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Use of the International Classification of Functioning, Disability and Health in Brain Injury Rehabilitation

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1. Introduction

In 1887 a book titled "The International Language" was published by Dr. Ludwig Zamenhof in Warsaw. In the introductory part the famous inventor of Esperanto stated: "How much time, labour, and money are wasted in translating the literary productions of one nation into the language of another, and yet, if we rely on translations alone, we can only become acquainted with a tiny part of foreign literature. If an international language existed, all the translations would have been made into it alone, as into a tongue intelligible to everybody, and works of an international character would be written directly in it. The Chinese wall dividing literatures would disappear, and the works of other nations would be as readily intelligible to us as those of our own authors. Books being the same for everyone, education, ideals, convictions, aims, would be the same too" (Zamenhof, 1887).

Decades after with the development of rehabilitation medicine as an independent discipline it turned out that it faced virtually the same problems and hopes: "Chinese walls" in the communication among professionals of different specialties involved in rehabilitation of the same person, the possibility to "become acquainted with a tiny part of foreign literature" due to the language barriers and different national standards in different countries and even within the same country. All this resulting in "much time, labour, and money wasted" that could have been used more efficiently for a good cause of the patient.

The situation changed in 2001 with the unanimous approval by the World Health Assembly of the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001). The main purpose of the classification is exactly to provide a common language for professionals working in health-related areas and establish an international standard for description of health-related states including brain injury rehabilitation. The ICF model and classification are briefly introduced below.

2. The integrative model of functioning, disability and health

The ICF is a comprehensive classification of health-related domains containing 1424 categories that can exhaustively describe the functional status of a person or simply functioning. WHO proposed to use the term functioning when referring to the real impact of a health condition on the day to day life of a person. When the term "health" can be

interpreted in many different and sometimes contradictory ways “functioning” is clearly defined within the ICF. Namely, in the ICF *functioning* refers to body functions, body structures, activities and participation, and disability refers to impairments in body functions and body structures, limitations in activities and restrictions in participation. Most importantly, although functioning and disability are associated with a health condition (diseases, disorders, natural processes of aging), they are not conceptualized as direct consequences of health conditions but rather the result of interactions between health conditions and contextual factors (environmental and personal factors).

The ICF complements the widely used International Classification of Diseases (ICD) allowing to describe the full lived experience of people with a health condition coded by the ICD. ICF captures multiple dimensions of functioning, related to a health condition in order to amplify the ICD predominantly biomedical perspective. It would be therefore beneficial to use ICD and ICF jointly because of their synergy and additional information advantages (Kostanjsek, 2010). This understanding is represented in Figure 1 which depicts the ICF model.

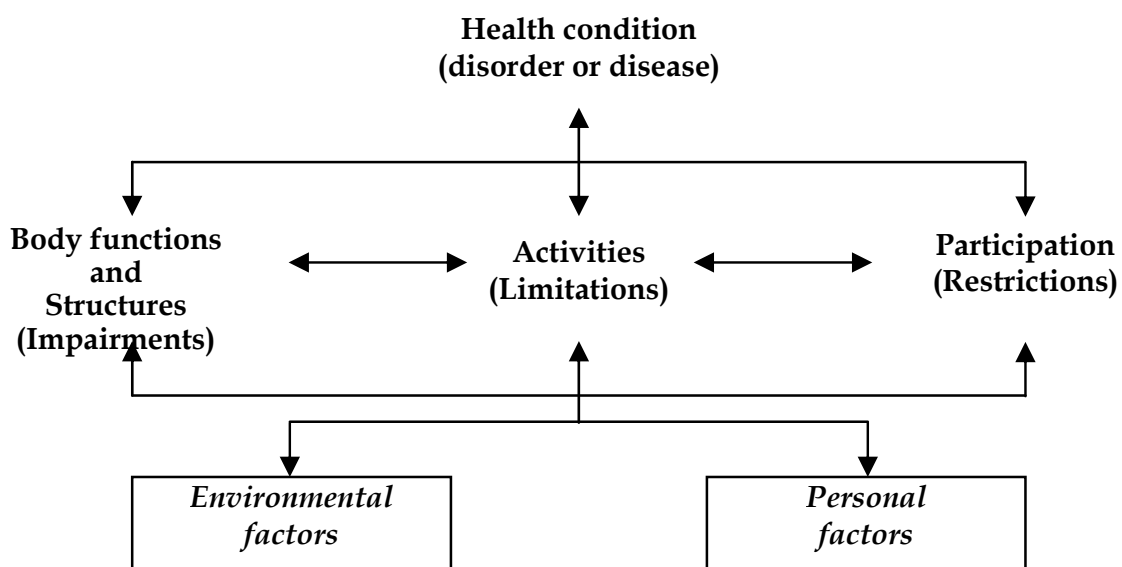


Fig. 1. The bio-psycho-social model of functioning, disability and health

As one can see there is a dynamic and bidirectional interaction among all the components of this model. Changes in one component may influence one or more of the other components. These modifications can always work in all directions. This model illustrates also the essential role of environmental and personal factors for the individual’s functioning. Environmental factors can act as *barriers* (producing or increasing the severity of a disability, or as *facilitators* (improving or eliminating a disability). For this reason, environmental factors must always be taken into account in when assessing functioning before and after the rehabilitation.

2.1 The structure and codes of the ICF

Overall, the classification consists of two parts - *functioning and disability* and *contextual factors*, each with two *components*. Part 1 includes the lists of Body Functions and Structures and Activities and Participation. Part 2 integrates Environmental and Personal Factors. Although personal factors have an impact on functioning and they are included in the ICF

model they are not yet classified. In all other components, *chapters* represent the 1st level of the classification which is the broadest. Each chapter is subdivided into the specific elements of the classification, called *categories*, which are also organized in a hierarchical structure of 2nd, 3rd or 4th levels.

For all categories, except those in body structures, definitions with inclusion and exclusion criteria are provided as shown in the following example:

<p>d520 Caring for body parts</p> <p>Looking after those parts of the body, such as skin, face, teeth, scalp, nails and genitals, that require more than washing and drying. <i>Inclusions: caring for skin, teeth, hair, finger and toe nails</i></p> <p><i>Exclusions: washing oneself (d510); toileting (d530)</i></p>
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The definitions and inclusion criteria provided for each category give a detailed description of the meaning of the category and help practitioners to correctly use the ICF codes. The exclusion criteria help to differentiate among related and seemingly similar ICF categories.

