients and health professionals. Of the many different ways to construct CART, we employed the technique proposed by Breiman et al. (16–17).

All data analyses were carried out with R 2.9.0 (18).

RESULTS

A total of 165 patients were included in the study; 67 with neurological, 37 with cardiopulmonary and 61 with musculoskeletal conditions. Mean age was 67.5 years (neurological: 63.9 years, cardiopulmonary: 78.3 years, musculoskeletal: 64.8 years), 46.1% were female (neurological: 35.8%, cardiopulmonary: 54.1%, musculoskeletal: 52.5%). Mean length of stay in the rehabilitation facility was 30.5 days (neurological: 34.2 days, cardiopulmonary: 23.7 days, musculoskeletal: 30.6 days). The most frequent diagnoses are shown in Table I. Patients with neurological conditions reported a mean functioning score of 2.6 (95% confidence interval (CI) 2.1–3.1) at admission and of 4.8 (95% CI 4.1–5.5) at discharge. Patients with cardiopulmonary conditions reported a mean functioning score of 4.1 (95% CIl 3.3–4.9) at admission and of 6.5 (95% CI 5.7–7.4) at discharge. Patients with musculoskeletal conditions reported a mean functioning score of 3.5 (95% CI 3.0–4.0) at admission and of 6.2 (95% CI 5.7–6.8) at discharge. All differences were statistically significant.

For patients with neurological conditions, statistical selection of ICF categories by LASSO and CART yielded 14 categories for the component Body Functions, 15 categories for the component Activities and Participation, 2 categories for the component Body Structures and 7 categories for the component Environmental Factors, i.e. a total of 31 categories for the functioning part and 7 categories for the contextual part of the ICF.

For patients with cardiopulmonary conditions, statistical selection of ICF categories by LASSO and CART yielded 12 categories for the component Body Functions, 9 categories for the component Activities and Participation, 1 category for the component Body Structures and 10 categories for the component Environmental Factors, i.e. a total of 22 categories for the functioning part and 10 categories for the contextual part of the ICF.

For patients with musculoskeletal conditions, statistical selection of ICF categories by LASSO and CART yielded 10 categories for the component Body Functions, 15 categories for the component Activities and Participation, no category for the component Body Structures and 6 categories for the component Environmental Factors, i.e. a total of 25 categories for the functioning part and 6 categories for the contextual part of the ICF.

Selection of categories along with information on the corresponding comprehensive ICF Core Sets is shown in Tables II–V.

DISCUSSION

For a sample of 165 patients undergoing post-acute rehabilitation we identified candidate categories for brief ICF Core Sets extracted from the comprehensive ICF Core Sets. These candidate categories provide a practical alternative to the lengthy comprehensive sets, in providing a minimal standard for measuring and communicating patients' functioning.

The results of the selection processes have high face validity, as the selected categories seem to accurately represent the relevant issues in the early post-acute situation.

For patients with neurological conditions, the selected categories of the component Body Functions generally reflect the typical spectrum of problems that have to be monitored, namely cognitive and speech functions, blood pressure, respiration, ingestion, urination, weight maintenance and gait pattern (19). The component Activities and Participation was represented by a number of categories from the chapters *Mobility* and *Self-care*, which are also highly relevant. Indeed, these are issues typically also covered by the instruments most commonly used in early post-acute rehabilitation facilities (20), the Functional Independence Measure (FIM) (21) and the Barthel Index (BI) (22). Additionally, categories were included that are important for the monitoring of therapy efficiency, and that are very often limited in patients with neurological conditions, namely *Listening* (d115), *Acquiring skills* (d155) and *Solving problems* (d175) (23). Also, products and technology

Table I. *Most frequent diagnoses responsible for inpatient stay (International Classification of Diseases-10; ICD-10)*

	All conditions *n*=165 *n* (%)	Neurological conditions *n*=67 *n* (%)	Cardiopulmonary conditions *n*=37 *n* (%)	Musculoskeletal conditions *n*=61 *n* (%)
Diseases of the respiratory system (J00-J99)	1 (0.6)	1 (1.5)	0 (0)	0 (0)
Diseases of the circulatory system other than cerebrovascular diseases (I00-I52 and I70-I99)	34 (20.6)	2 (3)	27 (73.0)	5 (8.2)
Cerebrovascular diseases (I60-I69)	27 (16.4)	27 (40.3)	0 (0)	0 (0)
Diseases of the nervous system (G00-G99)	25 (15.2)	22 (32.8)	0 (0)	3 (4.9)
Diseases of the musculoskeletal system and connective tissue (M00-M99)	25 (15.2)	10 (14.9)	1 (2.7)	14 (23.0)
Injury, poisoning and certain other consequences of external causes (S00-T98)	24 (14.5)	0 (0)	0 (0)	24 (39.3)
Neoplasms (C00-D48)	6 (3.6)	2 (3.0)	1 (2.7)	3 (4.9)
Symptoms, signs etc. (R00-R99)	8 (4.8)	1 (1.5)	7 (18.9)	0 (0)
Other diagnoses	15 (9.1)	2 (3.0)	1 (2.7)	12 (19.7)

Table II. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Functions contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in post-acute rehabilitation facilities*

ICF code	and category description	NEUR comp Core Set	NEUR Core Set	CP comp Core Set	CP Core Set	MSK comp Core Set	MSK Core Set
b110	Consciousness functions	×		×	×		
b114	Orientation functions	×		×	×		
b126	Temperament and personality functions	×	×				
b130	Energy and drive functions	×	×	×	×	×	
b134	Sleep functions	×		×	×	×	×
b140	Attention functions	×		×	×		
b144	Memory functions	×		×			
b147	Psychomotor functions	×					
b152	Emotional functions	×		×		×	
b156	Perceptual functions	×					
b160	Thought functions	×	×				
b164	Higher-level cognitive functions	×	×				
b167	Mental functions of language	×	×				
b176	Mental function of sequencing complex movements	×					
b180	Experience of self and time functions	×					
b210	Seeing functions	×	×				
b215	Function of structures adjoining the eye	×					
b230	Hearing functions	×					
b235	Vestibular functions	×					
b240	Sensations associated with hearing and vestibular function	×					
b260	Proprioceptive function	×		×	×	×	×
b265	Touch function	×					
b270	Sensory functions related to temperature and other stimuli	×				×	
b280	Sensation of pain	×		×		×	×
b310	Voice functions	×		×			
b320	Articulation functions	×					
b340	Alternative vocalization functions	×					
b410	Heart functions	×		×	×		
b415	Blood vessel functions	×		×		×	
b420	Blood pressure functions	×	×	×			
b430	Haematological system functions	×		×	×		
b435	Immunological system functions	×		×		×	×
b440	Respiration functions	×		×		×	
b445	Respiratory muscle functions			×			
b450	Additional respiratory functions	×	×	×	×		
b455	Exercise tolerance functions	×		×		×	
b460	Sensations associated with cardiovascular and respiratory functions			×			
b510	Ingestion functions	×	×	×	×		
b515	Digestive functions	×					
b525	Defecation functions	×		×		×	
b530	Weight maintenance functions	×	×	×		×	×
b535	Sensations associated with the digestive system	×					
b540	General metabolic functions	×					
b545	Water, mineral and electrolyte balance functions	×		×			
b550	Thermoregulatory functions	×	×				
b610	Urinary excretory functions			×			
b620	Urination functions	×	×	×		×	×
b630	Sensations associated with urinary functions	×					
b710	Mobility of joint functions	×		×		×	
b715	Stability of joint functions	×				×	
b730	Muscle power functions	×		×		×	×
b735	Muscle tone functions	×				×	
b740	Muscle endurance functions	×	×	×		×	×
b755	Involuntary movement reaction functions	×				×	×
b760	Control of voluntary movement functions	×		×		×	
b770	Gait pattern functions	×	×			×	
b780	Sensations related to muscles and movement functions			×		×	×
b810	Protective functions of the skin	×		×	×	×	
b820	Repair functions of the skin			×	×		

Table III. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Activities and Participation contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in post-acute rehabilitation facilities*

ICF code	ICF code and category description	NEUR comp Core Set	NEUR Core Set	CP comp Core Set	CP Core Set	MSK comp Core Set	MSK Core Set
d110	Watching	×					
d115	Listening	×	×				
d120	Other purposeful sensing	×					
d130	Copying	×					
d135	Rehearsing	×					
d155	Acquiring skills	×	×	×		×	×
d160	Focusing attention	×					
d166	Reading	×					
d170	Writing	×	×				
d175	Solving problems	×	×				
d177	Making decisions	×		×	×	×	×
d230	Carrying out daily routine			×		×	×
d240	Handling stress and other psychological demands			×	×	×	×
d310	Communicating with – receiving – spoken messages	×				×	
d315	Communicating with – receiving – nonverbal messages	×					
d330	Speaking	×					
d335	Producing nonverbal messages	×					
d350	Conversation	×					
d360	Using communication devices and techniques	×					
d410	Changing basic body position	×	×	×	×	×	×
d415	Maintaining a body position	×		×		×	×
d420	Transferring oneself	×	×	×	×	×	
d430	Lifting and carrying objects	×		×		×	×
d440	Fine hand use (picking up, grasping)	×	×	×		×	
d445	Hand and arm use	×		×		×	×
d450	Walking	×	×	×	×	×	×
d460	Moving around in different locations	×	×	×	×	×	
d465	Moving around using equipment	×	×	×	×	×	×
d510	Washing oneself	×		×		×	×
d520	Caring for body parts	×	×	×		×	×
d530	Toileting	×	×	×		×	×
d540	Dressing	×	×	×	×	×	×
d550	Eating	×	×	×		×	×
d560	Drinking	×	×	×		×	
d570	Looking after one's health			×		×	
d760	Family relationships	×		×		×	
d870	Economic self-sufficiency			×			
d910	Community Life			×	×		
d930	Religion and spirituality	×				×	
d940	Human rights					×	

Table IV. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Structures contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in post-acute rehabilitation facilities*

ICF code	ICF code and category description	NEUR comp Core Set	NEUR Core Set	CP comp Core Set	CP Core Set	MSK comp Core Set	MSK Core Set
s110	Structure of brain	×					
s120	Spinal cord and related structures	×					
s130	Structures of meninges	×					
s410	Structure of cardiovascular system	×	×	×			
s430	Structure of respiratory system	×		×	×		
s530	Structure of stomach	×					
s710	Structure of head and neck region	×				×	
s720	Structure of shoulder region	×				×	
s730	Structure of upper extremity	×	×			×	
s740	Structure of pelvic region					×	
s750	Structure of lower extremity	×				×	
s760	Structure of trunk			×		×	
s810	Structure of areas of skin	×		×		×	

Table V. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Environmental Factors contained in the comprehensive ICF Core Sets (comp) and proposed as candidates for the ICF Core Sets for patients with neurological (NEUR), cardiopulmonary (CP) and musculoskeletal (MSK) conditions in post-acute rehabilitation facilities*

ICF code	and category description	NEUR comp Core Set	NEUR Core Set	CP comp Core Set	CP Core Set	MSK comp Core Set	MSK Core Set
e110	Products or substances for personal consumption	×	×	×	×	×	×
e115	Products and technology for personal use in daily living	×	×	×	×	×	×
e120	Products and technology for personal indoor and outdoor mobility and transportation	×	×	×		×	×
e125	Products and technology for communication	×	×	×	×	×	
e150	Design, construction and building products and technology of buildings for public use			×		×	
e155	Design, construction and building products and technology of buildings for private use			×	×		
e225	Climate					×	×
e245	Time-related changes			×	×		
e250	Sound			×	×		
e260	Air quality			×			
e310	Immediate family	×		×		×	
e315	Extended family	×		×			
e320	Friends	×		×		×	
e340	Personal care providers and personal assistants					×	
e355	Health professionals	×	×	×		×	×
e360	Health related professionals	×		×			
e410	Individual attitudes of immediate family members	×		×		×	
e415	Individual attitudes of extended family members	×	×	×	×		
e420	Individual attitudes of friends	×		×	×	×	
e430	Individual attitudes of people in positions of authority					×	
e440	Individual attitudes of personal care providers and personal assistants					×	
e450	Individual attitudes of health professionals	×		×		×	×
e455	Individual attitudes of other professionals			×	×		
e465	Social norms, practices and ideologies	×		×	×		
e550	Legal services, systems and policies	×	×				
e555	Associations and organizational services, systems and policies			×		×	
e570	Social security, services, systems and policies	×		×			
e575	General social support services, systems and policies			×		×	
e580	Health services, systems and policies	×		×		×	

for personal use, mobility and communication are relevant as factors that are preconditions for successful reintegration into the community.

For patients with cardiopulmonary conditions, the selected categories for the component Body Functions relate to functions that will typically be monitored in the post-acute situation, namely heart functions and respiratory functions. A large part of the included categories describe higher integrated mental functions. Orientation, attention and sleep functions are particularly relevant for older patients with cardiovascular disease. Repair functions of the skin and protective functions of the skin point at the sequels of surgery. Categories of the component Activities and Participation include basic activities of daily living as well as psychosocial issues such as making decisions and handling stress, both important for long-term outcome of cardiopulmonary disease (24). Focus of the selected categories of the component Environmental Factors was in the area of psychological and psychosocial stress as potentially triggered by attitudes of family members and friends, as well as by social norms.

For patients with musculoskeletal conditions, many of the selected categories from both Body Functions and Activities and Participation referred to mobility and pain. Very typically, patients with musculoskeletal conditions are characterized by pain, limited mobility, subsequent loss of sleep and loss of function of the musculoskeletal system leading to restrictions in activities of daily living such as self care and ambulation. Major goals or post-acute rehabilitation are thus to enable patients to move and perform self care activities safely and independently, with the ultimate goal of resuming domestic and workplace activities (25). Likewise, selected categories from the component Environmental Factors refer mainly to assistive products for personal use and mobility.

The aim of this study was to define practical and feasible ICF Core Sets with no more than 20 items or ICF categories. In general, the criterion *feasibility* is satisfied when a measure can, in practical terms, be applied by health professionals, given circumstances of restricted time and resources. With this in mind, we sought in the present study to define practical and applicable ICF Core Sets with no more than 20 items or ICF categories. This upper limit was based on the precedent set by generic health status measures, and the practical requirement for a measure to be completed in a 20 min interview. The briefer ICF Core Sets emerging in the present study are generally

feasible in the post-acute situation, albeit containing slightly more than 20 categories to assess functioning. We proposed assessing a total of 21–29 categories from the components Body Functions and Activities and Participation, and, eventually, supplemented by 6–10 categories from Environmental Factors. Use of categories from Body Structures would depend on the underlying health condition, as required by the routine medical assessment.

Among the limitations of this study, it must be considered that selection bias may have occurred due to the use of a convenience sample of patients. Still, the spectrum of impairments and limitations encountered in our group of patients was consistent with the results from similar studies (26–27). Another limitation might arise from the statistical selection process. Although we used 2 established methods, a split sample approach might have proved superior validation of the results. However, this approach was not possible because of the limited sample size. Further studies of sufficient size would more firmly establish the validity of the proposed selection, and would yield more insights into the association structures (28) and potential scale attributes (29) of the categories.

Defining ICF Core Sets for patients in post-acute rehabilitation facilities has the advantage of providing the potential framework for standardized reporting and measurement and setting the framework along the continuum of care. ICF Core Sets encourage measurement of health status from a patient-centred and multi-professional perspective. This is not a generic, but a focused approach, taking into consideration the special needs and characteristics of that population.

In conclusion, the present selection of categories can be considered an initial proposal, serving to identify the issues most relevant for the assessment and monitoring of functioning in patients with neurological, cardiopulmonary, and musculoskeletal conditions. The main strength of the study lies in the selection of a restricted set of categories, facilitating the inclusion of ICF Core Sets into daily clinical routine. If it should occur that important categories are missing from the briefer Core Sets, the comprehensive ICF Core Sets could easily be used to reconfigure the assessment. Also, for patients with multiple diagnoses or for aged patients, a more generic Set could be constructed, containing all categories from the 3 comprehensive post-acute ICF Core Sets. Another advantage of the proposed selection is derived from its participatory approach, taking into consideration the perspectives both of patients and healthcare professionals. Thus, the ICF Core Sets for post-acute rehabilitation facilities can contribute substantially to the optimal management of patients, the teaching of health professionals, the planning of studies and the development of new assessment instruments.

ACKNOWLEDGEMENTS

This project was supported by the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften, (TP 1). The authors thank Dr Paul Cumming for revisions to the manuscript.

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J Rehabil Med 2011; 43: 139–144

ORIGINAL REPORT

BRIEF ICF CORE SET FOR PATIENTS IN GERIATRIC POST-ACUTE REHABILITATION FACILITIES

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Objective: **To identify candidate categories for International Classification of Functioning, Disability and Health (ICF) Core Sets for the reporting and clinical measurement of functioning in older patients in early post-acute rehabilitation facilities.**

Design: **Prospective multi-centre cohort study.**

Patients: **Older patients receiving rehabilitation interventions in early post-acute rehabilitation facilities.**

Methods: **Functioning was coded using the ICF. The criterion for selecting candidate categories for the brief ICF Core Sets was based on their ability to discriminate between patients with high or low functioning status. Discrimination was assessed using multivariable regression models, the independent variables being all of the ICF categories of the respective comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables.**

Results: **A total of 209 patients were included in the study, mean age 80.4 years, 67.0% female. Selection yielded a total of 29 categories for the functioning part and 9 categories for the contextual part of the ICF.**

Conclusion: **The present selection of categories can be considered an initial proposal, serving to identify the issues most relevant for the clinical assessment and monitoring of functioning in older patients undergoing early post-acute rehabilitation.**

Key words: ICF; health status measurements; outcome assessment; classification; regression analysis; rehabilitation; aged 80 and over; clinical.

J Rehabil Med 2011; 43: 139–144

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Submitted May 25, 2010; accepted August 19, 2010

INTRODUCTION

Although individuals of older age are not necessarily disabled, the incidence and prevalence of acute disease, disability and chronic conditions increase with age. An older person suffering an accident or an acute episode of illness may have several additional problems complicating the acute event and leading to functional decline and subsequent need for nursing home placement. There has been increasing awareness of the risks created by hospitalization and medical and surgical procedures in older individuals, namely incontinence, infections, malnutrition and immobility (1). Thus, older patients are more vulnerable to functional decline and require particular attention and specialized rehabilitation care (2). Early post-acute rehabilitation for older patients may be provided either in dedicated units of an acute care hospital or in specialized rehabilitation facilities. In some countries, such as Germany, there are units caring exclusively for older patients. An interdisciplinary team of physicians, nurses and therapists specialized in rehabilitation care cooperates to manage the demands of early post-acute rehabilitation (3–4).

In situations entailing post-acute and long-term rehabilitation, professionals specialized in rehabilitation care provision should share a common understanding of functioning, and utilize clinical assessment instruments that are based on a standard model of functioning in order to optimize the management of the rehabilitation process. It is known that systematic geriatric assessment in the course of rehabilitation improves outcomes (5). Hence, a multitude of measuring instruments has been used in older patients. However, a conference on healthcare outcomes of geriatric rehabilitation stated that the degree of detail and measurement complexity in geriatric assessment varies according to health domain. While domains of activities of daily living are well covered by various health status instruments, there are specific gaps regarding environmental factors, namely access to care, resources and support by others (6). While there is now a minimum data-set for older patients in clinical trials (7), there is still no consensus on which instruments are to be used consistently in rehabilitation practice (8), nor is there a conceptual framework unifying the different approaches to geriatric assessment. Thus, there is a need for implementing improved and standardized outcome measurement in geriatric rehabilitation.

The International Classification of Functioning, Disability and Health (ICF), a part of the family of international classifications of the World Health Organization (WHO), provides

a common framework for describing and classifying health and disability. The ICF classifies domains of functioning, along with their contextual factors, which are encountered in human life. As such, the ICF may arguably constitute a comprehensive framework and a guide for healthcare planning and for measuring the changes brought by interventions across a multitude of dimensions, from body functions to personal activities, societal participation and environmental factors. It also provides the potential framework for transition along the continuum of care. A classification must be exhaustive by its very nature and becomes highly complex in daily use unless it is transformed into practice-friendly tools. Comprising over 1400 categories, the entire volume of the ICF cannot be applied by the clinicians to all their patients. In daily practice clinicians will need only a fraction of the categories found in the ICF. Although there are generic instruments based on the ICF that are designed as practical translations of the ICF and are usable across a wide range of applications, the generic character may be a drawback in specific settings. Thus, in this trade-off between generalizability and the need to capture detail, the ICF must be adapted to the perspectives and needs of different users. The need to tailor ICF to the needs of particular contexts is the primary motivation behind the ICF Core Set project, which aims to extract selections of ICF categories from the entire classification that are relevant to specific health conditions or care situations. This on-going project of selection of the so-called ICF Core Sets will define common standards for what should properly be measured and reported.

In general, the ICF Core Set project seeks to define on an empirical basis the ICF categories relevant for the condition and rehabilitation of typical patients after an acute episode, especially when applied as an end-point in clinical trials, or if it was identified as being relevant following discussion among health professionals (9). By including all theoretically relevant categories, the selection process is comprehensive, omitting only those factors that proved to be irrelevant to designing treatment strategy or assessing outcome. Due to the consensus process, the ICF Core Sets in their present version are comprehensive, with applicability for the assessment of individual problems and needs. As such, they permit the estimation of prognosis and the potential for rehabilitation, with general applicability for assessment of functioning in any rehabilitation situation. A comprehensive ICF Core Set for older patients has been developed (9) and validated in the patients' and healthcare professionals' perspective (10–12). The Core Set is intended to be practical and useful for healthcare professionals specialized in rehabilitation and involved in interdisciplinary rehabilitation teams. They are based on the experience of patients in need of medical, nursing and therapeutic management.

The comprehensive geriatric ICF Core Set includes 123 second-level ICF categories. However, a minimally sufficient data-set, which is feasible in clinical practice may encompass only 20 different concepts or topics, but not much more. To give an example, the Geriatric Minimum Data Set identified 25 salient items that were also translated into ICF categories (13). Thus, subsets can be created from the comprehensive Core Set, according to specific needs of the individual user. Specific methods have been proposed for identifying candidate categories for brief ICF Core Sets, selected from the comprehensive post-acute ICF Core Sets (14).

