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Case Report

Feasibility and Clinical Utility of ICF Framework in Critical ill Patients: Case Report

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Abstract

Some authors have suggested the use of International Classification of Functioning, Disability and Health (ICF) in acute hospital setting and in intensive care unit (ICU) setting as a conceptual framework, however there are no reports of its application in daily clinical practice in ICU. The aim of this study was to show the feasibility and clinical utility of 12 selected categories of the ICF framework in two critically ill patients at different time points (pre-ICU, ICU admission, ICU awakening and ICU discharge). The application of ICF framework in two critical patients was feasible and had clinical utility because it provides order, synthesis and scored the impairment that limit functional mobility in critical patients. Futures clinimetric studies are now required to validate the psychometric properties of ICF-based score in ICU.

ABBREVIATIONS

ICF: International Classification of Functioning, Disability and Health; ICU: Intensive Care Unit; MRC SS: Medical Research Council Sum Score; FSS-ICU: Functional Status Score for the Intensive Care Unit; S5Q: Standardized Five Questions; ECMO: Extracorporeal Membrane Oxygenation Support; $ECCO_2$-R: Extra corporeal Carbon Dioxide Removal; HFOV: High Frequency Oscillatory Ventilation; IMV: Invasive Mechanical Ventilation; NIV: Non-Invasive Ventilation; ARDS: Acute Respiratory Distress Syndrome; OI: Oxygenation Index; ICU-AW: Intensive Care Unit Acquired Weakness

INTRODUCTION

Patients in developed countries now have a higher likelihood of surviving acute injury or illness [1]. However, recovery may be marred by significant loss of functioning [2]. Several factors are increasing the risk for future disability in patients in the acute hospitalization, e.g. prolonged stay at intensive care old age or previous frailty. Therefore, the healthcare professionals in the intensive care unit (ICU) should be able to make a assessment of their patient´s functioning so as to identify those patients who are especially vulnerable to future disability and set in motion timely strategies for recognize their subsequent rehabilitation needs [3]. To this end, there must be defined standards for to report and how to measure functioning and disability [4,5].

Particularly, physical functioning takes into account: the quality and quantity of daily activities a person can carry out, among which is mobility of the whole body, with the latter being one of the main goals in kinesiological intervention, which some authors have termed functional mobility [6,7].

A conceptual framework, the International Classification of Functioning, Disability and Health (ICF) [8,9], encompases four domains: Body Functions/Structures, Activities/Participation, Environmental Factors and Personal Factors. The ICF is a part of the family of international classifications of the World Health Organization (WHO) to provides a common language and framework for describing and classifying health and disability [10,11].

Some authors have suggested the use of ICF in acute hospital setting [12,13] and in ICU setting [4,14,15] as a conceptual framework. However, there have been no reports of application of the ICF framework in ICU daily clinical practice as part of a care process and none have shown the clinical utility it would have for order, synthesize and categorize the assessment and intervention of critical patients.

For the use of the ICF framework, core sets have been suggested as a group of categories selected for different health conditions [3,16]. The core set that most closely resembles the critical patient's health status is the "cardiopulmonary conditions in acute care" [16], that includes 48 ICF framework categories. We selected 8 categories of this core set and added 4 according to the assessment needs of role and work of the kinesiologist in intensive care at this center. These 12 categories were most applicable to the ICU setting.

The aim of this study was to show the feasibility and clinical utility of 12 selected categories of the ICF framework in two critically ill patients at pre-ICU, ICU admission, ICU awakening and ICU discharge on a medical intensive care unit (MICU). This is the first study showing the use of the ICF framework in daily critical care practice.

CASE PRESENTATION

Patients were admitted to the MICU with the medical diagnosis of Influenza A/H1N1-ARDS.

Selected "ICU functions" are shown in Table 1. Lung appearance on chest x-ray and muscle appearance on ultrasound were representative of "ICU structures" according to the ICF classification (see Table 2). "Pre-ICU activities" were assessed according to the Clinical Frailty Scale (see Table 3) and Functional Mobility was scored according to the FSS-ICU scale (see Table 4).

The alphanumeric codes proposed by the ICF are essential for its use and understanding. Each selected category was scored according to the proposal of the ICF, from 0 to 4 points, where 0 is without problem and 4 complete problem. Score 8 means not specified and 9 means not applicable [8].

The instruments used in the cases were Clinical Frailty Scale (CFS) [17,18], Standardized Five Questions (S5Q)[19], Medical Research Council Sum Score (MRC SS) [20-22], Functional Status Score for the Intensive Care Unit (FSS-ICU) [6,23] and Heckmatt score(24). More details of each instrument is shown in the appendix.

The main patients characteristics are described in Table 5 and the results of the application of the clinical assessment based on ICF for our ICU are shown in Table 6. The patients signed informed consent to use their records and data in this study.

Case 1

Pre-ICU: A 85-year-old retired man who served as a lawyer and he lives with his wife and 2 children has premorbid disease of arterial hypertension, multiple myeloma and cardiac arrhythmia due to atrial fibrillation. Previous activity level was 4 points of the CFS and therefore corresponds to a mild difficulty. In relation to other activities he had mild watching difficulty because he required the use of reading glasses and moderate difficulty to move around in different places due he does it in a slower way and has suffered 2 falls in the last year.

Fifteen days prior to MICU admission presents influenza, characterized by general condition compromise, non-productive irritative cough and fever.