ICF codes are composed of a prefix (**b** for body functions, **s** for body structure, **d** for activity and participation, and **e** for environmental factors) followed by a numeric code that consists of one digit for the first or chapter level, three digits for the second, four for the third, and five for the fourth level (see example below).

The hierarchical organization of the classification allows users to choose a broader (e.g. by using a 1st level chapter or a 2nd level category) or a more specific (e.g. by using a 3rd or 4th level category) description of an aspect of functioning. The level of specificity increases with each level as it is shown in the above example. The hierarchical organization allows users to choose the level of specificity that is required for the description of functioning for their purpose and information need. Although personal factors are not classified, users may assess and describe them in a manner that is suitable for their purposes.

2.2 ICF qualifiers

ICF qualifiers allow to describe the extent of a problem in functioning (impairment, limitation, restriction) and the impact of the environment on functioning and disability. To be meaningful, an ICF code requires at least one qualifier. Hence, a complete ICF code (composed of the letter and numeric code) is completed by at least the first qualifier placed after a dot following the numeric code, e.g. b280.3. For all components (body functions, body structures, activities and participation and environmental factors), the description of the extent of a problem uses the following *generic scale*:

xxx.0 NO problem	(none, absent, negligible,...)	0-4%
xxx.1 MILD problem	(slight, low,...)	5-24%
xxx.2 MODERATE problem	(medium, fair,...)	25-49%
xxx.3 SEVERE problem	(high, extreme,...)	50-95%
xxx.4 COMPETE problem	(total,...)	96-100%
xxx.8 not specified (if only insufficient information for the description of the extent of the problem is available)		
xxx.9 not applicable (if the description of a problem is inappropriate, e.g. in 'b650 Menstruation functions' in men)		

A different number of qualifiers is available for each of the four component (see Table 1). While there is only one qualifier (extent of impairment) for Body Functions, Body

Structures may be denoted with three qualifiers (first qualifier = extent of impairment, second qualifier = nature of impairment, third qualifier = location of impairment). For example, the ICF code **s7302.412** describes a complete impairment (4) due to total absence (1) of the left (2) hand (s7302).

For Activities and Participation, two qualifiers are used. The first qualifier is to describe *performance*, the second qualifier to describe *capacity*. Performance is understood as what an individual actually does in his or her current environment in light of the positive or negative impact of the environmental factors (including all aspects of the physical, social and attitudinal environment). Capacity, by contrast, describes an individual's intrinsic ability to perform a task or an action independently of the impact of the environment, including the particular personal assistance or assistive devices. Hence, when describing both performance and capacity for the same category the difference between them reflects the extent of the impact of environmental factors on an individual's functional state resulting in the experienced level of disability. For example, the ICF code **d450.04** describes a person whose ability to walk is completely impaired (4 = complete problem in capacity) but totally compensated by a prosthesis which is reflected with no limitations in walking in the performance (0 = no problem with performance).

Environmental factors are quantified by only one qualifier. However, the impact on the level of disability can be positive (facilitator) or negative (barrier). To denote this, a facilitator is marked with a plus sign instead the dot (+X) and a barrier follows the dot (.X), as in the following examples: **e310+2** (= Moderate facilitator 'Immediate family'), **e310.2** (=Moderate barrier 'Immediate family').

Qualifiers complement an ICF code and provide the complete description of a person's level of functioning or disability. If assessment instruments or other standards are used to measure the level of disability of a specific aspect of functioning, the results of such measurement can be 'translated' into a qualifier. Using qualifiers for the description of disability facilitates a common understanding of the description of a person's level of disability. Furthermore, the use of qualifiers makes it possible to develop functioning profile of a patient.

3. ICF core sets

With its 1424 categories, the ICF is an exhaustive classification. It allows to create a very detailed and highly individualized functional profile of a person when used as a whole. However, with exhaustiveness can be associated complexity and in some cases even impracticability. ICF is often considered too comprehensive and too complicated for daily practice. The obvious requirement of practicability was the primary reason for the WHO to develop user-friendly tools that would include a purpose-tailored selection of the ICF categories relevant for describing functioning and disability in various contexts related to health conditions (Stucki et al., 2008). These tools are called ICF Core Sets. An ICF Core Set is a selection of categories from the full ICF that correspond to a health condition as coded by the ICD or a particular purpose. There are two main types of the ICF Core Sets, namely, Comprehensive ICF Core Set and Brief ICF Core set.

The Comprehensive ICF Core Set includes categories that reflect the whole spectrum of typical problems a patient may face. The Comprehensive ICF Core Set can guide practitioners through the assessment and helps to *avoid overlooking* aspects of functioning *that are likely to present a problem* in a patient. Due to its comprehensive amount of categories it is a tool that allows a thorough and multidisciplinary assessment of functioning of a person with a health

Component	1 st Qualifier	2 nd qualifier	3 rd qualifier
Body functions	Extent of impairment 0 = NO impairment 1 = MILD impairment 2 = MODERATE impairment 3 = SEVERE impairment 4 = COMPLETE impairment 8 = not specified 9 = not applicable	-	-
Body structures	Extent of impairment 0 = NO impairment 1 = MILD impairment 2 = MODERATE impairment 3 = SEVERE impairment 4 = COMPLETE impairment 8 = not specified 9 = not applicable	Nature of impairment 0 = no change in structure 1 = total absence 2 = partial absence 3 = additional part 4 = aberrant dimension 5 = discontinuity 6 = deviating position 7 = qualitative changes in structure, including accumulation of fluid 8 = not specified 9 = not applicable	Location of impairment 0 = more than one region 1 = right 2 = left 3 = both sides 4 = front 5 = back 6 = proximal 7 = distal 8 = not specified 9 = not applicable
Activities and Participation	Extent of difficulty in performance 0 = NO difficulty 1 = MILD difficulty 2 = MODERATE difficulty 3 = SEVERE difficulty 4 = COMPLETE difficulty 8 = not specified 9 = not applicable	Extent of difficulty in capacity 0 = NO difficulty 1 = MILD difficulty 2 = MODERATE difficulty 3 = SEVERE difficulty 4 = COMPLETE difficulty 8 = not specified 9 = not applicable	-
Environmental factors	Extend of the impact of the environment 0 = NO barrier 1 = MILD barrier 2 = MODERATE barrier 3 = SEVERE barrier 4 = COMPLETE barrier 8 = barrier, not specified 9 = not applicable or +0 = NO facilitator +1 = MILD facilitator +2 = MODERATE facilitator +3 = SUBSTANTIAL facilitator +4 = COMPLETE facilitator +8 = facilitator, not specified 9 = not applicable	-	-