The objective of this study was to identify candidate categories for brief ICF Core Sets out of the comprehensive geriatric ICF Core Sets for the reporting and measurement of functioning in patients in geriatric rehabilitation facilities.

METHODS

Detailed methods of the ICF Core Set development have been described elsewhere (14). In brief, a prospective multi-centre cohort study was conducted from May 2005 to August 2008 in 5 facilities specialized in geriatric rehabilitation in Germany and Austria. Patients were eligible for inclusion if they were over 65 years of age and fulfilled the criteria for post-acute geriatric rehabilitation, namely frailty and multi-morbidity. Frailty is commonly defined as a state of declining ability of physiological systems to respond to external stressors resulting in vulnerability to adverse outcomes (15).

As noted above, we have developed the comprehensive ICF Core Sets in order to facilitate and encourage the use of the ICF in clinical practice and research. The comprehensive ICF Core Sets are selections from the entire list of ICF categories, which emerged from a multi-stage consensus process seeking to identify those aspects of functioning most relevant for patients in specific settings or with specific health conditions or with specific characteristics such as old age. As such, a comprehensive ICF Core Set for older patients does not relate to a specific health condition, but includes all health conditions that might necessitate rehabilitation care. A comprehensive ICF Core Set for older patients in early post-acute rehabilitation facilities (16) was developed in a multiprofessional formal decision process integrating evidence gathered from preliminary studies including focus groups, a systematic review from the literature, and a empirical study in older patients (9). The current study made use of this comprehensive Core Set for patient assessment.

For scoring of the Core Set, the ICF suggests assigning qualifiers ranging from 0 to 4 for each category. Because the properties of all qualifiers are not yet sufficiently evaluated, in the present study we used a simplified qualifier, defined as follows. Each category of the components Body Functions and Activities and Participation was graded with the qualifiers 0 for "no impairment/limitation/restriction", 1 for "moderate impairment/limitation/restriction", and 2 for "severe impairment/limitation/restriction". The categories of the component Body Structures were graded with the qualifiers 0 for "no impairment" and 1 for "impairment". The categories of the component Environmental Factors were graded with 0 for "no barrier/facilitator" and 1 for "barrier/facilitator". Impairments of body functions or structures, and limitations or restrictions of activities and participation were reported if they were directly associated with the need for rehabilitation, regardless of the underlying health condition.

To describe an overall view of functioning, the patients were asked to appraise their personal limitations in overall functioning using a horizontal visual analogue scale, ranging from zero, for complete limitation in all aspects of functioning to 10, for no limitation in functioning). Independently, and blinded to the patients' responses, the health professionals were asked to appraise their patients' functioning on the same analogue scale.

Patients were recruited and interviewed by health professionals trained in the application and principles of the ICF. Data was collected primarily from patients' medical record sheets, by interview with health professionals in charge of the patients, and by patient interviews. ICF Core Set categories were assessed within the first 24 h after admission (baseline). Written informed consent was obtained from the patient or from the patient's care-giver in cases where the patient was unable to make an informed decision.

The criterion for selecting candidate categories for the brief ICF Core Set was based on their ability to discriminate between patients

with high or low functioning status. Discrimination was assessed using multivariable regression models, in which the independent variables were all of the ICF categories of the comprehensive ICF Core Set. Analogue ratings of overall functioning as reported by patients and health professionals were used as dependent variables. To improve prediction accuracy, and to derive small subsets of independent variables having the strongest effects on the dependent variable, we used the least absolute shrinkage and selection operator (LASSO) (17). This procedure minimizes the residual sum of squared errors with a bound on the sum of the absolute values of the coefficients. To avoid large variance, as often occurs in ordinary least square regression, the LASSO sets some regression coefficients to zero and shrinks others based on a preset regularization parameter, the so-called penalty. Thus, the method acts recursively to select valid subsets with adequate discrimination.

To validate the approach for selection of an ICF Core Set described above, we additionally used the Random Forest algorithm, which is based on Classification and Regression Trees (CART) non-parametric regression techniques. CART divides a population into several subpopulations depending on certain characteristics defined by successive binary splits in predictor variables. In the course of the iterations, successive subpopulations emerge as increasingly homogenous with respect to the outcome variable, which in this case is the overall functioning as reported by patients and health professionals. Of the many different ways to construct CART, we employed the technique proposed by Breiman et al. (18–19).

All data analyses were carried out with R 2.9.0 (20).

RESULTS

A total of 209 patients were included in the study. The mean age of included patients was 80.4 years, and 67.0% were female. The mean length of stay in the rehabilitation facility was 24.1 days. The most frequent diagnoses are shown in Table I. Patients reported a mean functioning score of 5.0 (95% confidence interval (CI) 4.8–5.3) at admission and of 6.8 (95% CI 6.5–7.0) at discharge. The difference in functioning from admission to discharge was significant.

Statistical selection of ICF categories yielded 7 categories for the component Body Functions, 15 categories for the component Activities and Participation, 7 categories for the component Body Structures and 9 categories for the component Environmental Factors, i.e. a total of 29 categories for the functioning part and 9 categories for the contextual part of the ICF.

Selection of categories along with information on the corresponding comprehensive ICF Core Set is shown in Tables II–V.

DISCUSSION

From a sample of 209 patients we identified candidate categories for a brief ICF Core Set extracted from the comprehensive ICF Core Set for patients in geriatric early post-acute rehabilitation facilities. These candidate categories represent a practical alternative to the lengthy comprehensive sets, in providing a minimal standard for measuring and communicating patients' functioning.

The results of the selection process have high face validity, as the selected categories arguably represented the relevant issues for older patients in the early post-acute situation.

The selected categories of the component Body Functions reflect a small, but important, spectrum of problems associated with functioning in older patients, namely sleep, respiration, and urination. There is evidence that increased daytime sleeping in older patients indicates worse functional status and recovery (21). In the ageing individual, respiratory function undergoes a number of changes (22). Thus, breathing and the ability to clear secretions has to be monitored in particular, in order to avoid complications such as pneumonia. Additionally, incontinence is a typical geriatric syndrome precipitated by acute illness that predicts functional decline (23).

The component Activities and Participation was represented by a number of categories from the chapters "Mobility" and "Self Care". Indeed, precisely these aspects are also covered by existing measurement instruments that are commonly used in the post-acute situation (24) and that are also recommended as a minimum data-set for clinical trials in older individuals (7). Similarly, the ability to maintain activities of daily living was shown to predict mortality among older patients in hospital (25). Additionally, aspects of participation such as family relationships and economic transactions arose as candidates for a brief ICF Core Set, which is consistent with current recommendations (6).

In the component Environmental Factors, categories dealing with attitudes, societal norms and social security were selected as candidates. This reflects the conceptual idea of successful reintegration into the community by providing ongoing assistance or by planning any kind of organized assistance for the time after inpatient rehabilitation.

The aim of this study was to define a practical and applicable brief ICF Core Set with no more than 20 items or ICF categories. Setting this upper limit was based on the precedent

Table I. *Most frequent diagnoses responsible for inpatient stay (International Statistical Classification of Diseases and Related Health Problems (ICD 10)),* n = *209*

	n (%)
Diseases of the respiratory system (J00–J99)	10 (4.8)
Diseases of the circulatory system other than cerebrovascular diseases (I00–I52 and I70–I99)	26 (12.4)
Cerebrovascular diseases (I60–I69)	19 (9.1)
Diseases of the nervous system (G00–G99)	13 (6.2)
Diseases of the musculoskeletal system and connective tissue (M00–M99)	16 (7.7)
Injury, poisoning and certain other consequences of external causes (S00–T98)	59 (28.2)
Neoplasms (C00–D48)	5 (2.4)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00–R99)	28 (13.4)
Other diagnoses	33 (15.8)

Table II. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Functions contained in the comprehensive ICF Core Set and proposed as candidates for the brief ICF Core Set for older patients*

ICF	Category description	Candidates for the brief ICF Core Set
b110	Consciousness functions	
b114	Orientation functions	
b117	Intellectual functions	
b130	Energy and drive functions	
b134	Sleep functions	×
b140	Attention functions	
b144	Memory functions	
b147	Psychomotor functions	
b152	Emotional functions	
b156	Perceptual functions	
b167	Mental functions of language	
b176	Mental function of sequencing complex movements	
b180	Experience of self and time functions	
b210	Seeing functions	
b215	Function of structures adjoining the eye	
b230	Hearing functions	
b240	Sensations associated with hearing and vestibular function	
b260	Proprioceptive function	
b265	Touch function	
b270	Sensory functions related to temperature and other stimuli	
b280	Sensation of pain	
b320	Articulation functions	
b410	Heart functions	
b415	Blood vessel functions	
b420	Blood pressure functions	
b430	Haematological system functions	
b435	Immunological system functions	×
b440	Respiration functions	
b450	Additional respiratory functions	
b455	Respiratory muscle functions	×
b460	Sensations associated with cardiovascular and respiratory functions	×
b510	Ingestion functions	
b525	Defecation functions	
b530	Weight maintenance functions	
b535	Sensations associated with the digestive system	
b540	General metabolic functions	
b545	Water, mineral and electrolyte balance functions	
b620	Urination functions	×
b630	Sensations associated with urinary functions	×
b710	Mobility of joint functions	
b715	Stability of joint functions	
b730	Muscle power functions	
b735	Muscle tone functions	
b755	Involuntary movement reaction functions	
b760	Control of voluntary movement functions	
b765	Involuntary movement functions	×
b770	Gait pattern functions	
b780	Sensations related to muscles and movement functions	
b810	Protective functions of the skin	
b820	Repair functions of the skin	
b840	Sensation related to the skin	

Table III. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Activities and Participation contained in the comprehensive ICF Core Set and proposed as candidates for the brief ICF Core Set for older patients*

ICF	Category description	Candidates for the brief ICF Core Set
d130	Copying	
d155	Acquiring skills	
d177	Making decisions	
d230	Carrying out daily routine	×
d240	Handling stress and other psychological demands	
d310	Communicating with – receiving – spoken messages	
d315	Communicating with – receiving – nonverbal messages	
d330	Speaking	
d335	Producing nonverbal messages	
d360	Using communication devices and techniques	×
d410	Changing basic body position	×
d415	Maintaining a body position	×
d420	Transferring oneself	×
d440	Fine hand use (picking up, grasping)	
d445	Hand and arm use	
d450	Walking	×
d460	Moving around in different locations	×
d465	Moving around using equipment	×
d510	Washing oneself	×
d520	Caring for body parts	×
d530	Toileting	×
d540	Dressing	
d550	Eating	×
d560	Drinking	
d570	Looking after one's health	×
d760	Family relationships	×
d770	Intimate relationships	
d860	Basic economic transactions	×
d930	Religion and spirituality	
d940	Human rights	

Table IV. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Body Structures contained in the comprehensive ICF Core Set and proposed as candidates for the brief ICF Core Set for older patients*

ICF	Category description	Candidates for the brief ICF Core Set
s110	Structure of brain	×
s120	Spinal cord and related structures	
s320	Structure of mouth	×
s410	Structure of cardiovascular system	
s430	Structure of respiratory system	×
s610	Structure of urinary system	×
s620	Structure of pelvic floor	
s710	Structure of head and neck region	
s720	Structure of shoulder region	×
s740	Structure of pelvic region	
s750	Structure of lower extremity	×
s760	Structure of trunk	
s770	Additional musculoskeletal structures related to movement	×
s810	Structure of areas of skin	

Table V. *International Classification of Functioning, Disability and Health (ICF) – categories of the component Environmental Factors contained in the comprehensive ICF Core Set and proposed as candidates for the brief ICF Core Set for older patients*

ICF	Category description	Candidates for the brief ICF Core Set
e110	Products or substances for personal consumption	×
e115	Products and technology for personal use in daily living	
e120	Products and technology for personal indoor and outdoor mobility and transportation	
e125	Products and technology for communication	
e140	products and technology for culture, recreation and sport	
e145	Products and technology for the practice of religion or spirituality	
e150	Design, construction and building products and technology of buildings for public use	
e240	Light	
e245	Time-related changes	×
e250	Sound	
e310	Immediate family	
e315	Extended family	
e320	Friends	
e325	Acquaintances, peers, colleagues, neighbours and community members	
e330	People in position of authority	×
e355	Health professionals	×
e360	Health related professionals	
e410	Individual attitudes of immediate family members	
e415	Individual attitudes of extended family members	
e420	Individual attitudes of friends	
e425	Individual attitudes of acquaintances, peers, colleagues, neighbours and community members	×
e430	Individual attitudes of people in positions of authority	
e450	Individual attitudes of health professionals	×
e455	Individual attitudes of other professionals	
e460	Societal attitudes	×
e465	Social norms, practices and ideologies	×
e570	Social security, services, systems and policies	×
e580	Health services, systems and policies	

of generic health status measures. The briefer ICF Core Set emerging in the present study is generally feasible in geriatric rehabilitation facilities, albeit it contains slightly more categories. To assess functioning, we proposed a total of 22 categories from the components Body Functions and Activities and Participation, electively, supplemented by 9 categories from Environmental Factors. Use of categories from Body Structures would depend on the underlying health condition, as required by the routine medical assessment.

Among the limitations of this study, it must be considered that selection bias may have occurred due to the use of a convenience sample of patients. Still, the spectrum of impairments and limitations encountered here was consistent with the results from similar studies (26). Another limitation might arise from the statistical selection process. Although we used two established methods, a split sample approach might have proved superior validation of the results. However, this approach was not possible because of the limited sample size. Further studies of sufficient size would more firmly establish the validity of the proposed selection, and would yield more insights into the association structures and potential scale attributes of the categories (27–28).

Defining an ICF Core Set for geriatric rehabilitation has the advantage of providing the potential framework for standardized reporting and measurement and setting the framework along the continuum of care. ICF Core Sets encourage the measurement of health status from a patient-centred and multiprofessional perspective. This is not a generic but a focused approach, taking into consideration the special needs and characteristics of that population. It must be noted, however, that the rehabilitation pathways and care options described in this paper are limited to institutional models. Rehabilitation of older persons can occur and, indeed, is frequently offered in community-based settings. Thus, the applicability of both the brief and comprehensive ICF Core Set should also be examined in the hand of long-term care providers.

In conclusion, the present selection of categories can be considered an initial proposal, serving to identify the issues most relevant for the assessment and monitoring of functioning in older patients. The main strength of the study lies in the selection of fewer categories facilitating the inclusion of the ICF Core Set into daily clinical routine. If there are categories missing from this smaller Set, the comprehensive ICF Core Set can easily be used to reconfigure the assessment. Also, for multi-morbid patients, a more generic Set could contain all categories from the 3 post-acute ICF Core Sets, completed by the ICF Core Set for older persons. Another advantage of the proposed selection is derived from its participatory approach, taking into consideration the perspectives both of patients and healthcare professionals. Thus, the ICF Core Sets for older patients can contribute substantially to the optimal management of patients, the teaching of health professionals, the planning of studies and the development of new assessment instruments.

ACKNOWLEDGEMENTS

This project was supported by the LMUinnovativ project Münchner Zentrum für Gesundheitswissenschaften (TP 1). The authors thank Dr Paul Cumming for revisions to the manuscript.

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J Rehabil Med 2011; 43: 145–150

ORIGINAL REPORT

GOALS OF PATIENTS WITH REHABILITATION NEEDS IN ACUTE HOSPITALS: GOAL ACHIEVEMENT IS AN INDICATOR FOR IMPROVED FUNCTIONING

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Objective: **To identify goals of patients with rehabilitation needs in the acute hospital setting using the International Classification of Functioning, Disability and Health (ICF), to examine association of goal achievement with improvement in overall functioning, and to examine whether ICF Core Sets for the acute hospital cover patients goals.**
Design: **Multi-centre cohort study.**
Patients: **A total of 397 patients (50% female, mean age 63 years) from 5 hospitals in Austria, Switzerland and Germany.**
Methods: **A semi-structured questionnaire was used to assess patient goals and goal achievement. Overall functioning from the patients' and health professionals' perspective was assessed on a numerical rating scale. Improvement in functioning was calculated using a residualized gain score. Association between goal achievement and improvement in overall functioning was assessed with logistic regression.**
Results: **A total of 397 patients reported achievement of at least 1 goal. Eighty-eight percent of the goals were translated into categories of the ICF. Logistic regression analyses revealed significant association between goal achievement and overall functioning.**
Conclusion: **The ICF might be useful to identify and structure patient's goals in acute hospital care. The association between goal achievement and improved functioning underlines that it is essential to involve the patient in the process of planning rehabilitation interventions in acute hospitals.**

Key words: ICF; goals; advance care planning; cohort study; intensive care; outcome assessment; classification.

J Rehabil Med 2011; 43: 145–150

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Submitted May 25, 2010; accepted October 21, 2010

INTRODUCTION

Patients hospitalized for an acute injury or disease who receive maximum medical or surgical care are still at risk of transitory or permanent loss of functioning. Irrespective of the underlying health condition this may be due to complications, comorbidities, or prolonged immobilization (1). It is thus increasingly recognized that appropriate and early onset of rehabilitation interventions can maintain functioning, prevent disability, and promote the recovery of patients. Specifically, this has been shown for patients in intensive care (2–3).

Goal setting to structure intervention planning and organizing a more patient-centred care is an integral part of rehabilitation medicine (4–6). Timely goal setting in close consultation with the patient is essential to rehabilitation success (7–8). Arguably, this also applies to rehabilitation interventions in the acute situation. Wade (9, p. 273) defined "goal" in the rehabilitation situation as a "future state that is desired and/or expected", goals "refer to relative changes or to an absolute attainment". In this context, a rehabilitation goal does not only comprise the patient's individual perspective, but also his environment, family, or any other persons involved.

In the acute situation, due to the brevity of admissions and the focus on medical and surgical care, there is limited time for the provision and coordination of structured rehabilitation interventions (10). Despite limited time resources, decisions regarding interventions and their priority should be determined by both the expert's view and, in accordance with the principles of evidence-based-practice, the expectations, prospects and personal goals of the individual patient (11).

In contrast to rehabilitation planning in specialized rehabilitation facilities in the post-acute setting, a formal comprehensive goal setting process in the acute hospital situation might be too ambitious. Restricted length of inpatient stay and limited personal resources necessarily narrow the focus on treatment of the acute injury or disease. Hence, rehabilitation planning and coordination in the acute situation, comprising assessment, goal setting and evaluation, should be realized using specifically tailored assessment systems including the most relevant issues of the patients, specifically the patient's goals.

From an ethical and human rights perspective it is fundamental to consider patient's individual goals in any healthcare intervention, such as early provision of rehabilitation. Since goal setting and goal achievement is hardly discussed in the context of acute patient care, but rather in rehabilitation and management of chronic conditions, little is known about the association of individual goals with established outcomes, such as improvement in functioning. In addition, there is no clear consensus on how to describe or formulate individual patient's goals. With the International Classification of Functioning, Disability and Health (ICF) we can now refer on a common framework to describe these goals. The ICF is a globally ac-

cepted language for communication about functioning, which entails consideration of body function, autonomy of the individual, and engagement in society (12). It was developed to be used and understood by all potential user groups, including patients. In order to enhance the applicability of the ICF in clinical practice and research, and to overcome practical concerns relating to the large number of categories included within the ICF, comprehensive ICF Core Sets for patients in acute hospitals were created for the assessment of problems and needs in the acute situation, as well as for the estimation of prognosis and rehabilitation potential. Likewise, they can be used to coordinate rehabilitation interventions in this setting (13–16). Since comprehensive ICF Core Sets were designed to include the total spectrum of problems in functioning commonly relevant to patients in the acute situation, arguably they can also be used to code patient's goals.

The objectives of this study were:

- to identify goals of patients with rehabilitation needs in the acute hospital setting using the ICF;
- to examine the association of goal achievement with improvement in patient's overall functioning, as perceived by patients and health professionals;
- to examine whether the comprehensive ICF Core Sets for the acute hospital cover relevant patients goals.

METHODS

Study design

The current study is part of a larger multi-centre cohort study conducted for the development and validation of ICF Core Sets in the acute hospital and in early post-acute rehabilitation facilities (17). Patients were recruited consecutively between May 2005 and August 2008 from acute wards of 4 university hospitals in Austria, Germany and Switzerland and 1 Austrian general hospital. Patients were included if they were at least 18 years old and received rehabilitation interventions for treatment of any acute musculoskeletal, neurological or cardiopulmonary injury or disease coordinated by a rehabilitation physician (1). Informed consent was obtained from patients, or, if the patient was unable to make an informed decision, from the patient's caregiver. The study was approved by the institutional ethics committees of all involved hospitals prior to starting the research. Interviewers collecting data had been trained in the application and principles of the ICF, and provided with a manual. All interviewers were health professionals (physicians, medical students in clinical training, physical therapists, or nurses). During data collection interviewers obtained support and information from the ward staff in charge. Ongoing supervision of the interviewers was ensured by periodic telephone calls.

Measures

Goal achievement. Patients were asked at baseline (within 24 h after admission) to report up to 10 important aspects related to their health condition and their hospitalization. We asked for areas of body and mind, as well as for areas of daily activities and participation, or aspects related to the physical or social environment. It was indicated by the interviewers that the patients would be asked again at discharge to rate the perceived change in these aspects. At the end-point (within 36 h before discharge) we asked them to state which of the aspects mentioned at baseline they had achieved during the inpatient stay.

Overall functioning. Patients were asked to assess their overall functioning at baseline and at end-point on a numerical rating scale (where 0 = complete limitation in all aspects of functioning, and 10 = no limitation in functioning). Health professionals who collected the data were asked to assess patient's overall functioning using the same scale.

Additionally, socio-demographic (sex, age, education, living and occupation situation) and condition-specific data (underlying diagnosis, time until rehabilitation, number of co-morbidities and length of stay) were recorded.

Analysis

Linking of patient statements to the ICF. We translated the patients' statements into categories of the ICF to make data accessible for subsequent statistical analysis. The translation followed a standardized procedure: in the first step, 2 researchers independently identified all meaningful concepts with a common topic contained in the patients' statements. In case of dissent on the meaningful concept, a third independent researcher was involved in the discussion. The identified concepts were linked to categories of the ICF by 2 health professionals based on the established linking rules, which enable linking concepts to ICF categories in a systematic and standardized way (18–19). According to these linking rules, researchers trained in the ICF are advised to attribute each concept to the ICF category representing this concept most precisely. One concept can be linked to one or more ICF categorie, depending on the number of themes contained in the concept. Consensus between the 2 researchers was required to decide which ICF category should be linked to the identified concept. In case of a disagreement, a third person trained in the linking rules was consulted. In a discussion led by the third person, the 2 researchers who linked the concepts stated their pros and cons for the linking of the concept under question to a specific ICF category. Based on these statements, the third person made an informed decision. For feasibility reasons, the linking procedure was restricted to the second level of the ICF.

