

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.

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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 multi-centre 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, <i>n</i>	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, <i>n</i> (%)				
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

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 ^a	% ^b	n ^a	% ^b	% (CI) ^c	n ^a	% ^b	n ^a	% ^b	% (CI) ^c	n ^a	% ^b	n ^a	% ^b	% (CI) ^c	n ^a	% ^b	% (CI) ^c
b110	66	47	67	36	12 (5–22)	37	5	37	0	5 (1–18)								
b114	65	45	67	33	15 (8–26)	37	19	37	14	8 (2–22)								
b126	61	56	66	44	15 (7–27)													
b130	63	76	66	64	15 (7–26)	37	27	37	19	19 (8–35)	61	46	60	32	15 (7–27)			
b134	66	62	67	48	24 (15–36)	37	46	37	30	32 (18–50)	61	54	61	33	28 (17–41)			
b140	66	56	67	42	24 (15–36)	37	16	37	11	16 (6–32)								
b144	63	54	66	48	11 (5–22)	37	14	37	16	3 (0–14)								
b147	60	62	67	46	17 (8–29)													
b152	63	63	66	52	22 (13–34)	37	16	36	8	11 (3–26)	58	47	61	31	21 (11–33)			
b156	65	68	67	61	17 (9–28)													
b160	63	41	65	40	10 (4–20)													
b164	62	56	66	53	8 (3–18)													
b167	66	39	67	36	12 (5–22)													
b176	64	59	67	54	14 (7–25)													
b180	65	54	67	46	12 (5–23)													
b210	63	16	67	15	3 (0–11)													
b215	63	11	66	11	3 (0–11)													
b230	65	9	67	12	3 (0–11)													
b235	63	24	67	24	19 (10–31)													
b240	62	26	66	21	18 (9–30)													
b260	67	90	67	85	19 (11–31)	36	14	37	11	6 (1–19)	61	67	61	52	25 (14–37)			
b265	66	64	67	58	15 (8–26)													
b270	63	57	67	54	25 (15–38)													
b280	67	64	67	54	24 (14–36)	37	46	34	35	26 (13–44)	60	75	61	59	32 (20–45)			
b310	65	51	66	38	18 (10–30)	6	67	6	17	67 (22–96)								
b320	65	43	67	37	17 (9–28)													
b340	65	38	66	27	15 (8–26)													
b410	60	35	67	36	5 (1–14)	37	81	36	81	25 (12–42)								
b415	64	69	67	60	19 (10–30)	37	68	36	53	19 (8–36)	57	49	61	41	14 (6–26)			
b420	66	48	67	45	17 (9–28)	37	62	37	62	14 (5–29)								
b430	66	38	67	30	18 (10–30)	35	37	36	28	18 (7–35)								
b435	67	49	67	39	17 (9–26)	33	18	35	11	3 (0–16)	48	38	50	30	15 (6–28)			
b440	67	42	67	22	27 (17–39)	36	64	36	44	26 (12–43)	61	20	61	10	13 (6–24)			
b445						6	83	6	50	33 (4–78)								
b450	66	29	67	16	17 (9–28)	35	29	35	23	18 (7–35)								
b455	66	77	67	75	8 (3–17)	37	92	37	86	22 (10–38)	58	64	60	52	21 (11–33)			
b460						35	77	36	67	21 (9–38)								
b510						37	19	37	14	14 (5–29)								
b515	66	47	67	33	29 (18–41)	37	66	66	66	22 (10–38)								
b525	65	48	67	37	25 (15–37)													
b530	66	61	67	45	26 (16–38)	37	14	36	8	11 (3–26)	61	18	61	13	13 (6–24)			
b535	63	59	67	46	27 (17–40)	32	25	35	23	6 (1–21)	46	28	52	13	26 (14–41)			
b540	59	29	63	27	20 (11–33)													
b540	66	36	67	27	12 (5–22)													
b545	66	59	67	49	20 (11–31)	34	26	34	12	24 (11–42)								
b550	65	17	67	13	12 (5–23)													
b610						6	50	6	0	50 (12–88)								

Table II contd.

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 ¹	% ^b	% (CI) ^c	n ^a	% ^b	n ^a	% ^b	% (CI) ^c	n ^a	% ^b	n ^a	% ^b	% (CI) ^c	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)													
b730 Muscle power functions	67	97	67	97	6 (2–15)	37	68	37	51	22 (10–38)	61	69	61	92	8 (3–18)			
b735 Muscle tone functions	67	88	67	75	18 (10–29)													
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)													
b760 Control of voluntary movement functions	67	84	67	67	21 (12–33)	37	19	36	8	14 (5–29)	48	21	48	21	17 (7–30)			
b770 Gait pattern functions	67	97	67	93	28 (18–41)													
b780 Sensations related to muscles and movement functions						36	44	35	20	29 (15–46)	51	69	51	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)								

¹Number of valid answers.

²Proportion of impairments (“slight/moderate/severe” or “complete”) in the category.

³Proportion 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

ICF	ICF Code Description	Neurological conditions <i>n</i> =67					Cardiopulmonary conditions <i>n</i> =37					Musculoskeletal conditions <i>n</i> =61				
		Admission		Discharge		Change	Admission		Discharge		Change	Admission		Discharge		Change
		<i>n</i> ^a	% ^b	<i>n</i> ^a	% ^b	% (CI) ^c	<i>n</i> ^a	% ^b	<i>n</i> ^a	% ^b	% (CI) ^c	<i>n</i> ^a	% ^b	<i>n</i> ^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)

^aNumber of valid answers.

^bProportion of impairments (“slight/moderate/severe” or “complete”) in the category.

^cProportion 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

ICF	ICF Code Description	Neurological conditions n=67					Cardiopulmonary conditions n=37					Musculoskeletal conditions n=61										
		Admission		Discharge		Change % (CI) ^c	Admission		Discharge		Change % (CI) ^c	Admission		Discharge		Change % (CI) ^c						
		n ^a	% ^b	n ^a	% ^b		n ^a	% ^b	n ^a	% ^b		n ^a	% ^b	n ^a	% ^b							
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	0–41		
d940	Human rights													12	0	11	0	0	0	0–31		

^aNumber of valid answers.

^bProportion of limitations/restrictions (“slight/moderate/severe” or “complete”) in the category.

^cProportion 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

ICF	ICF Code Description	Specification	Neurological conditions <i>n</i> =67		Cardiopulmonary conditions <i>n</i> =37		Musculoskeletal conditions <i>n</i> =61	
			<i>n</i> ^a	% ^b	<i>n</i> ^a	% ^b	<i>n</i> ^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

^aNumber of patients in which the interviewers found the respective category relevant to describe the patient comprehensively.

^bProportion 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 (%)
<i>Body Functions</i>					
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)
<i>Body Structures</i>					
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)
<i>Activities and Participation</i>					
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.

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