Table 1. Overview of qualifiers for different components of the ICF

condition. *The Brief ICF Core Set* is derived from the Comprehensive ICF Core Set and is composed of categories that should be taken into account for any patient with a health condition or in any setting for which the ICF Core Set was developed, and captures the *essence of person's experience*. Hence, the *Brief ICF Core Set* is used when a brief assessment of functioning of a patient is necessary and sufficient. It therefore serves as the starting point for condition- or setting- specific description of functioning and creation of the basic clinical documentation.

3.1 ICF Core Sets for traumatic brain injury

Any ICF Core Set including the one for traumatic brain injury (TBI) is a result of a structured international scientific process. 139 ICF categories were selected for inclusion into the Comprehensive ICF Core Set for traumatic brain injury. These categories should be taken into account when conducting a comprehensive, multidisciplinary assessment. Out of these 139 categories, 23 ICF categories were selected for inclusion into the Brief ICF Core for TBI. Brief ICF Core Set for traumatic brain injury is presented below (ICF Research Branch, 2010).

ICF Code	ICF Category Title
Body Functions (8)	
b164	Higher-level cognitive functions
b152	Emotional functions
b130	Energy and drive functions
b760	Control of voluntary movement functions
b144	Memory functions
b280	Sensation of pain
b140	Attention functions
b110	Consciousness functions
Body Structures (1)	
s110	Structure of brain
Activities & Participation (8)	
d230	Carrying out daily routine
d350	Conversation
d450	Walking
d720	Complex interpersonal interactions
d845	Acquiring, keeping and terminating a job
d5	Self care
d920	Recreation and leisure
d760	Family relationships
Environmental Factors (6)	
e310	Immediate family
e580	Health services, systems and policies
e115	Products and technology for personal use in daily living
e320	Friends
e570	Social security services, systems and policies
e120	Products and technology for personal indoor and outdoor mobility and transportation

Table 2. ICF Brief Core Set for traumatic brain injury

4. ICF in brain injury rehabilitation. An overview

From the ICF perspective, rehabilitation medicine can be defined as the interdisciplinary management of a person's functioning and health. Rehabilitation therefore aims to enable people experiencing or likely to experience disability to *achieve and maintain optimal functioning*. At the same time, functioning is not considered as the consequence of a disease, but rather as the human experience that is the result of the *dynamic interaction* between a health condition and both personal and environmental factors (contextual factors). Assessment of functioning is the starting point of a patient and goal oriented, evidence-based and iterative rehabilitation process (Stucki et al., 2007).

The ICF as a conceptual model and ICF-based tools, such as ICF Core Sets, as practical instruments may contribute to a more holistic and structured description of functioning of persons after brain injury (BI). For example, the current data indicate that ICF can be useful in classifying the currently used assessment scales in traumatic brain injury (Cameron et al., 2009). It also allows a standardised and comprehensive analysis of health and health-related consequences, fully applicable to the rehabilitation after BI. Particularly in the area of neurorehabilitation, it may contribute to the evaluation of deficits and identification of treatment goals and targets for intervention (Bilbao et al., 2003). A special additional value of the ICF is seen in its capacity to describe and categorise the environmental factors relevant for rehabilitation (Fries et al., 2008). The rehabilitation programmes designed for patients with BI have to include assessment and treatment of the contextual factors and there is a need for development of the instruments that can quantify these factors. The information about functioning collected using the ICF could be also used to identify needs, match patients to interventions, track functioning over time, measure clinical outcomes and monitor treatment effectiveness.

The applicability of the ICF in brain injured patients was explored in at least fourteen articles published from 2002 to 2010. One article from 2003 generally discusses the applicability of the ICF model to brain injury concluding that it is a potentially useful tool to adequately classify and assess functioning and disability, related to TBI. Two articles are related to the development of the ICF Core Set for traumatic brain injury (TBI) discussing the need for having a practical ICF-based tool to describe functioning of TBI patients which would at the same time allow clinicians to adopt a comprehensive and holistic approach. The Italian clinical perspective on the potential of ICF core set for TBI argues that ICF makes it possible to describe in a systematic way not only body functions and structures, but also the activities and participation and the influence of the environmental factors. Another study tested the applicability of the ICF checklist for the description of patients with TBI. The authors concluded that although the checklist can be practical for clinical work, an ICF core set for TBI would be more adequate. Two other articles discuss the application of the ICF model for treatment of communication and cognitive disorders following the TBI. Larkins suggests that the ICF supports a systematic approach for understanding cognitive-communication disorders in persons with TBI and presents an example of the application of the ICF in such patients. Worrall and associates, however, point out that the WHO classification scheme simplifies the real-life communication and can be more useful for a generic description of communicational functioning rather than a individualized one. One study analyzed the possible benefits of the ICF for the description of functioning of returning war veterans who frequently suffer from the consequences of a traumatic brain injury. The author argues that ICF can help to refine the understanding of the challenges the

veterans have to confront after coming back. This can assist in making more appropriate decisions for allocation of resources, and for the development and implementation of therapies and rehabilitation interventions. One study summarized the available evidence on the use of the ICF to describe the functioning of severely brain injured persons and concluded that in light of available evidence, the ICF is a useful tool that describes the functioning and needs of patients with TBI. The authors point out that a wider utilization of the ICF can help to allocate resources in order to reach the improvement of the quality of life of patients with TBI. Quality of life is also a concern in another article by Pierce and Hanks. They tested whether the description of functioning based on the ICF can predict life satisfaction, concluding that a combination of ICF components and demographic factors significantly predicted life satisfaction. The study performed by Ehrenfors and associates examined the widely used assessment instruments for description of functioning of school-aged children with traumatic brain injury through the ICF lens. In their opinion widely used assessment instruments do not cover essential aspects of functioning and disability. An ICF-based questionnaire was developed for TBI patients by a group of Dutch researchers to assess activities and participation (Ptyushkin et al., 2010).