Statistical analysis. We used absolute and relative frequencies to describe patient's goals and corresponding ICF categories. Change in overall functioning was estimated with a residualized gain score. Estimating change by calculating the crude difference between scores at different time points can be biased by the effect called "regression to the mean". Individuals with a higher baseline score are more likely to score lower on re-test, whereas individuals with low baseline score are more likely to score higher on end-point (20–21). As a result of these tendencies, absolute changes may overestimate the effect of baseline differences on re-test scores (22). To avoid this effect Cronbach & Furby (23) suggest calculating a residualized gain score. We calculated the residualized gain score to estimate change in overall functioning using a linear mixed model that integrates the differing length of inpatient stays as a random effect. We used the function "lmer" of the package "lme4" of R 2.11.0 (24). A patient was rated as actually improved when his or her overall functioning improved more than predicted by the linear mixed model. Specifically, we rated the individual as "improved" when an individual experienced positive change from baseline to end-point and the improvement was greater than expected by the model, i.e. the residual was greater than zero, and as "not improved" when the residual was less than expected. This classification served as outcome variable for the subsequent multiple logistic regression analyses.

The main independent variable in multiple analysis was patient's goal achievement at discharge as classified with a dichotomous variable ("no goal achieved" vs "at least 1 goal achieved"). We took the variables "age", "sex", "length of inpatient stay", "number of comorbidities", "time from event to rehabilitation onset", "diagnosis groups" (neurological, cardiopulmonary, or musculoskeletal condition) and "need for professional nursing care prior to hospitalization" into account as potential confounders and included them in the model. In order to check for potential effect modification by sex we analysed the corresponding odds ratios. Collinearity was checked using correlation coefficients.

We calculated separate logistic regression models to estimate the effects of goal achievement on improvement in overall functioning from the patients' and the health professionals' perspectives, respec-

tively. Stepwise variable selection was carried out based on the Akaike Information Criterion (AIC).

All data analyses were carried out with R 2.11.0 (25).

RESULTS

We included 397 patients from 5 different acute hospitals in Austria, Switzerland and Germany. Patients' ages ranged from 18 to 100 years, with a median age of 65 years. Length of hospital stay ranged from 4 to 99 days (median 10 days). Fifty percent of the patients were female. Ninety-one patients (23%) presented with neurological, 109 (28%) with cardiopulmonary, and 191 (49%) with musculoskeletal conditions. Detailed diagnoses of the patients are reported in Table I. Median time from event to onset of rehabilitation interventions was 1 day (mean 7 days, range 0–180 days). Demographic characteristics and assessment of overall functioning from the patients' and health professionals' perspectives are summarized in Table II.

A total of 373 patients (94%) reported at least 1 goal, 69% (257) reported more than 1 goal (median 2 goals, mean 2.8 goals). A total of 998 goals were reported. 778 (77%) goals could be linked to the ICF, namely 95 ICF categories, 5 ICF chapters and 2 ICF components. A total of 216 goals (22%) could not be linked to any part of the ICF.

The most frequently reported goals were *Walking* (d450), *Sensation of pain* (b280), *Health services, systems and policies* (e580), *Recreation and leisure* (d920), *Washing oneself* (d510), *Caring for household objects* (d650), and *Sensations associated with cardiovascular and respiratory functions* (b460) (see also Table III).

The most frequently stated patient goals that could not be linked to the ICF were "Admission to home" (9% of all mentioned goals), "General health" (5%) and "General physical functioning" (2%). Thirty-five percent of the reported goals linked to ICF categories were not covered by the corresponding comprehensive ICF Core Sets (ICF categories named with a frequency $\geq$5% and the corresponding ICF Core Set are reported in also Table III).

Information on goal achievement was available from 327 patients (88%). A total of 260 patients (80%) had achieved at least 1 of their personal goals, whereas 114 patients (35%) claimed no achievement in any of their goals. In summary, 568 (57%) of the 998 goals were reported as achieved at discharge.

The mean overall functioning score from the patients' perspective was 4.54 (median 5) on admission and 6.63 (median 7) on discharge. The mean overall functioning score from the health professionals' perspective was 4.59 (median 5) on admission and 6.68 (median 7) on discharge.

Sixty percent of patients (n=190), were judged as improved, from both patients' and health professionals' perspectives.

In bivariate analyses, sex acted as an effect modifier of the association between goal achievement and improvement in functioning (odds ratio (OR) 3.9, 95% confidence interval (CI) [1.72–8.93] in women vs 1.8, 95% CI [0.88–3.70] in men). Therefore, the interaction term of sex and goal achievement was included in the multiple analyses.

After stepwise variable selection the final model (patients' perspective) contained the variables "Goal achievement", "Indication" and "Need for professional nursing care prior to hospitalization". A patient who achieved at least 1 goal was 2.7 times as likely to improve in overall functioning (OR=2.7). The interaction term of goal achievement and sex did not improve the explanatory power of the model and was removed.

After stepwise variable selection, the final model (health professionals' perspective) contained the variables "goal achievement", "time from event to rehabilitation onset", "number of comorbidities" and "need for professional nursing care prior to hospitalization". A patient who achieved at least 1 goal was almost 1.8 times as likely to improve in overall functioning (OR=1.8). Again, the interaction term was not included in the final model.

Tables IV and V summarize the results of both multivariable logistic regression models.

Table I. *Diagnoses responsible for inpatient stay (International Classification of Diseases-10*

Diagnosis	n (%)[a]
Diseases of the musculoskeletal system and connective tissue (M00-M99)	88 (22.5)
Injury, poisoning and certain other consequences of external causes (S00-T98)	80 (20.5)
Diseases of the circulatory system other than cerebrovascular diseases (I00-I52 and I70-I99)	69 (17.6)
Cerebrovascular diseases (I60-I69)	46 (11.8)
Neoplasms (C00-D48)	38 (9.7)
Diseases of the respiratory system (J00-J99)	29 (7.4)
Other diagnoses	23 (5.9)
Diseases of the nervous system (G00-G99)	18 (4.6)

[a]Percentage based on 391 patients.

Table II. *Characteristics of participants*

Variable: Category	n (%)
Gender	
Female	198 (49.9)
Male	199 (50.1)
Personal informed consent (vs consent by caregiver)	371 (93.5)
	Mean (median) [95% CI]
Age, years	63 (65) [61.2–64.8]
Duration of inpatient rehabilitation, days	15.6 (10) [14.1–17]
Time from event to rehabilitation onset, days[a]	7.5 (1) [5.5–9.4]
Number of comorbidities	2.7 (2) [2.5–2.9]
Overall functioning – health professionals' perspective[b]	
Admission, n=394	4.5 (4) [4.3–4.7]
Discharge, n=366	6.6 (7) [6.4–6.8]
Overall functioning – patients' perspective[c]	
Admission, n=376	4.5 (5) [4.3–4.7]
Discharge, n=349	6.6 (7) [6.4–6.8]

[a]n=391.

[b]For analysing change in overall functioning, n=364 due to missing values for admission or discharge data.

[c]For analysing change in overall functioning, n=345 due to missing values for admission or discharge data.

Table III. *Patient goals linked to International Classification of Functioning, Disability and Health (ICF) categories*

ICF category		Reported as patient goal *n*[a]	Reported as achieved goal *n* (%)	ICF category reported as patient goal but not in the corresponding ICF Core Set[b]
d450	Walking	104	58 (56)	neuro
b280	Sensation of pain	97	46 (47)	
e580	Health services, systems and policies	53	41 (77)	
d920	Recreation and leisure	33	9 (27)	neuro, cardio
d510	Washing oneself	24	19 (79)	
d650	Caring for household objects	22	7 (32)	neuro, msk, cardio
b460	Sensations associated with cardiovascular and respiratory functions	20	15 (75)	
d410	Changing basic body position	16	14 (88)	
d640	Doing housework	16	2 (12)	msk
d760	Family relationships	16	11 (69)	
d845	Acquiring, keeping and terminating a job	16	3 (19)	msk
b730	Muscle power functions	14	7 (50)	
d415	Maintaining a body position	14	9 (64)	
e450	Individual attitudes of health professionals	13	10 (77)	
d445	Hand and arm use	12	11 (92)	
d475	Driving	12	0 (0)	msk
d460	Moving around in different locations	11	9 (82)	cardio
b240	Sensations associated with hearing and vestibular function	10	6 (60)	
d330	Speaking	10	8 (80)	
d530	Toileting	10	5 (50)	
d660	Assisting others	10	1 (10)	
d850	Remunerative employment	10	5 (50)	
b265	Touch function	9	6 (67)	
d455	Moving around	9	4 (44)	
b134	Sleep functions	8	6 (75)	
b126	Temperament and personality functions	7	3 (43)	
b440	Respiration functions	7	7 (100)	
d550	Eating	6	2 (33)	
d166	Reading	5	0 (0)	
d440	Fine hand use	5	1 (20)	
d465	Moving around using equipment	5	2 (40)	
d540	Dressing	5	3 (60)	
d770	Intimate relationships	5	1 (20)	
e110	Products or substances for personal consumption	5	2 (40)	
e310	Immediate family	5	4 (80)	

[a]Only frequencies ≥5 reported.
[b]Only frequencies ≥5% reported.
neuro: neurological conditions; cardio: cardiopulmonary conditions; msk: musculoskeletal conditions.

DISCUSSION

To the best of our knowledge this is the first study in the acute hospital to investigate patient's functioning goals systematically. We found that patients attached great importance to basic abilities such as walking and self-care, but also to be free of pain and to obtain appropriate care. As in other settings it could be demonstrated that categories of the ICF are useful to describe patients' attitudes and views on their functioning and health (26). In addition, this is the first study to show that the

Table IV. *Results of the multivariable logistic regression model: patients' perspective*

Patients' perspective (*n*=316)	OR	95% confidence interval
(Intercept)	0.36	0.16–0.8
At least 1 goal achieved	2.66	1.54–4.63
Indication[a]: Cardiopulmonary conditions	1.55	0.87–2.84
Neurological conditions	0.6	0.34–1.06
Need for professional nursing care prior to hospitalization: No	2.26	1.17–4.46

[a]Reference category is musculoskeletal conditions.
OR: odds ratio.

Table V. *Results of the multivariable logistic regression model: health professionals' perspective*

Health professionals' perspective (*n*=316)	OR	95% confidence interval
(Intercept)	0.9	0.39–2.11
At least 1 goal achieved	1.75	1.02–2.98
Time from event to rehabilitation onset	0.98	0.96–1
Number of comorbidities	0.91	0.81–1.02
Need for professional nursing care prior to hospitalization: No	1.69	0.86–3.32

OR: odds ratio.

achievement of individual goals is associated with improvement in patient's overall functioning even in the acute hospital situation, as rated both from the patients' and the health professionals' perspective. It could also been shown that a majority of categories of the respective comprehensive ICF Core Sets corresponds with patient goals.

Since, so far, there are no comparable studies on patient goals and goal achievement in the acute situation, the study results have to be viewed in relation to studies on those topics carried out in the post-acute situation. Current research on patient goals indicates that mobility, especially independent walking, is one of the most prominent goals in rehabilitation (27). Independent self-care is a main prerequisite of independent living and is therefore highly plausible as a primary patient goal. The high number of patients who reported housework as an important goal might be surprising at the first glance. It shows, however, that patients even when suffering from severe acute conditions plan and care for their living situation after discharge from hospital. It is plausible that patients also wanted to be free of sensations related to cardiovascular and respiratory functions, such as dyspnoea and palpitations. Dyspnoea is among the first symptoms treated in an emergency situation and heavily impairs functioning and quality of life (28–29).

In addition to some very general aspects, such as maintaining general health or independent living, a very high proportion stated appropriate health service, empathic and qualified doctors and nurses as a major goal.

All in all, the stated goals reflect a prototypical spectrum of impairments and limitations as described by the comprehensive ICF Core Sets for acute hospital (13–14, 16). This study in a new sample of patients confirms the face validity of the comprehensive acute ICF Core Sets, which consistently provided a useful framework to categorize and standardize patient goals. This concurrence is a potentially important result of this study, since a common and accepted way to involve the patients' perspective in goal-setting has been lacking (30–31).

The linking of stated goals of patients in the acute hospital to categories of the ICF highlights that patients tend to express their view in very general phrases. It is up to the health professionals to clarify the general goals in a more detailed way and to deconstruct them into the components that can be addressed by therapy (27). Based on our experience the ICF can be seen as a tool that offers helpful terminology to translate unstructured information into a structured form, which can be analysed and reported in a standardized way, and can guide the treatment process.

As expected, goal achievement was associated with improvement in overall functioning, independent of the perspective taken. Studies could show that goal achievement was associated with patient progress (32). Likewise, in an earlier study of neurological rehabilitation, goal achievement was associated with improvements in functioning (33). In another study, this association was shown to be independent of patient's characteristics such as main diagnosis and age (34).

A rather surprising finding of our study is that several frequently reported patient goals are not covered by the corresponding comprehensive ICF Core Set, such as *Walking* (d450), *Recreation and leisure* (d920), or *Caring for household objects* (d650) (see also Table III). It has to be kept in mind that the acute ICF Core Sets were developed by acute care health professionals who focus on patients' survival, prevention of secondary conditions and complications and immediate basic activities, such as self-care. Goals such as housekeeping, remunerative work and leisure are important because the patient wants to return to his or her own life and autonomy, whether this is realistic or not. Although those goals might not be the immediate priority for acute rehabilitation interventions, they have to be regarded as relevant. The fact that *Walking* (d450) was not included into the first version of the comprehensive ICF Core Set for neurological patients followed a extensive discussion with the result that walking is not an immediate goal of treatment and rehabilitation in the acute situation, but one of the major goals in the post-acute situation (14).

Our study has some potential limitations. Patients were asked to report the 10 most relevant aspects of functioning pertaining to their disease and hospitalization rather than to report measurable, realistic goals. Nevertheless, these 10 aspects can be interpreted as significant for patients' personal desires and expectations concerning their disease and hospitalization. Therefore, we feel justified in considering these aspects to be synonymous with "goals" (9). The time from acute event to rehabilitation onset ranged up to 180 days for a minority of patients. This could be attributed to several transfers from one hospital or clinic to another due to exacerbation of the condition. We decided not to exclude the outliers, since we are confident that those patients are typical for our target population. A further aspect to bear in mind is the prevalence of impairment in cognitive or consciousness functions in patients in acute hospital care. It is not clear to what extent those patients are able to participate adequately in the formulation of goals. In our study, part of the sample had problems with mental functions (35). This might have led to selection bias towards the fitter patients.

In conclusion, the ICF proved to be a useful framework to identify and structure statements about goals of patients with rehabilitation needs in the acute hospital. Goals set by patients should be taken into account as a valuable outcome in the acute situation. Thus, translating these goals into categories of the ICF enables linking patient goals to standardized assessment instruments to measure goal achievement in a valid manner.

In addition, positive association between goal achievement and improved functioning underlines that it is essential to involve the patient in the process of planning rehabilitation interventions even in the acute situation to ensure a maximum of effectiveness of those interventions and to prevent complications and promote early rehabilitation.

ACKNOWLEDGEMENTS

We wish to thank the patients participating in the study and the teams at the Kaiser-Franz-Josef-Hospital, Vienna (Austria), University Hospital Vienna, Vienna (Austria), University Hospital, Zurich (Switzerland), University Hospital, Heidelberg (Germany), and Hannover Medical School, Hannover (Germany). The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501.

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J Rehabil Med 2011; 43: 151–155

ORIGINAL REPORT

THE ICF FORMS A USEFUL FRAMEWORK FOR CLASSIFYING INDIVIDUAL PATIENT GOALS IN POST-ACUTE REHABILITATION

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Objective: **Timely goal setting in close collaboration with the patient is essential to successful rehabilitation. We therefore sought to identify goals of patients in early post-acute rehabilitation as predictors of improved functioning.**

Design: **We conducted a prospective multi-centre cohort study in 5 early post-acute rehabilitation facilities.**

Patients: **Patients with musculoskeletal, cardiopulmonary and neurological conditions were recruited between May 2005 and August 2008.**

Methods: **A semi-structured questionnaire was used to identify patient goals and to assess improvement in overall functioning. Patients' goals were coded according to the International Classification of Functioning, Disability and Health (ICF). By means of a mixed effects model we examined the association between goal attainment and improved functioning.**

Results: **A total of 116 patients gave 546 statements, of which 426 were linked to 74 ICF categories, which were assigned to the existing comprehensive post-acute ICF Core Sets. Improvements in walking, recreation and leisure, pain, and transfer were the most frequently reported goals. In multivariable analysis patients' goal attainment was not a predictor for improved overall functioning.**

Conclusion: **The ICF can be used to identify and structure patients' goals. Patients' perspective should be considered in the rehabilitation process.**

Key words: ICF; goals; advance care planning; cohort study; rehabilitation; outcome assessment; classification.

J Rehabil Med 2011; 43: 151–155

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Submitted May 25, 2010; accepted November 16, 2010

INTRODUCTION

Timely goal setting on the advice of caregivers working in close consultation with patients is essential to rehabilitation success (1, 2). Wade (3) defines a rehabilitation goal as a "future state that is desired and/or expected", which might furthermore "refer to relative changes or to an absolute achievement" (p. 273). In this context, a goal comprises not only the patients' aspirations, but also his or her environment, family, or any other involved persons. Involving the patients' perspective by identifying his or her personal needs and problems is considered to be a basic principle of the goal planning process (3).

Despite benefiting from a successful acute treatment, many patients with acute injury or disease experience a significant loss of functioning, and their recovery may not be complete in the short-term. Such persons, in particular those at risk of functional decline, are ideally managed by an interdisciplinary team at a specialized rehabilitation facility. Patients in such a setting will have a large spectrum of needs, desires or goals relevant to their rehabilitation. These goals may pertain to their particular health condition or disability, return to the home environment, activities of daily living, or emotional situation. Standardized measures, however, often fail to encompass the salient features of patients' goals (4). The need for involving the patients' personal perspective in the rehabilitation process has been noted previously (5, 6). It follows that the extent of goal attainment for an evaluation of the outcome is of interest in clinical practice (6). It has been observed that patients who had been prompted to formulate treatment goals participated more actively in the rehabilitation process and perceived themselves to manage better after completion of their post-acute rehabilitation (2).

Arguably, the actual attainment of patients' goals should be associated with improvement in overall functioning as subjectively perceived by the patient, and as objectively recorded by the health professional. However, there is no consensus on how to assess the patients' perspective systematically, nor is it obvious whether the attainment of stated goals really indicates improvement in measured outcomes (6, 7).

The International Classification of Functioning, Disability and Health (ICF) is a globally accepted language for communication about functioning, which entails consideration of body function, autonomy of the individual, and engagement in society (7, 8). In order to enhance the applicability of the ICF in clinical practice and research, and to overcome practical concerns relating to the great number of categories afforded within the ICF, the so-called comprehensive ICF Core Sets for patients in early post-acute rehabilitation facilities were created to provide standards for multi-professional compre-

hensive patient assessment (9–12). These Sets were designed to include the typical spectrum of problems in functioning encountered in post-acute rehabilitation, so as to permit the coding of patients' goals.

The objectives of this study were first to use the ICF to identify the rehabilitation goals of patients in early post-acute rehabilitation, and then to examine the association of goal attainment as reported by the patient with objective measures of improvement in overall functioning. Patient goals in this study were not set as part of the routine rehabilitation process but reflected expectations, desires, hopes, and goals, as well as fears, doubts or problems arising from the underlying health condition, the hospitalization, or in association with the physical and social environment.

METHODS

Study design

The design was a prospective multi-centre cohort study, which was conducted from May 2005 to August 2008. We recruited rehabilitation patients with musculoskeletal, cardiopulmonary and neurological conditions from predefined wards of 5 early post-acute rehabilitation facilities in Germany: the University Hospital Munich, Department of Physical and Rehabilitation Medicine (PRM); the General Hospital Munich-Schwabing, Department of PRM, Munich, Hospital of Nuremberg, Department and Institute for PRM, and Hospital of Ingolstadt, Institute for PRM.

Patients were included if they were at least 18 years old and were receiving rehabilitation interventions. Informed consent was obtained from patients, or, if the patient was unable to make an informed decision, from the patients' care-giver. Affirmation of the institutional ethics committees from each involved hospital was obtained prior to starting the study.

Measures

In addition to socio-demographic data and main diagnoses, the case report included a semi-structured questionnaire for patient and health professional, designed to identify patient goals and to assess overall functioning from the health professional's perspectives. To describe an overall view of functioning, health professionals were asked to appraise the limitations in overall functioning using a horizontal visual analogue scale, ranging from zero, for complete limitation in all aspects of functioning to 10, for no limitation in functioning. "Overall functioning" was defined as encompassing all aspects of physical or mental state, of daily living, mobility and interaction with the environment and with others. Health professionals were asked to relate to the current health condition and the present state. Generally, functioning was appraised as a part of the regular team conferences. Rating at end-point was also blinded to the admission rating. The data were collected by interview approximately 24 h after admission (baseline), and within 36 h before discharge (end-point).

Patients were asked at baseline to report up to 10 important aspects related to their health condition and their hospitalization. These aspects were expectations, desires, hopes, and goals, as well as fears, doubts or problems arising from the underlying health condition, the hospitalization, or in association with the physical and social environment. In addition, patients were reminded of these aspects at end-point and were asked to decide which of the goals mentioned at baseline had been attained during the inpatient stay. Reporting the goals was not part of the routine rehabilitation management, thus goals were not necessarily specific, measurable, achievable, realistic, and timed (SMART) as proposed for the assessment of rehabilitation goal attainment.

Linking process

Patients' statements were translated into the ICF terminology following a standardized linking procedure, which is based on established linking rules (13, 14). We used the framework of the ICF to specify and group the information derived from the patients, so as to enable subsequent statistical analysis.