An important additional value of the ICF is seen in its capacity to describe and categorize environmental factors relevant for rehabilitation. Current rehabilitation programs designed for patients with TBI, it has been suggested, have to include assessment and response to contextual factors and there is a need for the development of instruments that can quantify these factors. The role of the ICF in this conceptual shift is discussed.

Finally, Whyte suggests that the direction brain injury research will take depends on a variety of factors and is guided in part by underlying theory and in part depends on the location of the target of treatment and how it is classified in the ICF. Recent data also indicate that ICF can be useful in classifying the currently used assessment scales for traumatic brain injury (Whyte, 2009).

5. Linking medical records of a patient with brain injury to the ICF.

A case study

ICF allows to create individual functional profiles of persons with any health condition. Such profiles can be especially valuable when dealing with the complicated and multifaceted health conditions like brain injury. Depending on the purpose when applying ICF in brain injury rehabilitation one can create an ICF profile of a patient either from the start or by linking the already existing medical records to the ICF. An example of the latter is presented below (Ptyushkin et al., 2009).

Medical records of a patient after brain injury caused by a traffic accident that took place in April, 2008, who was admitted to the University Rehabilitation Institute (URI) of the Republic of Slovenia in July, 2008, were linked to the ICF. The patient was male, 31 years old at the time of admission, and his Glasgow Coma Scale score after the accident was 6. He was admitted to our Institute after the acute treatment with 8 different diagnoses, all of them corresponding to the ICD section "S" ("Injury, poisoning and certain other consequences of external causes"). Information about functioning at admission and discharge was entered separately. Medical records comprised the admission and discharge form and the reports from physiotherapist, occupational therapist, speech therapist and psychologist.

The medical records, which were mostly in text format, were linked to the ICF using the so-called linking rules. The process was divided into the following stages:

- identification of the meaning unit – a short phrase or sentence that describes one concrete aspect of functioning;
- linking of the meaning unit to the ICF code; and
- selection of the appropriate qualifier.

An example of the linking process is shown in Table 3. Additionally, the Functional Independence Measure (FIM), which had been previously linked to the ICF by a group of experts at the level of code in the current study (4, 5, 6), was linked to the level of qualifier. The correspondence of the FIM scores to the ICF qualifiers is presented in Table 4. For practical purposes, it was assumed that the higher level of dependence by FIM, the higher the level of the problem.

Source	Report from psychologist
Meaning unit	...“marked decrease in attention”...
Correspondent ICF Code	b140 Attention functions
Correspondent qualifier	3 (serious problem – “marked”)

Table 3. Identification of a meaning unit and linking it to the ICF code and qualifier.

FIM score	ICF qualifier
1	4
2	3
3	3
4	2
5	1
6	1
7	0

Table 4. Correspondence of FIM scores to the ICF qualifiers.

Obtained ICF-based functional profile of a patient is presented in Table 5. The profile describes functioning of the patient at the admission and at the discharge. The majority of functional problems of a patient at the level of “body functions” were found in the domains of mental functions and movement-related functions. Within the list of “activities and participation”, the patient experienced more difficulties with acquiring skills, communication and activities, related to mobility and self-care. Several relevant environmental factors were identified as well.

In this particular example ICF did not provide any additional information about functioning of a patient, as all the information was taken from the existing medical records. Nevertheless, ICF provided structure to the large amount of diverse information and gave a clear, easy and holistic view of all the different aspects of functioning reflected in different reports and documents.

This case study also demonstrates some weak points of the medical documentation. For example, almost no information was found in the medical records regarding activities, related to the daily life (chapter 6 – Domestic life, which includes preparing meals, caring for

Code	Description	Admission	Discharge
		ICF qualifier	ICF qualifier
b1	MENTAL FUNCTIONS		
b110	Consciousness functions General mental functions of the state of awareness and alertness, including the clarity and continuity of the wakeful state.	0	0
b114	Orientation functions General mental functions of knowing and ascertaining one's relation to self, to others, to time and to one's surroundings.	3	1
b140	Attention functions Specific mental functions of focusing on an external stimulus or internal experience for the required period of time.	3	3
b144	Memory functions Specific mental functions of registering and storing information and retrieving it as needed.	3	1
b156	Perceptual functions Specific mental functions of recognizing and interpreting sensory stimuli.	0	0
b167	Mental functions of language Specific mental functions of recognizing and using signs, symbols and other components of a language.	3	1
b2	SENSORY FUNCTIONS AND PAIN		
b230	Hearing functions Sensory functions relating to sensing the presence of sounds and discriminating the location, pitch, loudness and quality of sounds.	8	8
b5	FUNCTIONS OF THE DIGESTIVE, METABOLIC AND ENDOCRINE SYSTEMS		
b510	Ingestion functions Functions related to taking in and manipulating solids or liquids through the mouth into the body.	1	0
b525	Defecation functions Functions of elimination of wastes and undigested food as faeces and related functions.	0	0
b6	GENITOURINARY AND REPRODUCTIVE FUNCTIONS		
b620	Urination functions Functions of discharge of urine from the urinary bladder.	0	0
b7	NEUROMUSCULOSKELETAL AND MOVEMENT RELATED FUNCTIONS		
b710	Mobility of joint functions Functions of the range and ease of movement of a joint.	1	1
b730	Muscle power functions Functions related to the force generated by the contraction of a muscle or muscle groups.	8	8
b750	Motor reflex functions Functions of involuntary contraction of muscles automatically induced by specific stimuli.	2	1
s	BODY STRUCTURES		
s2	THE EYE, EAR AND RELATED STRUCTURES	8	8
s610	Structure of urinary system	8	8
s750	Structure of lower extremity	8	8
s550	Structure of pancreas	8	8
s420	Structure of immune system	8	8
d	ACTIVITIES AND PARTICIPATION		
d155	Acquiring skills Developing basic and complex competencies in integrated sets of actions or tasks so as to initiate and follow through with the acquisition of a skill, such as manipulating tools or playing games like chess.	Cap 3	Cap 1
d166	Reading Performing activities involved in the comprehension and interpretation of written language (e.g. books, instructions or newspapers in text or Braille), for the purpose of obtaining general knowledge or specific information.	Cap 0 Per 0	Cap 0 Per 0
d175	Solving problems Finding solutions to questions or situations by identifying and analysing issues, developing options and solutions, evaluating potential effects of solutions, and executing a chosen solution, such as in resolving a dispute between two people.	Cap 3	Cap 1
d3	COMMUNICATION		
d310	Communicating with - receiving - spoken messages Comprehending literal and implied meanings of messages in spoken language, such as understanding that a statement asserts a fact or is an idiomatic expression.	Cap 3	Cap 1
d350	Conversation Starting, sustaining and ending an interchange of thoughts and ideas, carried out by means of spoken, written, sign or other forms of language, with one or more people one knows or who are strangers, in formal or casual settings.	Cap 1 Per 1	Cap 1 Per 1
d4	MOBILITY		

d410	Changing basic body position Getting into and out of a body position and moving from one location to another, such as getting up out of a chair to lie down on a bed, and getting into and out of positions of kneeling or squatting.	Cap 1 Per 1	Cap 1 Per 1
d420	Transferring oneself Moving from one surface to another, such as sliding along a bench or moving from a bed to a chair, without changing body position.	Cap 1 Per 1	Cap 1 Per 1
d440	Fine hand use Performing the coordinated actions of handling objects, picking up, manipulating and releasing them using one's hand, fingers and thumb, such as required to lift coins off a table or turn a dial or knob.	Cap 1 Per 1	Cap 0 Per 0
d450	Walking Moving along a surface on foot, step by step, so that one foot is always on the ground, such as when strolling, sauntering, walking forwards, backwards, or sideways.	Cap 3 Per 2	Cap 1 Per 1
d455	Moving around Moving the whole body from one place to another by means other than walking, such as climbing over a rock or running down a stree, skippin, scapering, jumping, somersaulting or running around obstacles.	Cap 1 Per 1	Cap 1 Per 1
d460	Moving around in different locations Walking and moving around in various places and situations, such as walking between rooms in a house, within a building, or down the street of a town.	Cap 1 Per 1	Cap 1 Per 1
d465	Moving around using equipment Moving the whole body from place to place, on any surface or space, by using specific devices designed to facilitate moving or create other ways of moving around, such as with skates, skis, or scuba equipment, or moving down the street in a wheelchair or a walker.	Cap 9	Cap 0
d5	SELF-CARE		
d510	Washing oneself Washing and drying one's whole body, or body parts, using water and appropriate cleaning and drying materials or methods, such as bathing, showering, washing hands and feet, face and hair, and drying with a towel.	Cap 1 Per 1	Cap 1 Per 1
d520	Caring for body parts Looking afer those parts of the body, such as skin, face, teeth, scalp, nails and genitals, that require more than washing and drying.	Cap 1 Per 1	Cap 1 Per 1
d530	Toileting Planning and carrying out the elimination of human waste (menstruation, urination and defecation), and cleaning oneself afterwards.	Cap 1 Per 1	Cap 1 Per 1
d540	Dressing Carrying out the coordinated actions and tasks of putting on and taking off clothes and footwear in sequence and in keeping with climatic and social conditions, such as by putting on, adjusting and removing shirts, skirts, blouses, pants, undergarments, saris, kimono, tights, hats, gloves, coats, shoes, boots, sandals and slippers.	Cap 1 Per 1	Cap 1 Per 1
d550	Eating Carrying out the coordinated tasks and actions of eating food that has been served, bringing it to the mouth and consuming it in culturally acceptable ways, cutting or breaking food into pieces, opening bottles and cans, using eating implements, having meals, feasting or dining.	Cap 1 Per 1	Cap 0 Per 0
d560	Drinking Taking hold of a drink, bringing it to the mouth, and consuming the drink in culturally acceptable ways, mixing, stirring and pouring liquids for drinking, opening bottles and cans, drinking through a straw or drinking running water such as from a tap or a spring; feeding from the breast.	Cap 1 Per 1	Cap 0 Per 0
d7	INTERPERSONAL INTERACTIONS AND RELATIONSHIPS	Cap 3 Per 3	Cap 1 Per 1
e1	PRODUCTS AND TECHNOLOGY		
e120	Products and technology for personal indoor and outdoor mobility and transportation Equipment, products and technologies used by people in activities of moving inside and outside buildings, including those adapted or specially designed, located in, on or near the person using them.	9	+3
e3	SUPPORT AND RELATIONSHIPS		
e310	Immediate family Individuals related by birth, marriage or other relationship recognized by the culture as immediate family, such as spouses, partners, parents, siblings, children, foster parents, adoptive parents and grandparents.	+8	+8
e355	Health professionals All service providers working within the context of the health system, such as doctors, nurses, physiotherapists, occupational therapists, speech therapists, audiologists, orthotist-prosthetists, medical social workers.	+8	+8
e5	SERVICES, SYSTEMS AND POLICIES		
e580	Health services, systems and policies Services, systems and policies for preventing and treating health problems, providing medical rehabilitation and promoting a healthy lifestyle.	+8	+8

Table 5. ICF-based functional profile of the patient (Cap=capacity, Per=performance).

household objects, doing housework etc.), interpersonal interactions and relationships, major life areas (which include education, work and employment, and economic life) and community, social and civic life (which includes recreation and leisure, religion and spirituality).