In the first step of the linking procedure, two researchers independently identified all meaningful concepts contained in the patients' statements. A meaningful concept can be described as a specific component of text, consisting either of a few words or a few sentences, which have a common motif (15). In the second step, the two researchers' versions of the concepts identified as being meaningful were compared. Structured discussion and informed decision of a third expert were used to resolve disagreements between the two versions. Then the final consensus version of meaningful concepts was linked to the most closely corresponding ICF categories by the two independent researchers, according to the defined linking rules. The results of the two experts were again compared; in the event of disagreement, structured discussion and consultation with a third expert was again used to arrive at a decision. In cases where a patients' goal could not be linked to the ICF, e.g. because the statement was too general for linking, or if the contents were not covered by the ICF, we summarized and grouped the data so as not to lose that information and to enable subsequent analysis.

Data analysis

We used absolute and relative frequencies to describe patients' goals. Based on the statements on goal attainment at discharge, we made a binary classification of the individuals (0 = no goal attained, 1 = at least one goal attained).

To analyse associations between goal attainment and functional recovery we used mixed effect regression models, including both fixed and random effects. This method of analysing longitudinal data is well-suited to examine change trajectories with unequally spaced data (16), as typically occurs in patient goal analysis. It supposes that the continuous outcome (such as the patients' overall functioning assessed by a numerical rating scale) occurs as a function of time for each individual, known as the growth trajectory, with an additional error term. The growth trajectory is described by a number of parameters; the intercept describes the individual starting level, i.e. patient functioning at admission, whereas the slope parameter represents the rate of change over time, i.e. the change of functioning between admission and discharge (17). We calculated an unadjusted model and a model adjusted for age, sex and condition group.

Goodness of fit of the models was assessed by comparing their Akaike Information Criterion (AIC = Deviation + 2 × (number of parameters in the model – degrees of freedom (df)). Fixed effects were tested for significance using the z-statistic, all tests being 2-tailed with a p-value ≤ 0.05 deemed to indicate statistical significance.

RESULTS

A total of 116 patients were included, 52 (45%) with musculoskeletal, 58 (50%) with neurological and 6 (5%) with cardiopulmonary conditions. Forty-seven (40%) patients were female, mean age at admission was 64 years (standard deviation (SD) = 14 years), mean length of stay 34 days (SD = 19 days). Demographic characteristics and assessment of overall functioning are summarized in Table I.

Patients reported a total of 546 goals. A total of 120 goals could not be linked to second-level categories of the ICF, mainly because they were overly broad, with improvement of general health condition or autonomy being a typical instance. Twenty-six statements were linked to ICF components (1 to

Table I. *Patient characteristics*

	Total (n=116) n (%)	Musculoskeletal conditions (n=52) n (%)	Neurological conditions (n=58) n (%)	Cardiopulmonary conditions (n=6) n (%)
Female	47 (40.5)	27 (51.9)	18 (31.0)	2 (33.3)
Diseases of the respiratory system (J00-J99)	1 (0.9)	0 (0)	1 (1.7)	0 (0)
Diseases of the circulatory system other than cerebrovascular diseases (I00-I52 and I70-I99)	9 (7.8)	4 (7.7)	2 (3.4)	3 (50)
Cerebrovascular diseases (I60-I69)	18 (15.5)	0 (0)	18 (31)	0 (0)
Diseases of the nervous system (G00-G99)	25 (21.6)	3 (5.8)	22 (37.9)	0 (0)
Diseases of the musculoskeletal system and connective tissue (M00-M99)	24 (20.7)	13 (25)	10 (17.2)	1 (16.7)
Injury (S00-T98)	19 (16.4)	19 (36.5)	0 (0)	0 (0)
Neoplasms (C00-D48)	6 (5.2)	3 (5.8)	2 (3.4)	1 (16.7)
Symptoms (R00-R99)	1 (0.9)	0 (0)	1 (1.7)	0 (0)
Other diagnoses	13 (11.2)	10 (19.2)	2 (3.4)	1 (16.7)
Age at admission, years	64.1 (14.1)	64.7 (13.6)	63.5 (15.1)	65.4 (7.7)
Length of stay, days	34.1 (18.9)	31.8 (17.8)	35.9 (20.5)	36.2 (11.9)

the component Body Functions and 25 to the Component Activities and Participation) and 68 to ICF chapters (18 to chapters of the component Body Functions, 38 to chapters of the component Activities and Participation and 12 to chapters of the component Environmental Factors). In all, 426 goals could be coded as second-level ICF categories, with the most frequently stated goals being Walking (d450), Recreation and leisure (d920), Sensation of pain (b280), and Changing basic body position (d410).

Of the 174 goals reported by patients with musculoskeletal conditions, 119 (68%) could be coded by categories covered in the comprehensive ICF Core Set for patients with musculoskeletal conditions in early post-acute rehabilitation facilities. Of the 217 goals reported by patients with neurological conditions, 196 (90%) could be coded by categories covered in the corresponding comprehensive ICF Core Set. Of the 35 goals reported by patients with cardiopulmonary conditions, 25 (71%) could be coded by categories covered in the corresponding comprehensive ICF Core Set. Details on frequencies of linked ICF categories are shown in Table II. Recreation and leisure (d920) was the most frequently coded category not contained in 1 of the 3 ICF Core Sets. Most of the other categories not contained were reported only once.

A total of 110 patients (50 with musculoskeletal, 54 with neurological and 6 with cardiopulmonary conditions) gave information on goal attainment. Ninety-three patients (84.6%) had attained at least one of their personal goals. Mean overall functioning score was 3 (SD=2) at admission and 6 (SD=2) at discharge.

The unadjusted mixed effect regression model showed a positive association between goal attainment and functional recovery, with an estimated difference in daily rate of change of 0.03 points. This association was not statistically significant (p=0.1003). The mixed effect regression model adjusted for age, sex and condition group showed a statistically significant difference in initial functioning among condition groups and according to age. Patients with neurological conditions and older patients started on average with a lower score than did the other two groups. There was a positive association between goal attainment and functional recovery, with an estimated daily rate of change of 0.03 points. This association was not significant at the 0.05 level (p=0.0775). Table III shows details of the regression models.

DISCUSSION

In this study, patients undergoing early post-acute rehabilitation reported mobility, namely transfer and walking, getting rid of pain, returning home and improving their general health condition as their main goals of the rehabilitation process. Goal areas could be standardized and analysed in a meaningful way

Table II. *Absolute and relative frequencies of 2nd level International Classification of Functioning, Disability and Health (ICF) categories linked to patient goals*

ICF Code	Description	Musculoskeletal conditions (n=174) n (%)	Neurological conditions (n=217) n (%)	Cardiopulmonary conditions (n=35) n (%)
b130	Energy and drive functions			2 (5.7)
b152	Emotional functions	8 (4.6)		
b280	Sensation of pain	19 (10.9)		4 (11.4)
d330	Speaking			2 (5.7)[a]
d410	Changing basic body position		21 (9.7)	
d415	Maintaining a body position		12 (5.5)	3 (8.6)
d450	Walking	16 (9.2)	13 (6.0)	4 (11.4)
d510	Washing oneself		10 (4.6)	
d550	Eating		14 (6.5)	
d920	Recreation and leisure	22 (12.6)†		2 (5.7)†
e115	Products and technology for personal use in daily living			3 (8.6)

[a]ICF category not included in ICF Comprehensive Core Set.
Only categories with a frequency ≥ 5% are reported.

Table III. *Mixed effects models on associations between goal attainment and functioning*

	Unadjusted model		Model adjusted for age, sex and condition group	
	Estimate	*p*-value	Estimate	*p*-value
A. Associations with functioning at admission				
Goal attainment (yes vs no)	1.0567	0.0236	0.5818	0.1829
Sex (male vs female)			–0.3328	0.2994
Age (in years)			–0.0233	0.0334
Condition group (reference = musculoskeletal)				0.001
Neurological			–1.263	
Cardiopulmonary			–0.7101	
B. Associations with daily rate of change in functioning				
Goal attainment (yes vs no)	0.0281	0.1003	0.0315	0.0775
Sex (male vs female)			0.0045	0.699
Age (in years)			–0.00003	0.93
Condition group (reference = musculoskeletal)				0.7444
Neurological			0.0021	
Cardiopulmonary			0.0185	
Goodness of fit (AIC)	902		896.9	

Estimates give mean differences in functioning as appraised by health professionals (A, on a 0–10 scale, where 0 signifies worst and 10 signifies best) between groups at admission and mean differences in functioning over time per day (B). To give an example, the negative estimate for a person with a neurological condition indicates that someone with this characteristic would have a lower score at admission than someone with a musculoskeletal condition.
AIC: Akaike Information Criterion.

by using the ICF. Goal attainment as a result of the rehabilitation process, however, was not statistically associated with improvement in patients' overall functioning.

Goal attainment scaling in rehabilitation has been shown to be more responsive than conventional summary scores; equally, individualized priority "personal" rehabilitation goals have been mapped to the ICF (18). Our approach has been slightly different, insofar as we did use goals that were set by the patients as the most important and relevant to them, but the goals were not part of the treatment and were not discussed and negotiated with the patients.

Most frequently, goals could be coded with ICF categories from the component Activities and Participation, namely from the chapters Mobility and Self-care. The reported goals reflect a typical spectrum of needs and goals expressed by patients in the rehabilitation situation (1). Regardless of the underlying health condition, walking was one of the more prominent goals.

More than 90% of all patient goals could be linked to the ICF, which supports the general utility of the Core Sets in the context of rehabilitation. However, 94 reported goals were insufficiently specific, and could therefore only be coded on a component or chapter level. Since goal setting in rehabilitation is arguably an interactive process between patient and therapist (19), an appropriate role of the therapist is to prompt a specification of the goal. To give an example, a statement such as "I want to be able to manage my day-to-day life" can be broken down into several smaller and more specific components, such as functioning with respect to household activities, running errands, or using public transportation. In a goal attainment approach, the therapist typically ensures that the goals stated at the initiation of rehabilitation correspond to the patients' values and that those goals can realistically be met through appropriate therapeutic interventions (20). In previous studies we have likewise seen that goals of physiotherapy interventions (21) and goals of nursing interventions (22) can be coded using the ICF.

Overall, we found in our study that the comprehensive ICF Core Sets reflect the patients' perspective, namely their goals. Nevertheless, a total of 27 reported categories proved not to be contained in the ICF Core Sets. Of these, Recreation and leisure (d920) was the most frequently coded category. While one might suppose that leisure activities are not the major issue for a patient at the beginning of rehabilitation, this goal is nonetheless to be respected as a motivational objective and should be reconsidered for the ICF Core Sets. Most of the other categories not contained in the comprehensive ICF Core Sets were reported only once, and were thus hardly representative.

Our results for patients in German rehabilitation clinics are in agreement with findings of an international study, which concluded that initial stating of goals can be a valid tool in rehabilitation, by directing patients' attention to the therapy process and increasing their motivation to participate actively (23). Our study showed a tendency towards an association between goal achievement and objective improvement of overall functioning, as assessed by health professionals. In an earlier study of neurological rehabilitation, goal attainment was likewise shown to be associated with improvements in functioning (24). This association indicates that health professionals' criteria for judging overall functioning are largely consistent with what their patients consider to be important aspects of their functional recovery (25). Our study failed to show statistical significance on the 5% level. This may be due to the small sample size or the small difference in clinically perceived difference in functioning.

Several limitations of this study merit comment. Firstly, it has to be acknowledged that the group of patients with cardiopulmonary conditions was too small to provide any generalizable results. Further research has to be carried out to make sure that this group is properly represented. Also, because more detailed analysis was uninformative, patients were categorized into only two groups (no goals attained vs at least one goal attained) without differentiating between those who attained all of their major goals and those who attained only one of their minor goals. This might have blurred the association between goal attainment and improvement in functioning. It might be advisable in future studies to ask patients to define one or two major goals or to identify several statements that are most important to them. Interpretability of the results might also have been improved by asking patients to be more specific in defining their rehabilitation goals and by ensuring that goals are always formulated in a structured process and in close cooperation between patient and therapist,

as noted previously (2). Moreover, patients were not asked about measurable, realistic goals, but rather were asked to report the 10 most relevant aspects of functioning pertaining to their disease and hospitalization. Nevertheless, these 10 aspects were generally reflective of patients' personal desires and expectations concerning their disease or injury, and their hospitalization, such that we feel justified in considering these aspects to be synonymous with "goals" (3). Asking patients about goal attainment in the course of treatment may be subjected to response shift and thus be another limitation of this study. Response shift refers to changes in internal standards, values or concepts of patients with severe illness (26) and may result in a change in one's self-evaluation of the target construct. There is, nevertheless, a difference between evaluation of a construct and evaluation of goal attainment. Thus, a patient who had reported improving her mobility as an issue of perceived relevance at baseline might have experienced a shift in meaning that attributed less importance to mobility. Still, she would report whether any improvement had taken place.

We found the ICF to be a useful framework to identify and structure patients' statements about their goals in early post-acute rehabilitation. Walking, transfer, alleviation of pain, regaining autonomy, returning home and improvement of the general condition emerged as the most important and most frequently reported aspects from the patient perspective. The positive association between goal attainment and improved functioning underlines that it is essential to involve the patient in the rehabilitation planning process, with an aim of obtaining an optimal outcome.

ACKNOWLEDGEMENTS

The authors thank all the study participants for patience and collaboration. We further thank all participating hospitals involved in data collection, Kaiser-Franz-Josef-Hospital, Institute of Physical Medicine and Rehabilitation, Vienna (Austria), University Hospital Munich, Department of Physical Medicine and Rehabilitation (Germany), General Hospital Munich Schwabing, Munich (Germany), Clinic and Institute for Physical and Rehabilitative Medicine, Nürnberg Süd Hospital (Germany), and Institute for Physical and Rehabilitative Medicine, Ingolstadt Hospital (Germany). We thank Dr Paul Cumming for manuscript revisions. The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501.

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J Rehabil Med 2011; 43: 156–161

ORIGINAL REPORT

PATIENT GOALS IN POST-ACUTE GERIATRIC REHABILITATION: GOAL ATTAINMENT IS AN INDICATOR FOR IMPROVED FUNCTIONING

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Objective: **To identify goals of older patients in geriatric rehabilitation and to measure their improvement in overall functioning.**
Design: **A prospective multi-centre cohort study.**
Methods: **A semi-structured questionnaire was used to identify patient goals and to assess improvement in overall functioning from patients' and health professionals' perspectives. Patients' goals were linked to the International Classification of Functioning, Disability and Health (ICF). Using a residualized change score, we identified patients who improved more than statistically expected.**
Results: **A total of 209 patients gave 476 statements. Of these, 346 (72.7%) statements were linked to 58 different ICF categories. More than 90% of the ICF categories were part of the comprehensive geriatric ICF Core Set. "Walking", "getting rid of pain", "autonomy" and "returning home" were the most frequently reported goals. Multivariable analysis identified shorter length of inpatient stay and goal attainment to be significant predictors for an improvement in overall functioning from the patients' perspective.**
Conclusion: **The ICF can be used to identify and structure patients' goals in geriatric rehabilitation. The association between goal attainment and improved overall functioning underlines the necessity of considering the patients' perspective in the rehabilitation process.**

Key words: ICF; goals; advance care planning; cohort study; rehabilitation; outcome assessment; classification; aged.

J Rehabil Med 2011; 43: 156–161

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Submitted May 25, 2010; accepted September 21, 2010

INTRODUCTION

After an acute adverse event or an acute episode of illness, older patients need special attention due to their higher vulnerability to functional decline during hospitalization (1). This increased risk of experiencing a loss of functioning is due to comorbidities, a high prevalence of cognitive impairment (2), in addition to factors such as depression (3), frailty (4) and other pre-existing limitations in functioning (1, 5). To prevent chronic disability, early onset of rehabilitation is essential (6).

The American Geriatrics Society (AGS) (7) defines rehabilitation "as the maintenance and restoration of physical and psychological health necessary for independent living and functional independence". As such, restoration or maintenance of patients functioning is the main objective of post-acute rehabilitation. Moreover, post-acute rehabilitation also aims at preventing disability and the need for long-term care as well as at promoting patients' autonomy (6). Ideally, an interdisciplinary team of physicians, nurses and therapists specialized in rehabilitation care should cooperate to manage the demands of early post-acute rehabilitation.

Timely goal-setting in close consultation with the patient is essential to rehabilitation success (8–9). Wade (10) considers a goal as a "future state that is desired and/or expected" and that "might refer to relative changes or to an absolute achievement" (p. 273). In this context a goal comprises not only the patients' aspirations, but also his environment, family, or any other involved persons. Involving the patients' perspective by identifying his personal needs and problems is considered to be a basic principle of the goal planning process (10).

Older, frail persons, in particular those at risk for functional decline, have a large spectrum of needs, desires or goals relevant to their rehabilitation. These goals may pertain to their particular health condition or disability, return to the home environment, activities of daily living, or emotional situation. The need for involving the patients' personal perspective in the rehabilitation process had been noted previously (11–12). In this context, the relevance of goal attainment for an evaluation of outcome is of interest in clinical practice (12). Arguably, the actual attainment of patients' goals is associated with improvement in overall functioning as subjectively perceived by the patient, and objectively recorded by the health professional. However, there is no consensus on how to assess systematically the patients' perspective, nor is it obvious whether the attainment of goals really indicates improvement in measured outcomes (12–14).

The International Classification of Functioning, Disability and Health (ICF) is a globally accepted language to communicate about functioning with consideration of body function, autonomy of the individual, and engagement in society (15–16). In order to enhance the applicability of the ICF in clinical practice and research and to overcome practical concerns relating to the great number of categories afforded within the ICF, a comprehensive ICF Core Set for patients in geriat-

 doi: 10.2340/16501977-0636 ISSN 1650-1977

ric post-acute rehabilitation facilities was created to provide standards for multi-professional patient assessment. This Set was designed to include the typical spectrum of problems in functioning encountered in older patients, so as to permit the coding of patients' goals.

The objectives of this study were to identify the rehabilitation goals of patients in early post-acute geriatric rehabilitation by using the ICF, and to examine the association of goal attainment with measures of improvement in overall functioning, as perceived by the patients and according to health professionals.

METHODS

Study design

The study design was a prospective multi-centre cohort study conducted from May 2005 to August 2008. The study population was recruited from geriatric wards and units in 3 German hospitals, and 2 Austrian hospitals; approximately 62% of the patients were recruited from the German centres. Patients were eligible for inclusion if they were over 65 years of age, and fulfilled the criteria for post-acute geriatric rehabilitation, according to their need for ongoing medical and nursing care in addition to rehabilitation. Informed consent was obtained prior to the study. For patients who were incapable of providing written, informed consent, the principal carer signed the informed consent form for participation. The study was approved by the institutional ethics committees.

Measures

The case record form comprised socio-demographic data and main diagnoses. Furthermore, it included a semi-structured questionnaire for patient and health professional to identify patient goals and assess overall functioning from the patients' and health professional's perspectives. The data were collected by interview about 24 h after admission (baseline), and within 36 h before discharge (end-point).

Patients were asked at baseline to report up to 10 important aspects related to their health condition and their hospitalization. These aspects were expectations, desires, hopes, goals as well as fears, doubts or problems due to the underlying health condition, the hospitalization or associated with the physical and social environment. In addition, patients were asked at end-point to decide which of the aspects or goals mentioned at baseline they had attained during the inpatient stay. Patients were also asked to assess their overall functioning at admission and at discharge on a numerical rating scale (where 0 = complete limitation in all aspects of functioning and 10 = no limitation in functioning). To gain information from the expert's perspective as well, health professionals were independently asked to assess patients' overall functioning using the same numerical scale.

Linking process

Patients' statements were translated into the ICF terminology following a standardized linking procedure, which is based on established linking rules (17–18). We used the framework of the ICF to specify and group the information derived from the patients, and by these means enable further statistical analysis.

In the first step of the linking procedure, two researchers independently identified all meaningful concepts contained in the patients' statements. A meaningful concept can be described as a specific component of text, consisting either of a few words or a few sentences having a common motif (19). In a second step, the two versions of the concepts identified as being meaningful were compared. Structured discussion and informed decision of a third expert were used to resolve disagreements between the two versions. Then the final version of meaningful concepts was linked to the most closely corresponding ICF categories by the two independent researchers according to the defined linking rules. The results of the two experts were again compared; in the event of disagreement, structured discussion and consultation with a third expert was used to arrive at a decision. In cases when a patients' goal could not be linked to the ICF, e.g. because the statement was too general for linking, or if the contents were not covered by the ICF, we summarized and grouped the data so as not to lose that information and to enable subsequent analysis.

Data analysis

We used absolute and relative frequencies to describe patients' goals. Based on the statements on goal attainment at discharge, we made a binary classification of the individuals (0 = no goal attained, 1 = at least one goal attained). In general, estimating change by calculating the difference between admission score and discharge score can be biased by an effect called "regression to the mean", wherein those individuals who scored higher at baseline are likely to score lower on re-test, whereas those who scored low at baseline are likely to score higher on re-test (20–21). As a result of these tendencies, difference scores (absolute changes) can overestimate the effect of baseline differences on re-test scores (22). To avoid this effect in assessing change between two measurements, Cronbach & Furby (23) suggest calculating a residualized gain score, which we used to determine change in functioning from the patients' and health professional's perspectives.

We calculated the residuals using a mixed regression model. This allows the integration into the model of differing length of inpatient stay as a random effect. With the mixed model, the statistically predicted discharge values were calculated for the whole study population. Subtracting the values predicted by the regression model from the observed values then gives the residualized score, which is the proportion of change not predicted from the baseline score, and controlled for length of inpatient stay. For subsequent regression analyses we defined a binary outcome variable according to the values of the residualized gain score. A gain score of 0 or less signified an improvement in overall functioning as less than or equal to the statistically expected change (0), whereas a gain score above 0 signified an improvement in overall functioning exceeding that which is statistically expected (1).

To analyse the predictors for an improvement in functioning, we used logistic regression models with improvement in overall functioning as the dichotomous dependent variable (0 = improvement in overall functioning as or less than expected; 1 = improvement in overall functioning more than expected). Independent variables examined were "age", "sex", "length of inpatient stay", "time from event to rehabilitation onset", "number of comorbidities", "living situation prior to hospitalization", "years of education" and "goal attainment". To decide which variables should enter the model, the relationship of each independent variable with the dichotomous outcome was assessed using bivariate χ^2 tests. Fisher's exact test was used when necessary. We stratified by sex in the bivariate analyses in order to test for potential gender interactions. A variable was considered to be a potential predictor if it had a p-value of < 0.20 in the bivariate test, or was of clinical relevance. To avoid collinearity, variables would only be selected for the multiple logistic regression model if the Spearman's correlation coefficient was < 0.5.

Two logistic regression models were then used to select the final set of predictors based on backward elimination ($p < 0.05$ to remove), 1 for overall functioning from the patients' perspective and 1 for overall functioning from the health professional's perspective. The potential predictors "age", "length of inpatient stay", "time from event to rehabilitation onset" and "number of comorbidities" entered the model as continuous variables. The variable "living situation prior to hospitalization" was coded as nominal (0 = living in a home for older people/nursing home, 1 = living alone or with another person, being in need of care, 2 = living alone or with another person, not being in need of care).

To determine the predictive ability of the final models we considered the c-value, which gives an estimate of the area under the receiver operating characteristic (ROC) curve (area under the curve; AUC) (24). The AUC can attain values between 0.0 and 1.0, with a practical lower bound value 0.5, and 1.0 indicating perfect predictive ability of a model.

RESULTS

A total of 209 patients from 5 different rehabilitation facilities were included in the study. Patients ranged in age from 57 to 101 years, with a median age of 80 years (mean 80 years (95% confidence interval (CI) (79; 81)). Sixty-seven percent of the patients were female. The most common reasons for admission were injuries and fractures, principally femur fractures, in addition to diseases of the circulatory system, principally cerebrovascular diseases. Median length of stay was 21 days (mean 23 days, 95% CI (21; 25)). Median time from event to rehabilitation onset was 13 days (mean = 15 days, 95% CI (13; 18)). Eighty-nine percent of the individuals were admitted from home, and 75% were discharged to home. Mini-Mental State Examination yielded a median of 26 points (mean 24.2 points). Demographic characteristics and assessment of overall functioning from patients' and health professional's perspective are summarized in Table I. Most frequent diagnoses responsible for inpatient stay are reported in Table II.

Table I. *Demographic characteristics and overall functioning of the study population (*n = *209)*

Characteristics	
Gender, female, *n* (%)	140 (67.0)
Age, years, mean (95% CI) [median]	79.9 (78.9–80.9) [80]
Duration of inpatient rehabilitation, days, mean (95% CI) [median]	23.1 (21.3–24.9) [21]
Time from event to rehabilitation onset, days[a], mean (95% CI) [median]	15.4 (13.0–17.8) [12.5]
Number of comorbidities, mean (95% CI) [median]	6.6 (6.3–7.0) [7.0]
Overall functioning – Health Professional[b], mean (95% CI) [median]	
Baseline (*n* = 190)	5.3 (5.1–5.6) [5.0]
Discharge (*n* = 190)	6.8 (6.5–7.1) [7.0]
Overall functioning – Patient[c], mean (95% CI) [median]	
Baseline (*n* = 202)	5.0 (4.8–5.3) [5.0]
Discharge (*n* = 172)	6.8 (6.5–7.0) [7.0]
Living Situation prior to hospitalization, *n* (%)	
Living alone	71 (34.0)
Living alone with need for care	21 (10.2)
Living with another person	61 (29.2)
Living with another person with need for care	29 (13.9)
Living with another person and cares for this person	3 (1.4)
Home for older people/nursing home	24 (11.5)
Living Situation after discharge, *n* (%)	
Home	156 (74.6)
Back to acute medical care	13 (6.2)
Change into home for older people/nursing home	33 (15.8)
Death	3 (1.4)
Not specified	4 (1.9)

[a]*n* = 208.
[b]For analysing change in overall functioning, *n* = 186 due to missing values for admission or discharge data.
[c]For analysing change in overall functioning, *n* = 167 due to missing values for admission or discharge data.
CI: confidence interval.

Table II. M*ost frequent diagnoses responsible for inpatient stay (International Classification of Diseases 10) (*n = *209)*

Diagnosis	*n* (%)
Injuries (S00–T14)	54 (25.8)
Injuries of hip and thigh (S70–S79)	35 (16.7)
Diseases of the circulatory system (I00–I99)	45 (21.5)
Cerebrovascular disease (I60–I69)	19 (9.1)
Symptoms, signs and abnormal clinical and laboratory findings (R00–R99)	28 (13.4)
Diseases of the musculoskeletal system and connective tissue (M00–M99)	16 (7.7)
Diseases of the nervous system (G00–G99)	13 (6.2)
Certain infectious and parasitic diseases (A00–B99)	12 (5.7)

Only diagnoses with a prevalence of at least 5% are reported.

A total of 202 patients (97%) reported at least one goal, whereas 87% reported up to 3 goals (mean = 2, median = 2). A total of 476 goals were reported. A total of 346 (73%) goals could be linked to 58 different ICF categories and 5 different chapters of the ICF. A total of 130 goals (27%) were not specific enough to be linked to single ICF categories.

Table III shows the most frequent goals coded with ICF categories. Fifty-eight different second-level ICF-categories were used for coding. "Autonomy", "returning home" and improvement of the "general condition" were the most frequently stated among those goals which could not be coded with the ICF. Forty-two (9%) of the reported goals were linked to ICF categories not presently included in the comprehensive ICF Core Set for older patients. Among them "domestic life" (d6) and "recreation and leisure" (d920) were the most frequent coded ICF categories not comprised in the ICF Core Set for older patients (Table IV).

A total of 170 patients (81%) gave information on goal attainment. Two hundred and forty-three (51%) of the 476 goals were reported as attained at discharge. One hundred and thirty-six patients (80%) had attained at least one of their personal goals, but 34 patients (20%) claimed no attainment in any of their goals.

Mean overall functioning score from the patients' perspective was 5 (median = 5) on admission and 7 (median = 7) on discharge. Mean overall functioning score from the health professional's perspective was 5 (median = 5) on admission and 7 (median = 7) on discharge.

From the patients' perspective 59% (*n* = 167), and from the health professional's perspective 63% (*n* = 186) of the patients improved in overall functioning more than would be statistically expected.

Seven variables met the inclusion criteria for the multivariable logistic models and were consequently selected as potential predictors: "age", "sex", "length of inpatient stay", "time from event to rehabilitation onset", "number of comorbidities", "living situation prior to hospitalization" and "goal attainment". Given that the bivariate analyses gave differing effects in men and women, an interaction term of sex and goal attainment was included.

From the patients' perspective, "length of inpatient stay" and "goal attainment" remained in the final model after backward elimination. A person who attained at least one personal goal was more than 5 times as likely to improve in overall

Table III. *Goals (*n = *476) in early post-acute geriatric rehabilitation for 209 patients*

Category	Total goals (*n* = 476) *n* (%)	Attained goals in category *n* (%)	Patients with at least 1goal in category (*n* = 209) *n* (%)
Goals coded[a]			
b1 Mental functions	18 (3.8)	7 (41.2)	17 (8.6)
b152 Emotional functions	7 (1.5)	3 (42,9)	7 (3.3)
b2 Sensory function and pain	36 (7.6)	21 (58.3)	36 (17.2)
b280 Pain	31 (6.5)	20 (64.5)	31 (14.8)
b4 Functions of the cardiovascular, haematological, immunological and respiratory systems	10 (2.1)	5 (50.0)	8 (3.8)
b440 Respiration functions	6 (1.3)	3 (50.0)	6 (2.9)
b7 Neuromusculoskeletal and movement related functions	27 (5.7)	15 (55.5)	23 (11.0)
b710 Mobility of joint functions	7 (1.5)	5 (71.4)	5 (2.4)
b770 Gait pattern functions	6 (1.3)	5 (83.3)	6 (2.9)
d4 Mobility	174 (36.6)	86 (49.4)	140 (67.0)
d450 Walking	99 (20.8)	53 (53.5)	92 (44.0)
d465 Moving around using equipment	16 (3.4)	9 (56.3)	16 (7.7)
d410 Changing basic position	7 (1.5)	2 (28.6)	7 (3.3)
d440 Fine hand use	8 (1.7)	4 (50.0)	7 (3.3)
d5 Self-care	18 (3.8)	11 (61.1)	16 (7.7)
d6 Domestic life	16 (3.4)	8 (50.0)	12 (5.7)
d920 Recreation and leisure	8 (1.7)	4 (50.0)	6 (2.9)
e1 Products and technology	9 (1.9)	0 (0.0)	7 (3.3)
e3 Support and relationship	14 (2.9)	11 (78.6)	14 (6.7)
e355 Health professionals	13 (2.7)	10 (76.9)	13 (6.2)
Goals not coded[b]			
Autonomy	32 (6.7)	16 (50.0)	32 (15.3)
Returning home/staying home	33 (6.9)	23 (69.7)	33 (15.8)
General condition/health	28 (5.9)	13 (46.4)	28 (13.4)
Others	23 (4.8)	10 (43.5)	20 (9.6)

Only frequencies > 5 reported.
[a]346 of all goals were coded as International Classification of Functioning, Disability and Health (ICF) categories.
[b]130 of all goals could not be coded as ICF categories.

functioning (odds ratio = 5.5). From the health professional's perspective "length of inpatient stay" "goal attainment" and additionally "number of comorbidities" remained in the final model. A person who attained at least one personal goal was 3 times as likely to improve in overall functioning. Length of stay was inversely associated with improvement in overall functioning. The interaction term of sex and global attainment was not significant. Table V summarizes the results of both multivariable logistic regression models. Predictive ability of both models was adequate as rated by the c-value.

Table IV. *Patient goals in early post-acute geriatric rehabilitation not covered in the International Classification of Functioning, Disability and Health (ICF) Core Set for geriatric patients (*n = *209)*[a]

Category	Total goals (*n* = 42) *n* (%)	Patients with at least 1 goal in category (*n* = 209) *n* (%
Goals coded		
d455 Moving around	4 (0.8)	4 (1.9)
d470 Using transportation	3 (0.6)	2 (1.0)
d6 Domestic life	16 (3.4)	12 (5.7)
d920 Recreation and leisure	8 (1.7)	6 (2.9)

Only frequencies > 2 reported.
[a]Patients reported 42 goals not covered in the ICF Core Set for geriatric patients.

Table V. *Results of the multivariable logistic regression model*

Parameter	*p*-value	Point estimate (OR)	95% confidence interval
Patient perspective[b]			
Length of inpatient stay	<0.0001	0.93	0.90–0.96
Goal attainment	0.0004	5.52	2.16–14.12
c-value (final model) = 0.77			
Age	0.3498*		
Number of comorbidities	0.2725*		
Living situation prior to hospitalization	0.1382*		
Sex	0.3816*		
Sex[a] goal attainment	0.1094*		
Health professional perspective[c]			
Length of inpatient stay	< 0.0001	0.93	0.90–0.96
Number of comorbidities	0.0142	0.81	0.68–0.96
Goal attainment	0.0348	2.68	1.07–6.71
c-value (final model) = 0.72			
Age	0.2376*		
Living situation prior to hospitalization	0.3674*		
Sex	0.1042*		
Sex[a] goal attainment	0.3733*		

Final model describing variables associated with the outcome "improvement in overall functioning", with a $p < 0.05$ on the Wald test.
[a]Not significant; [b]*n* = 158 due to missing values for the response or explanatory variables; [c]*n* = 155 due to missing values for the response or explanatory variables. OR:odds ratio.

DISCUSSION

In this study, older patients undergoing early post-acute rehabilitation reported regaining mobility/walking ability and autonomy, getting rid of pain, returning home and improving their general health condition as their main goals of the rehabilitation process. Goals could be standardized and analysed in a meaningful way by using the ICF. Goal attainment as a result of the rehabilitation process was independently associated with improvement in patients' overall functioning, both from the patients' perspective, and that of health professionals.

Current research on patient goals confirms that mobility is the main issue for older patients, e.g. after stroke (25). Being able to walk is strongly associated with independent living, as recently shown in a similar sample of older individuals undergoing early post-acute rehabilitation (26). Equally, independence in self-care and domestic life contribute to the general goal of autonomy. The central importance of autonomy for patients in early post-acute geriatric rehabilitation reflects in practice a fundamental human need (27). Based on this theoretical background, it is obvious that the patients' perspective must be part of the goal-setting process in modern rehabilitation (9).

Interestingly, patients had quite concrete ideas regarding their goals. Apart from some more general aspects, such as improvement of their general health condition or autonomy, the goals reflect a prototypical spectrum of impairments, limitations and restrictions as described by the comprehensive ICF Core Set for older patients (28). This replication in an independent group of patients again confirms the face validity of the comprehensive ICF Core Set, which consistently provided a useful framework to categorize and standardize patients' goals.

The concurrence is a potentially important result of this study, since a common and accepted way to involve the patient perspective in goal-setting has been lacking (13, 29). While some authors favour a structured tool to integrate the patient perspective (8, 30), others prefer or recommend unstructured, open methods to record patients' needs (11, 14, 31). Since communication with older persons is sometimes difficult, we used an open-ended questionnaire for evaluating the patients' perspective. In answering the questions, patients were assisted by trained interviewers. We found this method in practice to be the simplest strategy for consistently obtaining authentic statements from the individual patients.

In older persons, health conditions are characterized by their complexity and gravity (5). By translating the patients' goals into a standardized language it becomes obvious that patients express their notions of goals in very general terms. For instance, individuals make statement such as "I want to handle all activities on my own", "I want to regain my strength", or "I want to care for myself again" rather than making specific statements such as "I want to be able to open a bottle with my right hand" or "I want to strengthen the muscles of my affected leg". It is up to the health professional to clarify the general goals in a more detailed way and to deconstruct them into the components that can be addressed by therapy (25). Based on our experience the ICF can be seen as a tool that offers a helpful terminology to translate unstructured information into a structured form, which can be analysed and reported in a standardized way, and can guide the rehabilitation process.

Unsurprisingly, goal attainment was associated with improvement in overall functioning, independent of the perspective taken. In an earlier study of neurological rehabilitation, goal attainment was likewise shown to be associated with improvements in functioning (14). In another study, this association was shown to be independent of patients' characteristics such as main diagnosis and age (12).

When assessing change of functioning there frequently arises the problem of how to interpret and analyse the change score (32). We made the decision to use a mixed effects regression to model the average change in overall functioning. Only individuals who showed at least this average amount of change were considered as improved. The use of this strict criterion is a very conservative approach, which has been recommended to eliminate potential regression-to-the-mean effects (22–23). Since rehabilitation effectiveness is change by length of stay, it is important to include length of stay in any model of change. The mixed effects regression model is also a method to adjust for length of inpatient stay. Typically, in Germany and Austria as in many other health systems, length of stay in a rehabilitation facility is not primarily determined by goal achievement but also by reimbursement situation.

Some limitations of the study merit comment. First, patients were interviewed by health professionals in a face-to-face situation, such that the patients could potentially have been influenced by the interviewer's expectations. To avoid this, the interviewers had been trained in structured training meetings, and were provided with a manual and a list of standardized questions (5). Secondly, patients were not asked about measurable, realistic goals, but rather were asked to report the 10 most relevant aspects of functioning pertaining to their disease and hospitalization. Nevertheless, these 10 aspects were generally reflective of patients' personal desires and expectations concerning their disease and hospitalization, such that we feel justified in considering these aspects to be synonymous with "goals" (10). An additional point of concern is the prevalence of cognitive impairment in older rehabilitation patients. It is not clear to what extent older patients with cognitive impairment are able to participate in realistic goal setting. In our study, a part of the population had a least first signs of mild cognitive impairment, as measured by the Mini-Mental State Exam; however, this might have been a positive selection towards the mentally fit persons. Studies on goal setting in severely cognitively impaired persons are difficult to conceive.

In conclusion, we found the ICF to be a useful framework to identify and structure patients' statements about their goals in geriatric early post-acute rehabilitation. "Walking", "alleviation of pain", regaining "autonomy", "returning home" and improvement of the "general condition" could be identified as the most important and most frequent aspects from the patient perspective. The positive association between goal attainment and improved functioning emphasizes that it is essential to involve the patient in the rehabilitation planning process, with the aim of obtaining an optimal outcome.

ACKNOWLEDGEMENTS

The authors would like to thank the patients participating in the study and the teams at the geriatric rehabilitation hospital of the Arbeiterwohlfahrt Bezirksverband Unterfranken e.V. Würzburg, the Department of Geriatric Rehabilitation of the Malteser Hospital Bonn-Hardtberg, the Harthausen Clinic for Geriatrics, Rosenheim, the LBI Institute for Interdisciplinary Rehabilitation in Geriatrics at the Sophienspital, Vienna and the Institute for Physical Medicine and Rehabilitation of the Kaiser-Franz-Josef-Spital, Vienna. We thank Dr Paul Cumming for critical revisions to the manuscript. The project was supported by the German Ministry of Health and Social Security (BMGS) grant no. 124-43164-1/501.

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J Rehabil Med 2011; 43: 162–173

ORIGINAL REPORT

OPERATIONALIZATION AND RELIABILITY TESTING OF ICF CATEGORIES RELEVANT FOR PHYSIOTHERAPISTS' INTERVENTIONS IN THE ACUTE HOSPITAL

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Objective: **To operationalize items based on categories of the International Classification of Functioning, Disability and Health (ICF) relevant to patient problems that are addressed by physiotherapeutic interventions in the acute hospital, and to test the reliability of these items when applied by physiotherapists.**

Methods: **A selection of 124 ICF categories was operationalized in a formal decision-making and consensus process. The reliability of the newly operationalized item list was tested with a cross-sectional study with repeated measurements.**

Results: **The item writing process resulted in 94 dichotomous and 30 polytomous items. Data were collected in a convenience sample of 28 patients with neurological, musculoskeletal, cardiopulmonary, or internal organ conditions, requiring physical therapy in an acute hospital. Fifty-six percent of the polytomous and 68% of the dichotomous items had a raw agreement of 0.7 or above, whereas 36% of all polytomous and 34% of all dichotomous items had a kappa coefficient of 0.7 and above.**

Conclusion: **The study supports that the ICF is adaptable to professional and setting-specific needs of physiotherapists. Further research towards the development of reliable instruments for physiotherapists based on the ICF seems justified.**

Key words: ICF; classification; reliability; outcome measures; health status assessment.

J Rehabil Med 2011; 43: 162–173

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Submitted May 25, 2010; accepted September 30, 2010

INTRODUCTION

Healthcare management in the acute hospital must reflect patient's needs and the specific reasons for their hospitalization. The risk for loss of functioning is exacerbated by factors such as complications of intervention, pre-existing chronic conditions, co-morbidities and old age. The timely identification of these risk factors, and the consequent definition of adequate care provisions for maintaining or improving functioning, with an aim of minimizing disability, is of utmost importance, even in the acute hospital (1, 2).

Persistent loss of functioning can be prevented most effectively when early rehabilitation interventions are provided for the patient as part of the acute medical treatment (3–5). Part of the task of physiotherapists is to identify and assess acute functional impairment, and to take measures to correct or alleviate the long-term outcome (6, 7). In order to improve functioning and minimize disability, caregivers must have recourse to sound concepts and instruments for measuring functioning (8–10). This holds true for all health professionals and settings, but is particularly relevant for physiotherapists in the acute hospital setting (11–13).

The International Classification of Functioning, Disability and Health (ICF) (14) is a multipurpose classification that may constitute a suitable basis for assessment of functioning in a multidisciplinary environment. However, the ICF is comprehensive, encompassing every possible aspect of human functioning, and must consequently be tailored in several respects for the needs and purposes of its potential users (15–18). First, it must address all relevant concepts, such as those addressed by the particular interventions made by physiotherapists (19). Secondly, these concepts have to be operationalized in a way that is suitable to the setting, e.g. the acute hospital. Thirdly, any such operationalization must be of proven reliability in the hands of prospective users; here, physiotherapists. Once a reliable operationalization has been defined, the constituent items can be used to document categorical profiles of patients' functioning. If the need for a new instrument dealing with specific domains should arise, the objectivity and validity of subsets of these items have to be established.

To date, the utility and reliability of ICF categories operationalized specifically for use by physiotherapists has not been established. The objective of the present study was therefore to operationalize items based on ICF categories relevant to patient problems addressed by physiotherapeutic interventions in the acute hospital, and to test the reliability of these items in the hands of physiotherapists.

METHODS

Study design

Selection of ICF categories and operationalization. The ICF has two parts, each containing 2 separate components. Part 1 covers functioning and disability, and includes the components Body Functions (b) and Structures (s) and Activities and Participation (d). Part 2 covers contextual factors, and includes the components Environmental Factors (e) and Personal Factors.

Comprising a total of 1424 such categories, the ICF gives a comprehensive description of human functioning. Not all of those categories, however, are useful and relevant for physiotherapists. Based on a selection of categories for the acute hospital (so called ICF Core Sets) (15, 16, 18) and a Delphi exercise (19), we chose 124 categories potentially relevant for physiotherapists in the acute hospital. Both selection process (17) and Delphi exercise have been described in detail (19). In brief, the ICF Core Set development was a consensus process based on evidence gathered from preliminary studies, which included contributions of focus groups, systematic reviews and empirical data collection. The Delphi exercise was a consensus-building, 3-round, e-mail survey of a total of 263 physiotherapists in Germany and Switzerland. The first round requested lists of Body Functions, Body Structures, Activities and Participation, and Environmental Factors influenced by physical therapy intervention. The responses were then translated into ICF categories. In the second round, the participants were provided with the resulting ICF categories, along with their frequencies. The participating physiotherapists were then asked to judge whether a named ICF category fell within their professional prevue. The third round was carried out accordingly. This process resulted in the selection of 124 ICF categories describing the most common patient problems managed by physiotherapists in the acute hospital. The selection consisted of 49 categories of the component Body Functions, 18 of the component Body structures, 34 of the component Activities and Participation, and 23 of the component Environmental Factors.

All categories of the ICF are quantified using the same generic 0–4 scale, with qualifier 0 representing no problem, and qualifier 4 representing that the problem is complete or pervasive. In general, Environmental Factors can act as a facilitator or a barrier. Therefore, the categories of this component have a valence, thus ranging from –4 to +4. The qualifier "not specified" is to be used if the information available is not sufficient, and "not applicable" if the category is not applicable.