Little information was also found concerning the relevant environmental factors. Those that were identified correspond to “products and technology for daily use” and “support and relationships”. Health professionals and “health services, systems and policies” were also found to be the facilitating environmental factors. Rehabilitation had a positive influence mostly on functions of language and memory and activities that are related to mobility and self-care. Some of these are difficult to assess in a rehabilitation hospital, since the patient has to stay at home for some time in order to comprehend the extent of problems with these activities. The impact of the environment is also difficult to assess before the patient has been living at home for a while. Before finishing the rehabilitation, patients usually go home for a weekend to face the reality. After such visits, clinicians should describe the problems that the patients had at home better and be able to suggest feasible solutions. The later should also be written in the medical records.

Many areas could not be assessed specifically. The qualifier “8” (standing for “not specified”) was used due to the fact that particular aspects of functioning are not described sufficiently enough to determine the scale of the problem or the role of an environmental factor. In these areas, it was also not possible to demonstrate any improvement. Clinicians will have to find appropriate outcome measures for assessing these categories.

Another advantage of the ICF lies in its easy and language-independent format that is especially important in the united Europe and the globalised world of today. Being neutral, ICF also underlines the strong sides of an individual that are important for rehabilitation and further functioning. However, little information was found in relation with the environmental factors.

Therefore even in cases when conventional medical records have been already created ICF may help to structure the information about functioning in a clear, easy and holistic way. The study revealed that some aspects of functioning are currently not sufficiently described in the medical records. In the future, ICF could help professionals to draw more attention to the important aspects of functioning and the environmental factors relevant for functioning.

6. ICF as a tool to organize clinical information and evaluate the outcome of rehabilitation

Another retrospective study conducted in Slovenia involved analysis of the medical records of 100 patients with brain injury admitted to the URI. Its goal was to explore to what extent the ICF can be a useful tool to organize existing clinical information and to retrospectively evaluate the effect of interventions in patients with BI (Ptyushkin et al. 2010).

Overall (i.e., for all the patients included in the study, at admission and/or at discharge), 51 codes for body functions, 22 for body structures, 62 for activities and participation, and 35 relevant environmental factors were identified. They are presented in the Tables 6-9 below.

As it can be seen from Table 6, three major groups of functional problems corresponding to the list of *body functions* were identified: related to mental functions (15 out of 51 codes or nearly 30%), related to sensory functions (12 out of 51 codes or nearly 24%), and related to mobility (8 out of 51 codes or nearly 16%). Functional problems were also frequently found for speech (b310, b320 and b330). Major improvements were found regarding *orientation*

functions (b114), energy and drive functions (b130), memory functions (b144), mental functions of language (b167), vestibular functions (b235), sensation of pain (b280), voice and articulation functions (b310 and b320), ingestion functions (b510), defecation and urination functions (b525 and b620), mobility and muscle power functions (b710 and b730), and control of voluntary movement functions (b760). Little or no changes were observed for most of the mental functions. Worsening of a body function was detected in three patients - one in *perceptual functions* (b156), one in *sensation of pain* (b280), and one in *control of voluntary movement functions* (b760).

ICF code	Description	Described at admission	Described at admission as a problem	At discharge			
				Improvement	Worsening	No change	Unclear
Mental functions							
b110	Consciousness functions	100	0	0	0	100	0
b114	Orientation functions	89	63	22	0	66	1
b117	Intellectual functions	23	18	3	0	20	0
b126	Temperament and personality functions	44	38	2	0	42	0
b130	Energy and drive functions	61	22	10	0	51	0
b134	Sleep functions	6	5	0	0	5	1
b140	Attention functions	77	75	4	0	72	1
b144	Memory functions	97	93	33	0	64	0
b147	Psychomotor functions	18	16	2	0	10	6
b152	Emotional functions	48	39	5	0	42	1
b156	Perceptual functions	26	18	1	1	23	1
b160	Thought functions	32	30	0	0	31	1
b164	Higher-level cognitive functions	59	46	2	0	57	0
b167	Mental functions of language	95	79	34	0	61	0
b172	Calculation functions	3	3	0	0	2	1
Sensory functions							
b210	Seeing functions	32	32	2	0	26	4
b215	Functions of structures adjoining the eye	4	4	0	0	4	0
b230	Hearing functions	19	18	0	0	18	1
b235	Vestibular functions	55	53	23	0	21	11
b240	Sensations associated with hearing and vestibular function	16	16	1	0	13	2
b250	Taste function	5	4	1	0	4	0
b255	Smell function	7	6	0	0	7	0
b265	Touch function	2	2	1	0	1	0
b280	Sensation of pain	49	45	10	1	31	7
Voice and speech							
b310	Voice functions	12	12	6	0	6	0
b320	Articulation functions	28	21	9	0	19	0

b330	Fluency and rhythm of speech functions	26	23	4	0	22	0
Different organs functions							
b410	Heart functions	11	3	1	0	9	1
b415	Blood vessel functions	1	1	0	0	1	0
b420	Blood pressure functions	20	14	0	0	20	0
b430	Hematological system functions	2	1	0	0	2	0
b440	Respiration functions	7	5	0	0	7	0
b510	Ingestion functions	100	83	43	0	57	0
b525	Defecation functions	100	54	29	0	71	0
b530	Weight maintenance functions	3	3	0	0	3	0
b540	General metabolic functions	1	1	1	0	0	0
b550	Thermoregulatory functions	1	0	0	0	1	0
b555	Endocrine gland functions	5	5	0	0	5	0
b620	Urination functions	100	57	33	0	67	0
Mobility-related functions							
b710	Mobility of joint functions	69	50	19	0	43	7
b730	Muscle power functions	80	72	29	0	38	13
b735	Muscle tone functions	33	16	3	1	23	6
b750	Motor reflex functions	32	16	3	0	26	3
b755	Involuntary movement reaction functions	11	11	2	0	5	4
b760	Control of voluntary movement functions	20	16	9	1	8	2
b765	Involuntary movement functions	1	1	1	0	0	0
b770	Gait pattern functions	1	1	1	0	0	0
b8	FUNCTIONS OF THE SKIN AND RELATED STRUCTURES	1	1	0	0	1	0

Table 6. Body Functions (all values are no. of cases, which equal percentages since n=100).

Table 7 shows that the general profile of the patients regarding body structures corresponds to the diagnoses according to the ICD-10. Some of the structures are related to the TBI itself or concomitant injuries (structure of the brain and spinal cord, structure of head and neck region and extremities). Others (like structure of cardiovascular or respiratory system) reflect the comorbidities of the patient.