As the metric properties of this scale are not yet sufficiently evaluated, ICF categories and their qualifiers have to be converted into items. These items must be specific to the situation, to the patient group whose problems are to be observed, and to the health professional group intending to use the ICF as an assessment tool. The method used to write items for those ICF categories involved a formal decision-making and consensus process (20), which integrated evidence gathered from a systematic review (21) and expert opinion (22). Three weeks prior to the consensus conference (April 29th –May 1st, 2004), all participants received a compilation of the second level of the ICF (German edition) (23), a complete manual, as well as the results of the systematic review and information about the consensus process. At the conference, they were to decide on item definitions for the *a priori* selection of 124 ICF categories, overseen by 6 experts from Switzerland, all of whom had working experience in clinical physical therapy in the 3 groups of health conditions cited, and expertise in development and testing of clinical measures. The 6 experts also had previous experience in the application of the ICF model and the ICF classification.

In the first step of the process (Fig. 1), the participants had to decide on which type of scale the given ICF category should be measured. This could be either dichotomous, indicating that impairment or limitation is present or absent, or polytomous, indicating a possible grading of limitation or impairment on a qualifier scale from 0 to 4, as noted above. Next, the participants had to find definitions for the extreme anchor points of the polytomous categories, i.e. the qualifiers 0 and 4. Once these anchor points were set, the participants had to decide which clinically meaningful steps would be appropriate for the intervening qualifiers 1, 2 and 3. The item qualifiers were framed without specific attribution to medical conditions or disabling factors, but instead focused on physiotherapists' work in an acute hospital situation. As a consequence, the qualifier 0, attributable to persons without impairment or limitation, would represent the best possible outcome or functional status obtainable by therapy in the acute hospital, notwithstanding that a patient might still have potential for further improvement. A translated non-validated version of the operationalization is given in Appendix I.

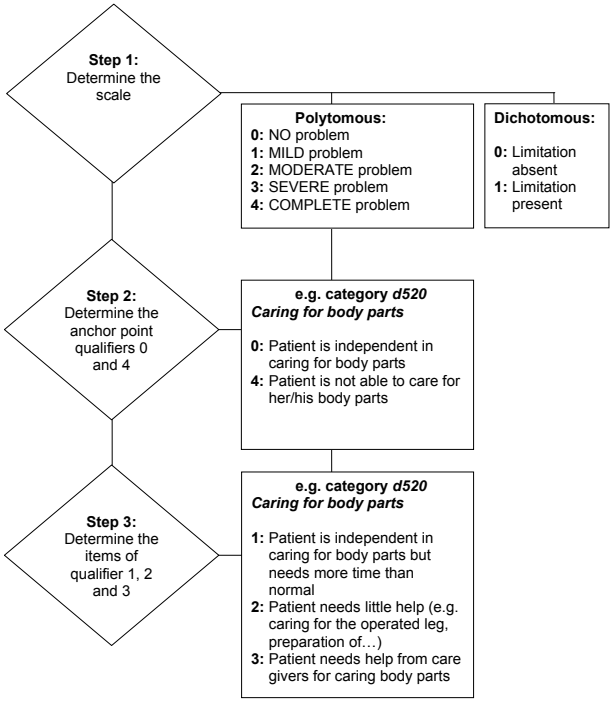

Fig. 1. Flow chart and example for decision-making and consensus process.

Reliability testing

The study design was cross-sectional with repeated measurements in a convenience sample of 28 patients with neurological, musculoskeletal, cardiopulmonary and internal organ conditions, requiring physiotherapy in an acute hospital. Physiotherapy was assigned on prescription by the respective ward physician, and according to predefined clinical pathways. Patients were recruited at the University Hospital Zurich between June and October 2004. Patients with neurological conditions were recruited from the Departments of Neurology and Neurosurgery, patients with musculoskeletal conditions from the Departments of Orthopedics, Rheumatology and Surgery, and patients with cardiopulmonary and internal organ conditions from the Departments of Internal Medicine, Surgery and Heart Surgery. Sample size was determined by feasibility and precision considerations. Even given a very high or very low proportion of positive ratings, a sample size of 22–33 would be sufficient to detect a moderate kappa (0.5–0.6) with a power of 0.8 (24).

Approval of the project was first obtained from the local institution ethics committee, in accordance with the Declaration of Helsinki. Informed consent was obtained from all participants.

Measures

As described above, 124 items had been written, based on the 124 ICF categories most relevant to patient problems addressed by physiotherapists in the acute hospital. Items could either be graded on a dichotomous (0/1) or polytomous (0–4) scale.

Data collection procedure

Upon recruitment, the patients were interviewed twice, at an interval of not less than 24 h and not exceeding 72 h. The two interviews were conducted by 2 different physiotherapists trained in the application and principles of the ICF. Inclusion criteria were that patients must be inpatients of at least 18 years of age, whose main health condition required treatment by a physiotherapist. All patients had to have good knowledge of the German language. We excluded patients with severe cognitive impairment who were unable to give informed consent to the study.

There were 6 interviewers with expertise in application of the ICF classification. Each interviewer worked as physiotherapist in the corresponding departments of the University Hospital Zurich.

Anonymous and standardized data collection forms with consecutive numbers were provided. Prior to the interview, each patient's medical record sheet was checked and relevant information on socio-demographic variables, diagnoses and assessments was extracted. The interviewers were instructed to collect the data from the most reliable source, so they were expected to ask the health professionals who were best informed about the condition of the patient being interviewed. Information that could not be retrieved from the records or from the health professionals was obtained directly from the patient. We assumed that both interviewers were likely to ask the therapist in attendance who had been responsible for assessment and treatment of the patient. Consequently, intra-rater and inter-rater reliabilities are similar in this study.

Each interviewer was blind to the results of the other.

Quality assurance procedures

Interviewers were trained in the course of a structured one-day meeting, and were provided with a manual. All data forms were then re-checked by a second person for completeness and plausibility. Patients who refused to participate were asked to complete a short questionnaire on socio-demographic variables, diagnosis, and to give a reason for their refusal to participate. Data were recorded by double entry. Raw data were inspected for accuracy and outliers.

Data analysis

Reliability was analysed using the percentage of raw agreement and Cohen's kappa for nominal scales (25). Overall raw agreement was calculated by dividing the sum of the frequencies of the main diagonal of a contingency table by the sample size. As with other measures of agreement, the maximum possible value of kappa is 1. By convention, a kappa value of 0.81–1.00 is defined as almost perfect agreement, 0.61–0.80 as substantial and 0.41–0.60 as moderate, 0.21–0.40 as fair, 0.00–0.20 as slight, and values below 0.00 as poor agreement (25). Following the recommendation of Gardner (26), we reported the percentage of items with raw agreement or kappa of 0.7 and above. Although there are situations where a kappa below 0.7 can be acceptable, this arbitrary threshold restricts our reporting to items with unambiguously high agreement. Confidence intervals for kappa were calculated using a bootstrap re-sampling methodology proposed by Vierkant (27). These analyses were carried out with SAS® v.9.1 (Cary, NC, USA).

RESULTS

Operationalization

Of the 124 items, 94 (76%) were dichotomous and 30 (24%) polytomous. Results per ICF category are given in Tables I–IV. To give an example of the operationalization, consider the qualifier scales for the ICF category *Walking* (d450), which was defined as follows:

- 0: More than 100 m, inside and outside (with or without walking device).
- 1: Independent walking inside between 10 and 100 m (with or without walking device), several times a day.
- 2: Walking independently in the ward, with or without walking device (10–100 m).
- 3: Can walk independently in his/her room (up to 10 m), with or without walking device.
- 4: Incapable of walking independently.

Patients

Twenty-eight patients were included in the study. Patients' ages ranged from 27 to 88 years, with a median age of 61 years and a mean of 59.6 years. Sixteen of the patients (57%) were female. Ten patients had neurological conditions, such as stroke, Parkinson's disease, multiple sclerosis, and brain injury. Ten patients had musculoskeletal conditions, disease of the joints, such as primary and secondary arthrosis, and fractures of the extremities. Because of withdrawals in the second interview, we could include only 8 patients with cardiopulmonary and visceral conditions, such as ischaemic heart disease, disease of respiratory system and tumours of internal organs. Incomplete data were not included in the analysis.

Out of all items, 56% of the 94 polytomous and 68% of the 30 dichotomous items had a raw agreement of 0.7 and above. Thirty-six percent of all polytomous and 34% of all dichotomous items had a kappa coefficient of 0.7 and above. The detailed results are presented in Tables I–IV for each component; we maintain the structure of ICF in chapters, but list the categories in decreasing order of percentage of agreement.

In the component Body Functions (Table I), all 10 polytomous items (100%) had a raw agreement of 0.7 and above, and 9 had a kappa of 0.7 and above (90%). All of the 39 dichotomous items had a raw agreement of 0.7 and above, and 28 had a kappa of 0.7 and above (72%).

In the component Body Structures (Table II), all 18 items (100%) had a raw agreement of 0.7 and above, and 12 had a kappa of 0.7 and above (67%).

In the component Activities and Participation (Table III), a total of 7 of the polytomous items (50%) had a raw agreement of 0.7 and above, and 4 had a kappa of 0.7 and above (29%). Thirteen dichotomous items (65%) had a raw agreement of 0.7 and above, 2 had a kappa of 0.7 and above (10%).

A total of 3 (25%) polytomous items of the component Environmental Factors (Table IV) had a raw agreement of 0.7 and above, and 15 dichotomous items (44%) had a raw agreement of 0.7 and above. No polytomous or dichotomous item had a kappa of 0.7 and above.

DISCUSSION

To the best of our knowledge, this is the first attempt to operationalize ICF categories in such a manner that the resulting items are useful and reliable when applied by physiotherapists in the acute hospital situation. In the components Body Functions and Body Structures more than two-thirds of the operationalized categories showed substantial agreement as measured by the kappa coefficient. It can be argued that

Table I. *Percentage of agreement and kappa coefficient for the categories of the International Classification of Functioning, Disability and Health (ICF) component Body Functions, per chapter of the ICF in decreasing order of percentage of agreement*

ICF code	Code description	Scale	Raw agreement *n*=28	Kappa *n*=28	95% CI
b1	Mental Functions				
b114	Orientation functions	d	0.96	0.86	0.49–1.00
b144	Memory functions	d	0.96	0.84	0.44–1.00
b110	Consciousness functions	p	0.93	0.57	0.00–1.00
b130	Energy and drive functions	d	0.93	0.84	0.53–1.00
b152	Emotional functions	d	0.93	0.75	0.37–1.00
b156	Perceptual functions	d	0.93	0.78	0.35–1.00
b147	Psychomotor functions	d	0.89	0.76	0.47–1.00
b126	Temperament and personality functions	d	0.86	0.70	0.43–0.93
b140	Attention functions	d	0.86	0.51	–0.06–0.87
b180	Experience of self and time functions	d	0.86	0.48	–0.05–0.87
b134	Sleep functions	d	0.82	0.62	0.25–0.87
b164	Higher-level cognitive functions	d	0.82	0.53	0.13–0.86
b2	Sensory Functions and Pain				
b215	Functions of structures adjoining the eye	d	0.96	0.93	0.77–1.00
b235	Vestibular functions	d	0.96	0.92	0.73–1.00
b265	Touch function	d	0.96	0.89	0.64–1.00
b230	Hearing functions	d	0.93	0.72	0.36–1.00
b260	Proprioceptive function	d	0.89	0.75	0.42–0.93
b280	Sensation of pain	p	0.89	0.86	0.70–1.00
b210	Seeing functions	d	0.86	0.63	0.18–0.90
b270	Sensory functions related to temperature and other stimuli	d	0.75	0.50	0.17–0.78
b3	Voice and Speech Functions				
b310	Voice functions	d	0.96	0.90	0.67–1.00
b320	Articulation functions	d	0.96	0.91	0.70–1.00
b4	Functions of the Cardiovascular, Haematological, Immunological and Respiratory Systems				
b410	Heart functions	d	0.93	0.85	0.62–1.00
b435	b4352 Functions of lymphatic vessels and b4353 Lymph nodes	d	0.93	0.92	0.72–1.00
b440	Respiration functions	p	0.93	0.84	0.53–1.00
b450	Additional respiratory functions	d	0.93	0.76	0.26–1.00)
b455	Exercise tolerance functions	p	0.93	0.88	0.69–1.00
b460	Sensations associated with cardiovascular and respiratory functions	p	0.93	0.88	0.68–1.00
b420	Blood pressure functions	d	0.89	0.74	0.40–0.94
b445	Respiratory muscle functions	d	0.89	0.72	0.28–0.93
b415	Blood vessel functions	d	0.82	0.66	0.36–0.89
b430	Haematological system functions	d	0.71	0.45	0.15–0.74
b5	Functions of the Digestive, Metabolic and Endocrine Systems				
b510	Ingestion functions	p	1.00	1.00	0.00–0.00
b540	General metabolic functions	d	0.96	0.94	0.83–1.00
b525	Defecation functions	d	0.93	0.85	0.62–1.00
b6	Genitourinary and Reproductive Functions				
b620	Urination functions	d	1.00	1.00	0.00–0.00
b7	Neuromusculoskeletal and Movement-Related Functions				
b730	Muscle power functions	p	0.96	0.95	0.84–1.00
b735	Muscle tone functions (hypotonus)	d	0.93	0.87	0.68–1.00
b770	Gait pattern functions	p	0.93	0.91	0.80–1.00
b710	Mobility of joint functions	p	0.89	0.85	0.69–1.00
b715	Stability of joint functions	d	0.89	0.83	0.63–1.00
b765	Involuntary movement functions	d	0.89	0.68	0.28–1.00
b735	Muscle tone functions (hypertonus)	p	0.86	0.73	0.45–0.93
b750	Motor reflex functions	d	0.86	0.77	0.54–0.95
b755	Involuntary movement reaction functions	d	0.86	0.75	0.51–0.94
b740	Muscle endurance functions	d	0.82	0.72	0.49–0.93
b760	Control of voluntary movement functions	d	0.79	0.54	0.20–0.80
b8	Functions of the Skin and Related Structures				
b820	Repair functions of the skin	d	0.93	0.87	0.65–1.00
b810	Protective functions of the skin	d	0.86	0.71	0.39–0.93

CI: confidence interval.

Table II. *Percentage of agreement and kappa coefficient for the categories of the International Classification of Functioning, Disability and Health (ICF) component Body Structures, per chapter of the ICF in decreasing order of percentage of agreement*

ICF code	Code description	Scale	Raw agreement *n*=28	Kappa *n*=28	95% CI
s1	Structures of the Nervous System				
s120	Spinal cord and related structures	d	0.93	0.79	0.48–1.00
s140	Structure of sympathetic nervous system	d	0.93	0.77	0.35–1.00
s110	Structure of brain	d	0.89	0.80	0.55–0.94
s150	Structure of parasympathetic nervous system	d	0.89	0.68	0.22–0.91
s2	The Eye, Ear and Related Structures				
s260	Structure of inner ear	d	1.00	1.00	0.00–0.00
s3	Structures Involved in Voice and Speech				
s320	Structure of mouth	d	0.89	0.68	0.27–1.00
s330	Structure of pharynx	d	0.86	0.44	–0.09–0.80
s340	Structure of larynx	d	0.86	0.50	0.00–0.84
s4	Structures of the Cardiovascular, Immunological and Respiratory Systems				
s420	s4200 Lymphatic vessels and s4201 Lymphatic nodes	d	0.93	0.80	0.47–1.00
s430	Structure of respiratory system	d	0.93	0.85	0.64–1.00
s410	Structure of cardiovascular system	d	0.79	0.58	0.29–0.87
s7	Structures Related to Movement				
s750	Structure of lower extremity	d	0.96	0.93	0.77–1.00
s730	Structure of upper extremity	d	0.93	0.84	0.55–1.00
s740	Structure of pelvic region	d	0.93	0.80	0.46–1.00
s760	Structure of trunk	d	0.93	0.86	0.66–1.00
s720	Structure of shoulder region	d	0.89	0.78	0.53–1.00
s710	Structure of head and neck region	d	0.86	0.60	0.18–0.89
s8	Skin and Related Structures				
s810	Structure of areas of skin	d	0.89	0.73	0.47–0.93

CI: confidence interval.

diagnosis by physiotherapists is based mainly on their assessment of body functions (28). It is obvious that most of the categories of Body Functions and Body Structures that proved to have less than substantial agreement describe issues (such as *Blood vessel functions* (b415) and *Haematological system functions* (b430)) that are beyond the professional prevue and daily practice of physiotherapists.

In the components Activities and Participation and Environmental Factors, agreement of the operationalized categories was not entirely satisfactory, with the exception of the chapters *Mobility* and *Self-Care*, where agreement ranged from moderate to almost perfect. Again, this is probably due to the scope of professional expertise of physiotherapists, who are especially proficient in assessing mobility issues, such as *Walking* (d450), and activities of daily living, such as *Eating* (d550) or *Drinking* (d560). Indeed, within the chapter *Mobility*, polytomous items obtained even better agreement than dichotomous items, thus showing that the lack of agreement was not necessarily caused by a flawed operationalization, but arose due to item definitions that were not sufficiently clear for the user. Moreover, the ICF provides 2 different constructs for the categories of the component Activities and Participation, "Capacity" and "Performance" (14). "Capacity" pertains to a patient's limitation with or without receiving assistance. In contrast, "Performance" describes the problem in the person's current environment, i.e. the limitation a person is experiencing, even with the use of assistive devices. Even though the interviewers were advised always to assess the patient in the context of "Capacity", this may have proven difficult for categories manifesting mainly beyond the acute hospital environment, such as *Driving* (d475), *Doing housework* (d640) and *Acquiring, keeping and terminating a job* (d845). For this reason, the ICF recommends using a standardized environment for the assessment of "Capacity". While the acute hospital indeed constitutes a kind of standardized environment, the extent of the standardization of assessment must evidently go even further. For example, when assessing categories of the component Activities and Participation it might be necessary to evaluate both "Capacity" and "Performance", both with and without assistance, since these are major issues for goal setting (29, 30).

Although Environmental Factors cannot be influenced directly by physiotherapists, physiotherapists are well aware of their potential impact on outcome and prognosis (19). It is therefore very important for physiotherapists to know the influence of Environmental Factors. Arguably, the ICF provides very general and broad definitions for the categories of the component Environmental Factors. To give an example, *Products and technology for personal use in daily living* (e115) includes all general and assistive products, such as clothes, textiles and furniture, but also prosthetic devices or remote control systems. Therefore, the reliability of this category directly depends on how explicitly the item is described. Any fundamentally reliable assessment of Environmental Factors within the ICF has to delve more deeply into the particulars of definitions and details.

In interpreting these results, it must always be borne in mind that indices of agreement, such as the kappa coefficient, are artificially lower in populations with a restricted spectrum of the measured characteristic as in the present. Nonetheless,

Table III. *Percentage of agreement and kappa coefficient for the categories of the International Classification of Functioning, Disability and Health (ICF) component Activities and Participation, per chapter of the ICF in decreasing order of percentage of agreement*

ICF code	Code description	Scale	Raw agreement $n=28$	Kappa $n=28$	95% CI
d1	Learning and Applying Knowledge				
d110	Watching	d	1.00	1.00	0.00–0.00
d115	Listening	d	0.93	0.00	0.00–0.00
d130	Copying	d	0.93	–0.04	–0.08–0.00
d160	Focusing attention	p	0.93	0.83	0.58–1.00
d120	Other purposeful sensing	d	0.89	0.51	–0.06–1.00
d155	Acquiring skills	d	0.89	0.00	0.00–0.00
d2	General Tasks and Demands				
d210	Undertaking a single task	p	0.71	0.45	0.12–0.74
d240	Handling stress and other psychological demands	d	0.68	0.37	0.05–0.67
d230	Carrying out daily routine	p	0.61	0.32	0.03–0.62
d3	Communication				
d310	Communicating with – receiving – spoken messages	d	0.96	0.00	0.00–0.00
d330	Speaking	d	0.96	0.87	0.56–1.00
d335	Producing non-verbal messages	d	0.96	0.00	0.00–0.00
d4	Mobility				
d445	Hand and arm use	p	0.86	0.77	0.55–0.94
d415	Maintaining a body position	p	0.79	0.70	0.46–0.89
d450	Walking	p	0.79	0.72	0.52–0.91
d440	Fine hand use (picking up, grasping)	d	0.75	0.40	0.03–0.73
d420	Transferring oneself	d	0.71	0.41	0.05–0.74
d460	Moving around in different locations	d	0.71	0.56	0.27–0.80
d4551	Climbing (stairs)	p	0.61	0.47	0.25–0.72
d475	Driving	d	0.61	0.31	0.05–0.6
d430	Lifting and carrying objects	p	0.54	0.41	0.16–0.63
d410	Changing basic body position	p	0.50	0.34	0.11–0.60
d465	Moving around using equipment	d	0.32	0.08	–0.12–0.32
d5	Self-Care				
d530	Toileting	d	0.86	0.67	0.35–0.92
d560	Drinking	p	0.79	0.58	0.21–0.86
d550	Eating	p	0.75	0.56	0.30–0.83
d510	Washing oneself	p	0.57	0.43	0.18–0.65
d520	Caring for body parts	p	0.57	0.41	0.16–0.67
d540	Dressing	p	0.57	0.42	0.19–0.68
d570	Looking after one's health	d	0.29	–0.18	–0.45–0.06
d6	Domestic Life				
d640	Doing housework	d	0.57	0.36	0.17–0.63
d7	Interpersonal Interactions and Relationships				
d710	Basic interpersonal interactions	d	0.93	0.63	–0.05–1.00
d8	Major Life Areas				
d845	Acquiring, keeping and terminating a job	d	0.50	0.25	–0.02–0.51
d9	Community, Social and Civic Life				
d920	Recreation and leisure	d	0.46	0.19	–0.07–0.50

CI: confidence interval.

kappa provides a good overall estimate of the chance-corrected agreement, at the risk, however, of reducing the data to a single number that can be interpreted only if the underlying contingency table is examined and the clinical context is considered (31, 32). More sophisticated methods to assess reliability, such as log-linear models, might eventually find use in larger scale investigations of this sort (33).

Our study is not without limitations. For reasons of feasibility, the sample size had to be restricted, which necessarily yielded agreement estimates with low precision. Sample size was determined to yield confidence intervals not including the null point. Arguably, it would have been equally appropriate to test the difference relative to a pre-set threshold kappa such as 0.5, but this would have required 10–50-fold greater sample sizes. Still, the precision was sufficiently high to differentiate items with good agreement from those with low agreement. *A posteriori* power estimation using the power diagrams by Donner & Eliasziw (34) shows that at the present sample size and at an alpha level of 0.05 test power was adequate (0.8) for detecting a substantial agreement, i.e. a kappa value of 0.6 and above. Another limitation pertains to the definition of items, as alluded to above in the context of Environmental Factors. In most categories we decided to adopt the definition of the second level, which was, however, in a few instances insufficiently specific. To give an example, the second-level category *Lifting and carrying objects* (d430) is defined as rising up an object

Table IV. *Percentage of agreement and kappa coefficient for the categories of the International Classification of Functioning, Disability and Health (ICF) component Environmental Factors, per chapter of the ICF in decreasing order of percentage of agreement*

ICF code	Code description	Scale	Raw agreement *n*=28	Kappa *n*=28	95% CI
e1	Products and Technology				
e110+[a]	Products or substances for personal consumption	d	0.89	0.36	0.00–0.78
e110–[a]		d	0.61	0.17	–0.16–0.51
e115+	Products and technology for personal use in daily living	d	0.71	0.17	–0.20–0.59
e115–		d	0.93	0.47	–0.05–1.00
e120+	Products and technology for personal indoor and outdoor mobility and transportation	d	0.64	0.09	–0.90–0.27
e120–		d	0.64	0.14	–0.17–0.53
e135+	Products and technology for employment	d	0.61	0.39	0.15–0.64
e135–		d	0.57	0.33	0.06–0.59
e140+	Products and technology for culture, recreation and sport	d	0.36	–0.02	–0.26–0.27
e140–		d	0.46	0.03	–0.30–0.36
e155+	Design, construction and building products and technology of buildings for private use	d	0.54	0.26	0.04–0.50
e155–		d	0.61	0.38	0.17–0.64
e2	Natural Environment and Human-Made Changes to Environment				
e250+	Sound	d	0.82	0.44	–0.06–0.83
e250–		d	0.75	0.52	0.24–0.80
e3	Support and Relationships				
e310+	Immediate family	p	0.43	0.21	–0.04–0.44
e310–		p	0.71	0.01	–0.16–0.37
e315+	Extended family	p	0.54	0.40	0.20–0.65
e315–		p	0.64	–0.03	–0.16–0.32
e320+	Friends	p	0.46	0.29	0.08–0.51
e320–		p	0.75	0.41	0.05–0.76
e325+	Acquaintances, peers, colleagues, neighbours and community members	p	0.39	0.25	0.01–0.46
e325–		p	0.71	0.41	–0.02–0.73
e330+	People in positions of authority	d	0.36	0.17	–0.05–0.38
e330–		d	0.46	0.15	–0.08–0.38
e340+	Personal care providers and personal assistants	d	0.39	0.16	–0.03–0.38
e340–		d	0.50	0.16	–0.05–0.43
e355+	Health professionals	p	0.43	0.03	–0.20–0.31
e355–		p	0.61	0.21	–0.12–0.58
e4	Attitudes				
e410+	Individual attitudes of immediate family members	d	0.79	0.47	–0.04–0.80
e410–		d	0.86	0.59	0.00–0.89
e415+	Individual attitudes of extended family members	d	0.68	0.52	0.25–0.81
e415–		d	0.71	0.40	0.07–0.70
e420+	Individual attitudes of friends	d	0.79	0.50	0.16–0.87
e420–		d	0.79	0.33	–0.07–0.77
e430+	Individual attitudes of people in positions of authority	d	0.43	0.23	0.04–0.47
e430–		d	0.50	0.15	–0.05–0.42
e450+	Individual attitudes of health professionals	p	0.64	0.45	–0.09–0.77
e450–		p	0.64	–0.01	–0.13–0.22
e465+	Social norms, practices and ideologies	d	0.57	0.22	–0.09–0.50
e465–		d	0.68	0.23	–0.06–0.58
e5	Services, Systems and Policies				
e570+	Social security, services, systems and policies	d	0.82	0.10	–0.12–0.33
e570–		d	0.86	0.28	0.00–0.48
e575+	General social support services, systems and policies	d	0.64	0.22	–0.03–0.55
e575–		d	0.79	0.08	–0.10–0.48
e580+	Health services, systems and policies	d	0.75	0.13	–0.25–0.50
e580–		d	0.86	0.28	–0.08–0.78

[a] ”+” for category graded as a facilitator and ”–” for category graded as a barrier. CI: confidence interval.

or taking something from one place to another; this definition clearly mixes the 2 concepts of “Lifting” and “Carrying”. In contrast, the third-level categories differentiate fully between the 2 concepts. Most probably, their use would have resulted in the writing of more reliable items, albeit at the expense of a more complex questionnaire.

Future research directions

This study examined the reliability of single items based on the ICF. In practice, functioning is often assessed by physiotherapists with the help of composite scales. While those scales may be valid and reliable, they tend to measure only single aspects of functioning, and they are, by definition, masking

the effects of single items. Moreover, most of the established measures have not been based on a comprehensive framework such as the ICF, but arose from the requirements of particular aspects of functioning. With this in mind, there are several potential future directions of research to develop ICF-based assessments. First, it must be recalled that subsets of the items presented here could be combined to form new measures. This may scarcely be necessary for all the items, since there are already a number of established measures perfectly meeting their purpose. On the other hand, there may be a need for new measures to be used in specific situations, such as the acute hospital, and by physiotherapists. Validity and objectivity of such new measures would then have to be ascertained. In addition, the present items can be used "as they are" to document patients' categorical functioning profile and to highlight those aspects of functioning expected to improve through therapy. The usefulness and applicability of this approach has yet to be studied.

In conclusion, physiotherapists should adopt the ICF as a unifying framework in order to be able to communicate patients' needs in a language that is understood by all health professionals. It has to be emphasized that the assessment of functioning should always be a team effort, with each profession contributing. ICF-based items should be the basis of a common language in the acute hospital setting. The World Health Organization (WHO) encourages future ICF users to develop clinical standards and to assign clinically meaningful and appropriate wording to its existing qualifier frame. We have now provided proof of principle that the ICF can be adapted to the professional and setting-specific needs of physiotherapists who can reliably use the operationalized ICF as a checklist and tool to assess patients and monitor the results of interventions. Further research is directed towards combining these items into single scales.

ACKNOWLEDGEMENTS

The authors would like to thank the Swiss Physiotherapy Association, Sursee, Switzerland for providing financial support for the operationalization conference in Ermatingen (CH). We also thank the experts involved in the conference: Ruud Knols, Esther Kramer, Roland Paillex, Barbara Rau, Veronika Schoeb and Markus Wirz. Also, Andrea Camenisch, Désirée Forster, Liz Penzkofer, Doris Rüedi, Martina Schütz, Marguerite Stauffacher, the interviewers and Hiltrud Schmid, Marie-Louise Squaratti, Astrid Zanettin and the physiotherapy staff and the head therapists of all wards involved at the University Hospital Zurich for assistance in data collection. We also thank Leanne Pobjoy and Dr Paul Cumming for their help in preparing the manuscript.

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APPENDIX I. Physiotherapists' operationalization of qualifiers for selected categories from the International Classification of Functioning, Disability and Health (ICF). Languages of operationalization were German, French and Italian. The English translation was not validated.

	Body Functions
b110	**Consciousness functions**
	b110.0: No constraints of consciousness, normal attentional behavior
	b110.1: Slight consciousness disturbance
	b110.2: Patient is awake but sleepy
	b110.3: Patient can be woken up
	b110.4: No reaction, non-responsive
b280	**Sensation of pain**
	b280.0: 0 points on the NRS*
	b280.1: 1 to 2 points on the NRS
	b280.2: 3 to 5 points on the NRS
	b280.3: 6 to 9 points on the NRS
	b280.4: 10 points on the NRS
	**NRS: Numeric Rating Scale: 10 Point Scale (0=no pain; 10=maximal pain)*
b440	**Respiration functions**
	b440.0: Normal, voluntary breathing
	b440.1: Patient has a slight problem (requires inhalation, O_2, shows an increased breathing frequency
	b440.2: Patient breaths voluntarily but needs instrumental support from time to time (most of the time without support)
	b440.3: Patient breaths voluntarily but regularly needs instrumental support (most of the time with support)
	b440.4: No voluntary breathing
b455	**Exercise tolerance functions**
	b455.0: The patient is not restricted in his cardiovascular capacity
	b455.1: The patient is restricted when ascending stairs due to diminished cardiovascular capacity
	b455.2: The patient is restricted when walking in the corridor due to diminished cardiovascular capacity
	b455.3: The patient is restricted when walking in a room due to diminished cardiovascular capacity
	b455.4: The patient is severely restricted due to diminished cardiovascular capacity, so that he is only capable of lying.
b460	**Sensations associated with cardiovascular and respiratory functions**
	The patient senses chest tightness, shortness of breath, palpitation, racing heart or dyspnoea
	b460.0: Never
	b460.1: Seldom
	b460.2: Sometimes
	b460.3: Often
	b460.4: Always
b510	**Ingestion functions**
	Within the framework of the consensus conference this category has been defined by swallowing items
	b510.0: Capable of taking in normal, solid and liquid food
	b510.1: Capable of drinking, but needs time and special attention
	b510.2: Capable of taking in pureed food and/or concentrated liquids in sips
	b510.3: Only capable of taking in solid food in pieces
	b510.4: No oral food intake possible.
b710	**Mobility of joint functions**
	b710.0: No movement constraints in the joints
	b710.1: Movement constraints up to a third of the mobility of the joints
	b710.2: Movement constraints up to half of the mobility of the joints
	b710.3: Movement constraints up to two-thirds of the mobility of the joints
	b710.4: Movement is completely constrained

	Body Functions, *contd.*
b730	**Muscle power functions**
	b730.0: Strength is equivalent to muscle test value M4 – M5
	b730.1: Strength is equivalent to muscle test value M3
	b730.2: Strength is equivalent to muscle test value M2
	b730.3: Strength is equivalent to muscle test value M1
	b730.4: No muscle activity (M0)
b735	**Muscle tone functions: only hypertonus** *(hypotonus was defined separately as dichotomous)*
	b735.0: Normal tonus
	b735.1: Slight resistance at the end of the movement
	b735.2: Significant resistance over 50% of the degree of movement
	b735.3: Strong resistance, passive movement is hindered
	b735.4: The specific body part is rigid in one direction of movement
b770	**Gait pattern functions**
	b770.0: No dysfunction of movement patterns when walking
	b770.1: Light limping with free flowing movement and dynamic walking
	b770.2: Significant limping with impaired dynamics and reduced speed
	b770.3: Halted walking and/or uncoordinated gait
	b770.4: Only capable of walking a few steps due to severe disturbance of movement pattern
	Activities and Participation
d160	**Focusing attention**
	d160.0: Focusing attention during more than 30 min
	d160.1: Focusing attention during 15 to 30 min
	d160.2: Focusing attention during 5 to 15 min
	d160.3: Focusing attention for up to 5 min
	d160.4: Cannot focus attention
d210	**Undertaking a single task**
	d210.0: Can undertake a single task
	d210.1: Can undertake a single task but needs more time
	d210.2: Needs guidance to undertake a single task
	d210.3: Needs manual support of somebody to undertake a single task
	d210.4: Cannot undertake a single task
d230	**Carrying out daily routine**
	d230.0: Can independently manage and complete the daily routine
	d230.1: Can independently manage and complete the daily routine but needs breaks
	d230.2: Needs references to manage and complete the daily routine
	d230.3: Needs continuous support to manage and complete the daily routine
	d230.4: Cannot manage and complete the daily routine
d410	**Changing basic body position**
	The following 6 changes of basic body position have been declared as relevant: d4100 Lying down/d4102 Kneeling/d4103 Sitting/ d4104 Standing/ d4105 Bending/d4106 Shifting the body's centre of gravity
	d410.0: Patient can independently change body position
	d410.1: Is independent in at least 4 of the 6 basic body position changes
	d410.2: Needs supervision or aids for some body position changes
	d410.3: Needs a lot of manual support for body position changes
	d410.4: Impossible to change body position (e.g. from lying to sitting, sitting to standing, etc.)
d415	**Maintaining a body position**
	The following 4 basic body position are considered:d4150 Maintaining a lying position/d4152 Maintaining a kneeling position/d4153 Maintaining a sitting position/ d4154 Maintaining a standing position
	d415.0: Patient can maintain independently all 4 body positions
	d415.1: Can maintain at least 3 of the 4 body positions
	d415.2: Needs aids or supervision to maintain some of the body positions
	d415.3: Needs a lot of manual support to maintain a body position
	d415.4: Cannot maintain a body position
d430	**Lifting and carrying objects**
	d430.0: Can lift and carry heavy objects (e.g. a chair)
	d430.1: Can only lift a heavy object
	d430.2: Can lift and carry only light objects (e.g. a bottle)
	d430.3: Can lift a cup or a glass
	d430.4: Cannot lift and carry objects

	Activities and Participation, *contd.*
d445	**Hand and arm use**
	d445.0: Normal use of hand and arm
	d445.1: Normal use of hand and arm with only one arm or difficulties using both arms overhead
	d445.2: Hand and arm use is affected on both sides but possible with adapted aids
	d445.3: Only marginal movements are possible on both sides
	d445.4: Hand and arm use not possible
d450	**Walking**
	d450.0: More than 100 meters including outdoors (with or without walking aids)
	d450.1: Several times a day indoors from 10 to 100 meters (with or without walking aids)
	d450.2: Walking independently in the ward (10 to 100 meters) with or without walking aids
	d450.3: Walking independently in the room (up to 10 meters) with or without walking aids
	d450.4: Walking independently is not possible
	Climbing *(only stairs)*
d4551	d4551.0: Climbing 2 or more floors
	d4551.1: Can manage climbing one floor
	d4551.2: Can manage climbing half of a floor's staircase
	d4551.3: Some stairs can be surmounted but less than half of a staircase
	d4551.4: Climbing stairs is not possible
d510	**Washing oneself**
	d510.0: Patient can wash himself independently
	d510.1: Patient can wash himself independently but needs more time
	d510.2: Needs little support for washing oneself (e.g. help for washing operated extremity, help to get ready at the basin, etc.)
	d510.3: Needs manual support from a healthcare professional
	d510.4: Washing oneself is not possible
d520	**Caring for body parts**
	d520.0: Patient can take care of parts of his body independently
	d520.1: Patient can take care of parts of his body independently but needs more time
	d520.2: Needs little support taking care of body parts (e.g. for operated extremity, preparation, etc.)
	d520.3: Needs manual support from a healthcare professional
	d520.4: Caring for body parts is not possible
d540	**Dressing**
	d540.0: Patient can independently get dressed up
	d540.1: Patient can independently get dressed up but needs more time
	d540.2: Needs little support to get dressed up (e.g. for socks on operated extremity, help on small buttons)
	d540.3: Needs manual support from a healthcare professional
	d540.4: Getting dressed independently is not possible
d550	**Eating**
	d550.0: Patient can eat independently
	d550.1: Patient can eat independently but needs more time
	d550.2: Needs little support for eating (e.g. cutting meat, special grips on the cutlery, etc.)
	d550.3: Needs support from a healthcare professional for feeding
	d550.4: Patient cannot eat
d560	**Drinking**
	d560.0: Patient can drink independently
	d560.1: Patient can drink independently but needs more time
	d560.2: Needs little support for eating (e.g. open the bottle, adapted glass, etc.)
	d560.3: Needs support from a healthcare professional for drinking
	d560.4: Patient cannot drink
	Environmental Factors
e310+	**Immediate family**
	e310+0: The immediate family does not offer any support
	e310+1: The immediate family offers little support
	e310+2: The immediate family offers an average amount of support
	e310+3: The immediate family offers a lot of support
	e310+4: The immediate family offers utmost support
e310	**Immediate family**
	e310.0: The immediate family is not a barrier for me
	e310.1: The immediate family is a slight barrier for me
	e310.2: The immediate family is an average barrier for me
	e310.3: The immediate family is a strong barrier for me
	e310.4: The immediate family is an utmost barrier for me

	Environmental Factors, *contd.*
e315+	**Extended family**
	e315+0: The extended family does not offer any support
	e315+1: The extended family offers little support
	e315+2: The extended family offers an average amount of support
	e315+3: The extended family offers a lot of support
	e315+4: The extended family offers utmost support
e315	**Extended family**
	e315.0: The extended family is not a barrier for me
	e315.1: The extended family is a slight barrier for me
	e315.2: The extended family is an average barrier for me
	e315.3: The extended family is a strong barrier for me
	e315.4: The extended family is an utmost barrier for me
e320+	**Friends**
	e320+0: My friends do not offer any support
	e320+1: My friends offer little support
	e320+2: My friends offer an average amount of support
	e320+3: My friends offer a lot of support
	e320+4: My friends offer utmost support
e320	**Friends**
	e320.0: My friends are not a barrier for me
	e320.1: My friends are a slight barrier for me
	e320.2: My friends are an average barrier for me
	e320.3: My friends are a strong barrier for me
	e320.4: My friends are an utmost barrier for me
e325+	**Acquaintances, peers, colleagues, neighbours and community members**
	e325+0: My circle of acquaintances does not offer any support
	e325+1: My circle of acquaintances offers little support
	e325+2: My circle of acquaintances offers an average amount of support
	e325+3: My circle of acquaintances offers a lot of support
	e325+4: My circle of acquaintances offers utmost support
e325	**Acquaintances, peers, colleagues, neighbours and community members**
	e325.0: My circle of acquaintances is not a barrier for me
	e325.1: My circle of acquaintances is a slight barrier for me
	e325.2: My circle of acquaintances is an average barrier for me
	e325.3: My circle of acquaintances is a strong barrier for me
	e325.4: My circle of acquaintances is an utmost barrier for me
e355+	**Health professionals**
	e355+0: Health professionals do not offer any support
	e355+1: Health professionals offer little support
	e355+2: Health professionals offer an average amount of support
	e355+3: Health professionals offer a lot of support
	e355+4: Health professionals offer utmost support
e355	**Health professionals**
	e355.0: Health professionals are not a barrier for me
	e355.1: Health professionals are a slight barrier for me
	e355.2: Health professionals are an average barrier for me
	e355.3: Health professionals are a strong barrier for me
	e355.4: Health professionals are an utmost barrier for me
e450+	**Individual attitudes of health-related professionals**
	e450+0: The attitudes (approach) of a few health professionals are a support to me
	e450+1: The attitudes of a quarter of health professionals are a support to me
	e450+2: The attitudes of a quarter to a half of health professionals are a support to me
	e450+3: The attitudes of a half or more health professionals are a support to me
	e450+4: The attitudes of all health professionals are a support to me
e450	**Individual attitudes of health-related professionals**
	e450.0: The attitudes (approach) of a few health professionals are a barrier to me
	e450.1: The attitudes of a quarter of health professionals are a barrier to me
	e450.2: The attitudes of a quarter to a half of health professionals are a barrier to me
	e450.3: The attitudes of a half or more health professionals are a barrier to me
	e450.4: The attitudes of all health professionals are a barrier to me

J Rehabil Medicine 2011; 43: 174–177

ORIGINAL REPORT

THE ICF AS A WAY TO SPECIFY GOALS AND TO ASSESS THE OUTCOME OF PHYSIOTHERAPEUTIC INTERVENTIONS IN THE ACUTE HOSPITAL

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Objective: **The aim of this study was to demonstrate the use of the International Classification of Functioning, Disability and Health (ICF) to measure the effect of physiotherapy treatment.**

Design: **A prospective cohort study with an additional case report.**

Patients: **Individuals were eligible for the study if they were patients at the University Hospital of Zurich and had received physiotherapeutic interventions during their inpatient stay.**

Methods: **Patient's functioning was assessed by physiotherapists at initiation of physiotherapeutic treatment and at discharge using ICF Core Sets.**

Results: **A total of 425 patients were analysed, mean age 60 years, 42% female. The median of treatment days varied between 4 (intensive care unit) and 19 (low back pain). The majority of patients had improved or stable results; improvement was most prominent in the surgical and internal medicine group. The ICF category d450 "Walking" appears in 4 out of 6 ICF Core Sets, being only infrequently treated in intensive care unit and low back pain.**

Conclusion: **Analysis showed that the ICF can be used to record precise information on patients' functioning in the acute hospital. Typical impairments and restrictions, intervention goals and trajectories of functioning could be documented. The qualifiers used in our clinical example were sensitive to change. Definitions of qualifiers, however, should be the subject of further research.**

Key words: ICF; physiotherapy; physical therapy; goals; outcome assessment; classification.

J Rehabil Medicine 2011; 43: 174–177

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Submitted May 25, 2010; accepted September 7, 2010

INTRODUCTION

Physiotherapeutic interventions are an important part of coordinated treatment in the acute hospital. The aim of these interventions is to prevent impairments, medical complications and risks, and to restore selected aspects of functioning. Specific goals of physical therapy depend on diagnosis and functional status, but also on the patient's age, life situation and person factors. Early planning and onset of physiotherapy improves functioning and ultimately contributes to the prevention of impairment and disability (1–4).

Physiotherapeutic interventions are part of a continuous process of defining and addressing patients' needs and goals. The success of any intervention should be evaluated to be able to adapt goals and interventions if necessary (5). Thus, physiotherapeutic interventions might be described by their respective goals.

Despite this importance for patient outcome, until now there has been no standardized tool that describes both the goals of physiotherapeutic interventions and measures the effect of these interventions. An instrument is needed that is easy to use in the hands of the prospective user, which is not time-consuming, and which focuses on the specific needs of the patients in the acute hospital.

The International Classification of Functioning, Disability and Health (ICF) is an interesting option for describing single components of functioning and specific goals of physiotherapy. Introduced by the World Health Organization (WHO) to classify and structure human functioning in all its facets, it is specifically intended for the documentation of health status to be used by all groups of health professionals (6). It has been shown to be relatively simple to use, valid and reliable in the hands of physical therapists in the acute hospital (7, 8), applicable regardless of the underlying health condition or clinical situation, comprehensive across elements of functioning, and there are short versions useful for specific health conditions or settings, such as the acute hospital (9).