Restrictions in activities and participation (Table 8) were frequently found in *acquiring skills* (d155), *reading and writing* (d166 and d170), *solving problems* (d175) and *undertaking a task* (d210 and d220). Another group of common restrictions is related to communication - *receiving messages* (d310 and d315), *speaking* (d330), *writing messages* (d345) and *conversation* (d350). Frequently there were also disturbed activities related to mobility (*changing and maintaining a body position, transferring oneself, walking and moving around*) and very

ICF code	Description	Described at admission	Described at admission as a problem	At discharge			
				Improvement	Worsening	No change	Unclear
s110	Structure of brain	100	100	1	0	87	12
s120	Spinal cord and related structures	2	2	0	0	2	0
S2	THE EYE, EAR AND RELATED STRUCTURES	7	7	0	0	7	0
s3200	Teeth	1	1	0	0	1	0
s410	Structure of cardiovascular system	11	11	0	0	10	1
s420	Structure of immune system	1	1	0	0	1	0
s430	Structure of respiratory system	7	7	0	0	7	0
s550	Structure of pancreas	1	1	0	0	1	0
s610	Structure of urinary system	2	2	0	0	2	0
s630	Structure of reproductive system	1	1	0	0	1	0
s710	Structure of head and neck region	26	26	0	0	25	1
s720	Structure of shoulder region	4	4	0	0	4	0
s730	Structure of upper extremity	10	10	0	0	10	0
s740	Structure of pelvic region	1	1	0	0	1	0
s750	Structure of lower extremity	20	20	3	1	15	1
s760	Structure of trunk	9	9	0	0	9	0
S8	SKIN AND RELATED STRUCTURES	32	32	0	0	27	5

Table 7. Body Structures (all values are no. of cases, which equal percentages since n=100).

frequently those related to self-care (d510-d570). Finally problems were found frequently in the areas of interpersonal relationships (d710 – d770), *in acquiring, keeping and terminating a job* (d845) and *recreation and leisure* (d920).

Considerable improvements at the discharge were detected in the following areas: *acquiring skills, solving problems and receiving spoken messages, mobility* (d410-d460) and *self-care* (d510 – d560). Improvement was also found for *general interpersonal interactions* (d7). Worsening was frequently found for *driving* (d475). Worsening was also found once for *complex interpersonal interactions* (d720), *formal relationships* (d740) and *acquiring, keeping and terminating of a job* (d845).

Based on the medical records, 35 environmental factors were identified in the 100 studied individuals. Twenty of them, which are presented in Table 9, were present in the majority of patients. Some of those environmental factors may act both as facilitators and barriers in different patients. For example, the role of the *immediate family* (e310) may be either a strong facilitator or equally strong barrier for rehabilitation.

ICF code	Description	Described at admission	Described at admission as a problem	At discharge			
				Improvement	Worsening	No change	Unclear
d110	Watching	4	3	1	0	3	0
d115	Listening	5	4	2	0	3	0
d155	Acquiring skills	96	91	34	0	62	0
d166	Reading	27	20	3	0	22	2
d170	Writing	34	26	5	0	27	2
d172	Calculating	10	9	1	0	9	0
d175	Solving problems	96	91	34	0	60	2
d210	Undertaking a single task	24	14	4	0	19	1
d220	Undertaking multiple tasks	24	18	3	0	19	2
d230	Carrying out daily routine	26	19	11	0	13	2
d310	Communicating with - receiving - spoken messages	96	80	33	0	63	0
d315	Communicating with - receiving - nonverbal messages	23	19	9	0	14	0
d330	Speaking	26	15	7	0	19	0
d335	Producing nonverbal messages	2	1	2	0	0	0
d345	Writing messages	31	28	2	0	26	3
d350	Conversation	36	29	6	0	28	2
d360	Using communication devices and techniques	2	2	0	0	1	1
d410	Changing basic body position	100	88	40	0	60	0
d415	Maintaining a body position	26	17	10	0	15	1
d420	Transferring oneself	100	80	43	0	57	0
d430	Lifting and carrying objects	1	1	0	0	1	0
d440	Fine hand use	100	83	43	0	57	0
d450	Walking	81	60	45	1	34	1
d455	Moving around	89	75	41	0	48	0
d460	Moving around in different locations	88	72	51	0	37	0
d465	Moving around using equipment	14	11	5	0	5	4
d475	Driving	34	33	0	14	19	1
d510	Washing oneself	100	93	52	0	48	0
d520	Caring for body parts	100	88	45	0	55	0
d530	Toileting	100	82	41	0	59	0
d540	Dressing	100	89	49	0	51	0
d550	Eating	100	83	43	0	57	0
d560	Drinking	100	83	43	0	57	0
d570	Looking after one's health	11	6	3	0	8	0
d630	Preparing meals	1	1	1	0	0	0
d640	Doing housework	6	5	2	0	3	1
d660	Assisting others	1	0	1	0	0	0

D7	INTERPERSONAL INTERACTIONS AND RELATIONSHIPS	95	86	34	0	60	1
d710	Basic interpersonal interactions	15	6	3	0	11	1
d720	Complex interpersonal interactions	15	10	4	1	10	0
d730	Relating with strangers	4	1	0	0	4	0
d740	Formal relationships	26	7	3	1	22	0
d750	Informal social relationships	5	0	0	0	5	0
d760	Family relationships	6	2	0	0	6	0
d770	Intimate relationships	1	1	0	0	1	0
d810	Informal education	1	1	0	0	1	0
d820	School education	5	4	1	0	3	1
d830	Higher education	4	4	0	0	4	0
d845	Acquiring, keeping and terminating a job	39	35	0	1	28	10
d850	Remunerative employment	1	1	0	0	1	0
d920	Recreation and leisure	13	10	1	0	10	2
d950	Political life and citizenship	1	1	0	0	1	0

Table 8. Activities and Participation – Performance (all values are no. of cases, which equal percentages since n=100).