ICF categories can have multiple purposes, namely for assessment and categorization of functional impairment and activity restriction from the patient perspective. In particular, they can be used to standardize goals of physiotherapeutic interventions (10). It has to be emphasized that the assessment of functioning should always be a team effort, with each profession contributing. ICF-based items can therefore be the basis of a common language in the acute hospital setting. Selections of the ICF, called ICF Core Sets for the acute hospital were developed and validated for clinical practice. Yet, experience with the practical application of the ICF Core Sets is scarce. The physiotherapy department of the Institute of Physical

Medicine of the University Hospital in Zurich has been part of the ICF research since its beginning and has been using the ICF Core Sets for patient assessment. Thus, motivation was high to provide the first examples of the application of the ICF in physiotherapy in the acute hospital.

The aim of this study was to demonstrate the use of the ICF to describe therapy goals and to assess the potential effect of rehabilitation interventions, first by implementing operationalized ICF qualifiers and, secondly, through a case report.

METHODS

Patients and data collection

Individuals were eligible for the study if they were patients at the University Hospital of Zurich from April to September 2008 and had received physiotherapeutic interventions during their inpatient stay. Patients were characterized primarily by their respective health condition requiring medical treatment, i.e. patients in surgical (SUR) and internal medicine wards (INT), patients in the intensive care unit (ICU), patients with neurological conditions (NEU) or after neurosurgery (NES), and patients with low back pain (LBP). This allocation was chosen according to the organizational structure of the physiotherapeutic services of the hospital. To find a balance between practicability and representativeness, we recruited up to 100 patients by health condition group, allowing a maximum of 6 months for recruitment.

Measures

The ICF is a model and multipurpose classification that belongs to the WHO family of international classifications. In a preceding Delphi study ICF categories representing goals of physiotherapeutic interventions typical for the acute hospital had been defined (11). Along this choice of categories, typical second-level ICF categories were chosen. A problem was defined as typical if 10% or more of the patients were treated for it. This led to 6 ICF Core Sets in accordance with the organizational structure of the physiotherapeutic services, an ICF Core Set for SUR, INT, ICU, NEU, NES and LBP. The 6 ICF Core Sets consisted of 42–121 categories per set (SUR = 45, INT = 56, ICU = 42, NEU = 121, NES = 87, LBP = 48).

Physiotherapists with expertise in assessment and the ICF decided on the appropriate operationalization of the ICF categories. Detailed description of the process and operationalization of the items is given in Grill et al. (12).

Data collection

Each patient's impairment in Body Functions and Structures or restriction in Activities and Participation was assessed by physical therapists according to 1 of the 6 ICF Core Sets. The assessment took place at initiation of physiotherapeutic treatment and at the end. In addition, the physical therapists recorded whether the respective problem was the goal of a PT intervention. Since we report routine data serving as a hospital specific quality improvement system, informed consent and approval of the ethics committee was not obtained. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statistical analyses

We reported means and standard deviations or the respective median and quantiles for continuous variables and percentages for ordinal or nominal variables. For the reporting of treatment outcomes we excluded patients with missing values at the end of treatment.

RESULTS

Implementation of ICF Core Sets for quantitative physiotherapeutic reporting

A total of 549 patients were recruited initially. For the analyses 124 patients were excluded due to missing data at the end of the treatment (SUR 6 patients, INT 20 patients, ICU 59 patients, NEU 24 patients, NES 13 patients and LBP 2 patients). Mean age was 60 years, 42% were female. Detailed demographic information is shown in Table I. Median of treatment days varied between 4 (ICU) and 19 (LBP). All patients presented with more problems present than were treated.

The most frequent diagnoses were bypass, valvular transplant and traumatic brain injury for SUR; conditions affecting the lungs (e.g. pneumonia, asthma, chronic obstructive pulmonary disease) and neoplasms (e.g. leukaemia, lymphoma, tumours of the internal organs) for INT; stroke and multiple sclerosis for NEU; brain disease (e.g. subarachnoidal bleeding, tumours) with or without neurological deficits for NES and chronic low back pain for LBP. The ICU included patients from all clinical departments, regardless of the underlying diagnosis. The 3 categories most frequently treated per ICF Core Set are shown in Table II. The ICF category *Walking* (d450) appears in 4 out of 6 ICF Core Sets, being only infrequently treated in ICU and LBP.

Outcomes of the 3 categories most frequently treated per ICF Core Set are shown in Table II. The majority of patients had improved or stable results; improvement was most prominent in the surgical and internal medicine group.

Application of ICF Core Sets to a case report

In the following case report we describe the therapy process of a 39-year-old male patient with a cerebrovascular insult after a carotid artery dissection on the left side. The current medical treatment was intravenous thrombolysis. The consequences

Table I. *Demographic characteristics of included patients, stratified for International Classification of Functioning, Disability and Health (ICF) Core Set surgery (SUR), internal medicine (INT), intensive care unit (ICU), neurology (NEU), neuro-surgery (NES) and low back pain (LBP)*

	ALL	SUR	INT	ICU	NEU	NES	LBP
Patients, *n*	425	94	80	41	73	81	56
Female, %	41.9	39.4	38.8	36.6	37	48.2	51.8
Mean age (SD)	59.9 (16.9)	57.8 (19.4)	59.0 (16.5)	62.0 (14.7)	60.2 (18.0)	61.2 (14.6)	61.1 (16.7)
Days with therapy, median (1st quartile; 3rd quartile)	8 (4;15)	7 (4;11)	8 (4;20.5)	4 (3;7)	8 (5;11)	8 (4;14)	19 (11;26)
Mean number of problems present, *n*	13.0	9.2	12.8	10.8	16.1	17.9	10.2
Mean number of problems treated, *n*	9.7	7.6	9	8.8	9.6	15.2	7.1

SD: standard deviation.

Table II. *Most frequently treated International Classification of Functioning, Disability and Health (ICF) categories, stratified for ICF Core Set surgery (SUR), internal medicine (INT), intensive care unit (ICU), neurology (NEU), neuro-surgery (NES) and low back pain (LBP), and the percentage of patients improved, stable or deteriorated in the respective category*

Core Set	ICF Category	Definition	Improved %	Stable %	Deteriorated %
SUR (n=94)	d450	Walking	85.7	14.3	0.0
	b4550	General physical endurance	89.4	10.6	0.0
	d4551	Climbing	73.0	27.0	0.0
INT (n=80)	d450	Walking	65.7	28.4	6.0
	b4550	General physical endurance	60.6	31.0	8.5
	d4551	Climbing	63.2	32.4	4.4
ICU (n=41)	b440	Respiration functions	56.4	38.5	5.1
	b4402	Depth of respiration	10.3	89.7	0.0
	d410	Changing basic body position	55.0	45.0	0.0
NEU (n=73)	b755	Involuntary movement reaction functions	15.9	84.1	0.0
	b760	Control of voluntary movement functions	8.6	91.4	0.0
	d450	Walking	62.1	37.9	0.0
NES (n=81)	b735	Muscle tone functions (hypotone)	8.2	91.8	0.0
	b760	Control of voluntary movement functions	9.1	90.9	0.0
	d450	Walking	23.9	65.8	1.4
LBP (n=56)	b280	Sensation of pain	79.3	20.8	0.0
	b4550	General physical endurance	71.2	28.9	0.0
	b710	Mobility of joint functions	39.6	60.4	0.0

of the diagnosis presented a hemiparesis of the right side and regredient aphasia. His ability to speak was regressive (d330). He could not remain in a sitting position (d4153) or a standing position (d4154) and was unable to walk (d450). Paresis of his right hand resulted in restricted hand and arm use (d445), making it impossible to lift and carry objects (d430) and restricted his fine hand use (d440). Carrying out daily routine was restricted (d230). The patient had the full support of his immediate family (e310) acting as a facilitator for therapy. Extensor muscles of his fingers were hypotonic (b7300). Single muscle contractions of the hand could be evoked; they were, however, insufficient for hand use because of impaired muscle endurance (b740). Coordination (b760), proprioception (b260) and sensibility (b265) were impaired and thus affected coordination of movement. Lower extremity muscle function (b7301) was weakened; proprioception (b1801, b260) and sensibility were reduced accordingly. Balance was impaired (b755). Aphasia presented itself by impaired fluency and rhythm of speech (b330).

The therapy goals were upper and lower extremity functions and activities to enable autonomy and return to work (d440, d445, d450). Physiotherapeutic interventions comprised several units with the goal to remain in standing position (d4154) and to carry out daily routine (d230). Specific exercises aimed at muscle power of isolated muscles or muscle groups (b7300), muscle power of an extremity (b7301), reduced muscle tone (b735), control of voluntary movements (b760), proprioception (b260), touch function (b265), body experience (b1801), and involuntary movement functions (b755).

Fig. 1 shows evaluation of intervention goals *Fine hand use* (d440), *Hand and arm use* (d445) and *Walking* (d450) at admission and discharge. Qualifier 4 stands for complete restriction, 0 stands for no or minimal restriction.

Although there was improvement in the patient's hand and arm use, the qualifier scale was not sensitive enough to assess the changes experienced. Improvements in *Fine hand use* (d440) and *Walking* (d450), however, were shown.

DISCUSSION

We demonstrated that physiotherapists in the acute hospital can code functioning, treatment goals and treatment results with the help of the ICF. Physiotherapeutic documentation in the acute hospital is very challenging because it has to include the entire process of diagnosis, goal-setting, intervention and outcomes. Additionally, documentation has to be meaningful for other health professionals involved in patient management.

There are few examples and proposals for standardized documentation of physiotherapeutic interventions and their outcomes in the acute hospital. Few recent studies explored the possibilities to use the ICF as a multidisciplinary language in the acute hospital e.g. to compare patients' functioning profiles

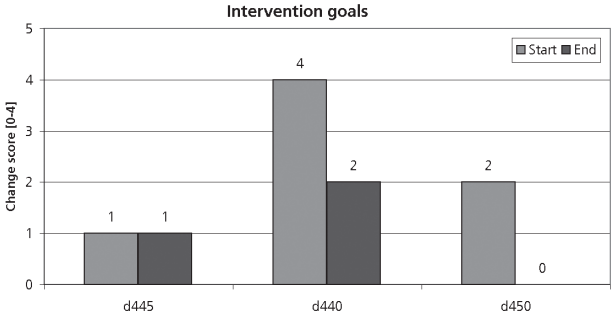

Fig. 1. Change of functioning from beginning of physical therapy to the end for 3 International Classification of Functioning, Disability and Health (ICF) categories, *Hand and arm use* (d445), *Fine hand use* (d440) and *Walking* (d450) for a patient with cerebrovascular insult. Lower scores indicate less restriction.

(13) or to classify facilitators and barriers to effective communication with the patient (14). We could show that categories of the ICF can be useful in the hands of physiotherapists in several ways. Firstly, they can serve as an assessment of the patient's actual problems. Secondly, once assessed, those categories can help to define therapy goals. Thirdly, refining qualifiers and delving into lower levels of the classification may help to specify interventions. Fourthly, once specified, therapy goals can serve as outcome measures for the degree of goal attainment and the success of therapy.

There is, to date, no assessment system tailored to the needs of the physiotherapists that would fulfill all 4 purposes. In neurological conditions for example, the Barthel Index (BI) is a commonly used assessment instruments in neurological rehabilitation to measure the independence of a patient (15).

The BI is also used for the assessment of change. While the BI and various other similar measures are established in post-acute neurological rehabilitation, it is not clear if they can capture the specific short-term effects of physiotherapeutic interventions. Likewise, their underlying concepts may not be broad enough to specify therapy goals or interventions.

However, applying the ICF in physical therapy in the proposed way may have several limitations. Early feedback from health professionals suggested that the definition of ICF Core Sets was a step in the right direction towards establishing evidence-based measurement in the acute hospital. Due to the consensus process, the ICF Core Sets in their present version are comprehensive, with applicability for the assessment of individual problems and needs, and for the estimation of prognosis and the potential for rehabilitation potential, and with general applicability for assessment of functioning in the acute situation. As such, the ICF Core Sets can be used to coordinate physiotherapeutic interventions, e.g. at the intensive care unit. However, a minimally sufficient data-set, which is feasible in clinical practice, may encompass only 20 different concepts or topics, but not much more as contained in the comprehensive ICF Core Sets. Thus, subsets can be extracted from the comprehensive Core Sets, according to specific needs of the individual user. There is work in progress to define those smaller sets, also for physiotherapists. On the other hand, patients' health condition in acute care is often unstable. Therapy goals and interventions may vary from day to day, impeding meaningful documentation. Also, we found that, in some of the functioning aspects, the qualifier scale proposed by the ICF and operationalized by consensus is not sensitive enough to code small effects of therapy. The qualifiers still need to be refined and validated.

Quantitative analysis of a small sample of patients and a case report showed that the ICF can be used to record precise information on patients' functioning in the acute hospital. Typical impairments and restrictions, intervention goals and trajectories of functioning can be documented. The qualifiers used in our clinical example were sensitive to change. Definitions of qualifiers, however, should be the subject of further research.

ACKNOWLEDGEMENTS

The authors wish to thank the physiotherapists of all wards involved at the University Hospital Zurich for data collection.

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APPENDIX I. International Classification of Functioning, Disability and Health (ICF) Core Sets for the acute hospital and for the post-acute situation (see Foreword on pages 85–86)

ICF Core Set	Publication on the preliminary studies	Publication on the consensus conference/ Date of the consensus conference	Publication on testing and validation	Application studies
Acute context				
Neurological conditions	Scheuringer M, Grill E, Boldt C, Müllner P, Stucki G. Systematic review of measures and their concepts used in published studies focusing on rehabilitation in the acute hospital and in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 419–429. Grill E, Quittan M, Huber EO, Boldt C, Stucki G. Identification of relevant ICF categories by health professionals in the acute hospital. Disabil Rehabil 2005; 27: 437–445. Grill E, Huber EO, Stucki G, Herceg M, Fialka-Moser V, Quittan M. Identification of relevant ICF categories by patients in the acute hospital. Disabil Rehabil 2005; 27: 447–458.	Grill E, Ewert T, Chatterji S, Kostanjsek N, Stucki G. ICF Core Set development for the acute hospital and early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 361–366. Ewert T, Grill E, Bartholomeyczik S, Finger M, Mokrusch T, Kostanjsek N, et al. ICF core set for patients with neurological conditions in the acute hospital. Disabil Rehabil 2005; 27: 367–337. Consensus conference: 28 November–1 December, 2003	Müller M, Boldt C, Grill E, Strobl R, Stucki G. Identification of ICF categories relevant for nursing in the situation of acute and early post-acute rehabilitation. BMC Nurs 2008; 18; 7: 3. Grill E, Stucki G. Criteria for validating the comprehensive ICF Core Sets and developing brief ICF Core Set versions. J Rehabil Med 2011; 43: 87–91. Müller M, Grill E, Stier-Jarmer M, Strobel R, Gutenbrunner C, Fialka-Moser V, Stucki G. Validation of the comprehensive ICF Core Sets for patients receiving rehabilitation interventions in the acute care setting. J Rehabil Med J Rehabil Med 2011; 43: 92–101. Grill E, Quittan M, Fialka-Moser V, Müller M, Strobl M, Kostanjsek N, et al. Brief ICF core sets for the acute hospital. J Rehabil Med. J Rehabil Med 2011; 43: 123–130. Müller M, Strobl M, Grill E. Goals of patients with rehabilitation needs in acute hospitals: Goal achievement is an indicator for improved functioning. J Rehabil Med 2011; 43: 145–150.	Grill E, Gloor T, Huber EO, Stucki G. Operationalization and reliability testing of ICF categories relevant for physiotherapists' interventions in the acute hospital. J Rehabil Med J Rehabil Med 2011; 43: 162–173. Huber EO, Tobler A, Gloor-Juzi T, Grill E, Gut B. The ICF as a way to specify goals and to assess the outcome of physiotherapeutic interventions in the acute hospital. J Rehabil Med 2011; 43: 174–177. Müller M, Lohmann S, Strobl R, Boldt C, Grill E. Patients' functioning as predictor of nursing workload in acute hospital units providing rehabilitation care: a multi-centre cohort study. BMC Health Serv Res 2010; 29; 10: 295. Grill E, Huber EO, Gloor-Juzi T, Stucki G. Intervention goals determine physical therapists' workload in the acute care setting. Phys Ther 2010; 90: 1468–1478.
Musculoskeletal conditions	See "Neurological conditions" Weigl M, Cieza A, Kostanjsek N, Kirschneck M, Stucki G. The ICF comprehensively covers the spectrum of health problems encountered by health professionals in patients with musculoskeletal conditions. Rheumatology 2006; 45: 1247–1254.	See Grill et al. 2005 under "Neurological conditions" Stoll T, Brach M, Huber EO, Scheuringer M, Schwarzkopf SR, Kostanjsek N, et al. ICF core set for patients with musculoskeletal conditions in the acute hospital. Disabil Rehabil 2005; 27: 381–387. See Grill et al. 2010 under "Neurological conditions" Consensus conference: 28 November–1 December, 2003	See "Neurological conditions"	
Cardiopulmonary conditions	See "Neurological conditions"	See Grill et al. 2005 under "Neurological conditions" Boldt C, Grill E, Wildner M, Portenier L, Wilke S, Stucki G, et al. ICF core set for patients with cardiopulmonary conditions in the acute hospital. Disabil Rehabil 2005; 27: 375–380. See Grill et al. 2010 under "Neurological conditions" Consensus conference: 28 November–1 December, 2003	See "Neurological conditions"	

APPENDIX I. *contd.*

ICF Core Set	Publication on the preliminary studies	Publication on the consensus conference/ Date of the consensus conference	Publication on testing and validation	Application studies
Early post-acute context				
Neurological conditions	See Acute context "Neurological conditions" Grill E, Lipp B, Boldt C, Stucki G, Koenig E. Identification of relevant ICF categories by patients with neurological conditions in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 459–465.	See Grill et al. 2005 under Acute context "Neurological conditions" Stier-Jarmer M, Grill E , Ewert T, Bartholomeyczik S, Finger M, Mokrusch T, et al. ICF core set for patients with neurological conditions in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 389–395. Consensus conference: 28 November–1 December, 2003	See Acute context "Neurological conditions" Grill E, Strobl M, Müller M, Quittan M, Kostanjsek N, Stucki G. ICF core sets for early post-acute rehabilitation facilities. J Rehabil Med 2011; 43: 131–138. Müller M, Stier-Jarmer M, Quittan M, Strobl R, Stucki G, Grill E. Validation of the comprehensive ICF core sets for patients in post-acute rehabilitation facilities. J Rehabil Med 2011; 43: 102–112. Lohmann St, Decker J, Müller M, Strobl M, Grill E. The ICF forms a useful framework for classifying individual patient goals in post-acute rehabilitatıon. J Rehabil Med 2011; 43: 151–155.	
Musculoskeletal conditions	See Acute context "Neurological conditions"	See Grill et al. 2005 under Acute context "Neurological conditions" Scheuringer M, Stucki G, Huber EO, Brach M, Schwarzkopf SR, Kostanjsek N, et al. ICF core set for patients with musculoskeletal conditions in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 405–410. Consensus conference: 28 November–1 December, 2003	See Acute context "Neurological conditions" See Early post-acute context "Neurological conditions"	
Cardiopulmonary conditions	See Acute context "Neurological conditions"	See Grill et al. 2005 under Acute context "Neurological conditions" Wildner M, Quittan M, Portenier L, Wilke S, Boldt C, Stucki G, et al. ICF core set for patients with cardiopulmonary conditions in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 397–404. Consensus conference: 28 November–1 December, 2003	See Acute context "Neurological conditions" See Early post-acute context "Neurological conditions"	

APPENDIX I. *contd.*

ICF Core Set	Publication on the preliminary studies	Publication on the consensus conference/ Date of the consensus conference	Publication on testing and validation	Application studies
Geriatric patients	See Acute context "Neurological conditions" Grill E, Stucki G, Boldt C, Joisten S, Swoboda W. Identification of relevant ICF categories by geriatric patients in an early post-acute rehabilitation facility. Disabil Rehabil 2005; 27: 467–473.	Grill E, Hermes R, Swoboda W, Uzarewicz C, Kostanjsek N, Stucki G. ICF core set for geriatric patients in early post-acute rehabilitation facilities. Disabil Rehabil 2005; 27: 411–417. Consensus conference: 28 November–1 December, 2003	See Acute context "Neurological conditions" Stier-Jarmer M, Grill E, Müller M, Strobl R, Quittan M, Stucki G. Validation of the comprehensive ICF Core Set for patients in geriatric post-acute rehabilitation facilities. J Rehabil Med 2011; 43: 113–122. Grill E, Müller M, Quittan M, Strobl R, Kostanjsek N, Stucki G. Brief ICF Core Set for patients in geriatric post-acute rehabilitation facilities. J Rehabil Med 2011; 43: 139–144. Kus S, Müller M, Strobl R, Grill E. Patient goals in post-acute geriatric rehabilitation: Goal attainment is an indicator for improved functioning. J Rehabil Med 2011; 43: 156–161.	Grill E, Joisten S, Swoboda W, Stucki G. Early-stage impairments and limitations of functioning from the geriatric ICF Core Set as determinants of independent living in older patients after discharge from post-acute rehabilitation. J Rehabil Med 2007; 39: 591–597.
Spinal cord injury	Kirchberger I, Biering-Sørensen F, Charlifue S, Baumberger M, Campbell R, Kovindha A, et al. Identification of the most common problems in functioning of individuals with spinal cord injury using the International Classification of Functioning, Disability and Health. Spinal Cord 2010; 48: 221–229. Scheuringer M, Kirchberger I, Boldt C, Eriks-Hoogland I, Rauch A, Velstra IM, et al. Identification of problems in individuals with spinal cord injury from the health professional perspective using the ICF: a worldwide expert survey. Spinal Cord 48: 529–36. Kirchberger I, Sinnott A, Charlifue S, Kovindha A, Lüthi H, Campbell R, et al. Functioning and disability in spinal cord injury from the consumer perspective: an international qualitative study using focus groups and the ICF. Spinal Cord 2010; 48: 603–613. Post MW, Kirchberger I, Scheuringer M, Wollaars MM, Geyh S. Outcome parameters in spinal cord injury research: a systematic review using the International Classification of Functioning, Disability and Health (ICF) as a reference. Spinal Cord 2010; 48: 522–528.	Kirchberger I, Cieza A, Biering-Sørensen F, Baumberger M, Charlifue S, Post MW, et al. ICF core sets for individuals with spinal cord injury in the early post-acute context. Spinal Cord 2009; 48: 297–304. Consensus conference: 15–18 November 2007		