After linking, it became clear that the three major groups of functional problems regarding *body functions* in patients after TBI are related to mental functions, sensory functions and mobility. Another important group is related to speech. The improvements found at the end of rehabilitation for mobility-related functions (b710-b770), and in some patients for speech functions, can be explained by the fact that the current rehabilitation program is mainly focused on these particular aspects of functioning. At the same time much less improvement was observed for mental functions with the exception of orientation, energy and drive functions and memory, although the patients were assessed and advised by a psychologist. This important difference in the evolution of mental and physical consequences is very common in patients after the TBI. It can be also related to the fact that the time of rehabilitation is usually too short to produce and detect substantial changes at the level of mental functions.

The general profile of patients regarding *body structures* corresponded to the diagnoses according to the ICD-10. Some of the structures are related to the TBI itself or concomitant injuries (structure of the brain and spinal cord, structure of head and neck region and extremities). Others (like structure of cardiovascular or respiratory system) reflect the comorbidities of the patient.

Restrictions in *activities and participation* found in the study were frequently caused by or related to the disturbances in *mental functions* (like *acquiring skills, reading and writing, solving problems and undertaking a task*) and generally show little to moderate changes from the admission to the discharge. Another large group of restricted *activities and participation* which showed considerable improvement was related to mobility functions (11 out of 62 codes or nearly 18%). Notable improvements were also found in activities related to self-care and this can be explained by the fact that the work of nurses and occupational therapists involved in the process of rehabilitation is mainly focused on these aspects of

Environmental factors			
Barriers		Facilitators	
e155	Design, construction and building products and technology of buildings for private use	e110	Products or substances for personal consumption
e165	Assets	e115	Products and technology for personal use in daily living
e210	Physical geography	e120	Products and technology for personal indoor and outdoor mobility and transportation
e310	Immediate family	e310	Immediate family
e460	Societal attitudes	e320	Friends
e525	Housing services, systems and policies	e330	People in positions of authority
e570	Social security services, systems and policies	e355	Health professionals
e575	General social support services, systems and policies	e410	Individual attitudes of immediate family members
		e570	Social security services, systems and policies
		e575	General social support services, systems and policies
		e580	Health services, systems and policies
		e585	Education and training services, systems and policies

Table 9. The Environmental Factors found to be relevant for the majority of patients.

functioning. More serious problems described for *driving* at the discharge were not because at the admission the driving abilities of the patients were necessarily better, but because during the rehabilitation they were found insufficient, often after being tested on the driving simulator and this was clearly stated at the time of the discharge.

Some of the relevant environmental factors identified in the study may act both as facilitators and barriers in different patients. For example, the role of the immediate family (e310) may be either a strong facilitator of equally strong barrier for rehabilitation. The potential of the ICF to describe the impact of the environmental factors is an important strength of the classification and ICF-based tools. However, it should be mentioned that the study also revealed that insufficient attention is still drawn to the role of environmental factors for rehabilitation and after rehabilitation life of an individual. This can be due to the lack of suitable instruments for describing the environment. Gathering information about the environmental factors in a systematic and internationally standardized way can help take the influences of the environment more into consideration at all levels, and the ICF may be helpful in this respect.

The ICF also structures the large amount of information and provides a clear, easy and holistic view of all different aspects of functioning, reflected in different reports and documents. Another advantage of the ICF is in its easy and language-independent format that is especially important in a united Europe and globalized world of today. Being neutral, ICF can also underline the strong sides of an individual important for rehabilitation and further functioning. Frequent use of the qualifier "8" ("not specified") is mainly related to the fact that particular aspects of functioning are not described sufficiently enough to determine the scale of

the problem or the role of an environmental factor. At the same time, the value of the qualifier "not specified" should not be underestimated as it draws attention to a particular aspect of functioning where based on the available information the level of the problem cannot be clearly defined. Activities and participation related with the daily life that are especially important for functioning after discharge (like Chapter 6, Domestic life, and Chapter 9, Community, social and civic life) were poorly described in the medical records. This indicates that still not enough attention is drawn to these aspects of human functioning during rehabilitation. We assume that in some cases it is very difficult if not impossible to assess these aspects of functioning during the hospitalization and it is only possible to predict that difficulties will be there when a person is back in his or her common environment.

A strength of the ICF is also in its capacity to describe the consequences of the comorbidities, i.e., conditions that are not related to the main condition (TBI).

In general it can be said that substantial improvement was found for those functions, activities and participation, the current rehabilitation program is focused on. Therefore the ICF may help in modifying the existing programs or adapting them to the individual cases.

7. Conclusions

Use of the ICF in brain injury rehabilitation interactively models functioning and disability associated with this health condition. The appropriate tools for daily practice such as ICF Core Sets for Traumatic Brain Injury allow to apply this interactive holistic approach into practice. ICF-based rehabilitation of the persons after brain injury facilitates truly interdisciplinary work by providing a common framework for all professionals involved in rehabilitation of such a patient. Practical ICF tools can allow specialists to speak the common professional language and extend the boundaries of rehabilitation making the whole process highly individualized on solving problems of a concrete patient though rigorously standard.

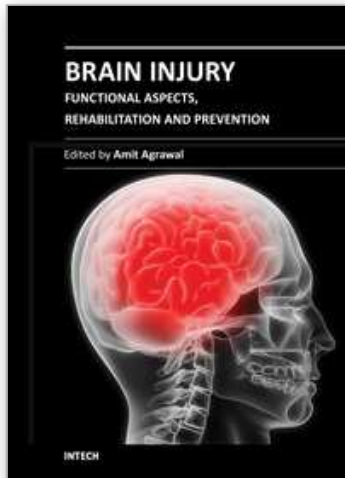
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The present two volume book "Brain Injury" is distinctive in its presentation and includes a wealth of updated information on many aspects in the field of brain injury. The Book is devoted to the pathogenesis of brain injury, concepts in cerebral blood flow and metabolism, investigative approaches and monitoring of brain injured, different protective mechanisms and recovery and management approach to these individuals, functional and endocrine aspects of brain injuries, approaches to rehabilitation of brain injured and preventive aspects of traumatic brain injuries. The collective contribution from experts in brain injury research area would be successfully conveyed to the readers and readers will find this book to be a valuable guide to further develop their understanding about brain injury.

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