ICU admission: At MICU admission he enters in regular general conditions, awake and full cooperation. Patient is diagnosed after admission with Influenza A/H1N1-ARDS. On physical examination the patient was dyspnoeic, with respiratory rate of 32 breaths per minute and peripheral oxygen saturation of 91% on room air. APACHE II at MICU admission (first 24 hours) was 18 points. Non invasive ventilation (NIV) was chosen to manage hypoxemia and decrease work of breathing. The patient has severe respiratory impairment due to the need for continuous non-invasive ventilation and severe lung structural impairment. NIV did not improve oxygenation levels and respiratory mechanics, so performed endotracheal intubation and invasive mechanical ventilation (IMV). Deep sedation was required to promote lung protection, as evidenced by alteration of gaseous exchange with PaO2/FiO2 ratio of 125 (Moderate ARDS) and oxygenation index (OI) of 15.9. He also had complete airway clearance impairment and an increase in PaCO2.

ICU awakening: After 13 days with invasive mechanical ventilation and 3 failed spontaneous breathing trial he was extubated. This time point began with mild cooperation level impairment and respiratory impairment remained severe because continuous post-extubation NIV was required. This was related to inability to clear airway secretions.

On awakening muscle strength was assessed with an MRC SS of 26/60 points or severe muscle strength impairment, which describes the presence of intensive care unit acquired weakness (ICU-AW). The patient had a FSS-ICU of 1/35 points, showing complete difficulty in all activities (Table 6).

ICU discharge: After 20 days, he leaves of the ICU scoring 5/5 for cooperation level, with moderate respiratory impairment because he still required intermittent NIV in the day and nocturnal ventilation. This may be associated with a mild airway clearance impairment and moderate lung structure impairment. On the other hand, strength improved from severe impairment to a moderate impairment (MRC SS of 44/60 points) and functional mobility performed better in all activities except on walking because it could not be assessed due to weakness (Table 6). The result of the FSS-ICU at ICU discharge was 13/35 points.

Case 2

Pre-ICU: A 63-year-old house wife woman lives with her boyfriend for 3 years without children. It has premorbid history included smoking, daily alcohol consumption, chronic liver disease and body mass index of 31. Futhermore the previous activity level was 3 points of the CFS and therefore corresponds to a "without difficulty". As for other activities, she required reading glasses, had mild difficulty to move around in different places due to knee pain and presents poor family relationships because his direct family lives in another city 849 kilometers away.

After a week of progressive respiratory symptoms (fever, dyspnea, productive and purulent cough) entered a public hospital where she was hospitalized for only one day and then transferred to intensive care unit.

ICU admission: She enters in the MICU in regular general conditions, hemodynamically stable, with deep sedation and neuromuscular blocking agent for first 48 hours. APACHE II at MICU admission was 23 points and the medical diagnosis was

Table 1: Selected ICU functions.

ICF Code	Function[a]	Instrument	No impairments (0)	Mild impairments (1)	Moderate impairments (2)	Severe impairments (3)	Complete impairments (4)
b1102	**Cooperation level**	**S5Q**	5/5 correct answers (full cooperation)	4/5 correct answers (close to full cooperation	3/5 correct answers (moderate cooperation	<3/5 correct answers (no to low cooperation	0/5 correct answers (no cooperation)
b440	**Respiratory function**	**Respiratory support**	Spontaneous ventilation (room air)	Oxygen therapy[a]	Intermittent[b] IMV / NIV	Continued IMV/ NIV	Extracorporeal vital support, (ECMO/ $ECCO_2$-R), HFOV or prone position
b450	**Airway clearence**	**Airway clearence assistance[c] every 12 hours**	No secretion presence or manages your secretions independently	Requires one assistance every 12 hours	Requires assistance 2 times every 12 hours	Requires assistance 3 times every 12 hours	Requires assistance more than 3 times every 12 hours
b7304	**Muscle strength**	**MRC Sum Score**	60 points	48– 59 points	36– 47 points	12-35 points	Less than 12 points

[a]Includes low and high flow oxygen therapy less than 40% of oxygen inspired fraction.
[b]Defined when the patient is able to remain without mechanical ventilation for more than 1 hour.
[c]Includes breathing exercises, chest physiotherapy and instrumental respiratory therapy.
Abbreviations: ICF: International Classification of Functioning, Disability and Health; MRC SS: Medical Research Council Sum Score; S5Q: Standardized Five Questions; ECMO: Extracorporeal Membrane Oxygenation support; $ECCO_2$-R: Extracorporeal Carbon Dioxide Removal; HFOV: High-Frequency Oscillatory Ventilation; IMV: Invasive Mechanical Ventilation; NIV: Non-Invasive Ventilation

Table 2: Selected ICU structures.

ICF Code	Structure	Instrument	No impairments (0)	Mild impairments (1)	Moderate impairments (2)	Severe impairments (3)	Complete impairments (4)
s4301	Lung structure	Quadrant occupied[a] on chest x-ray	Normal Chest x-ray	1 quadrant occupied on chest x-ray	2 quadrant occupied on chest x-ray	3 quadrant occupied on chest x-ray	4 quadrant occupied on chest x-ray
s75002	Muscle structure	Muscle ultrasound (Heckmatt score[b])	Grade 1 in right and left quadriceps	Grade 2 in right or left quadriceps	Grade 2 in right and left quadriceps	Grade 3 in right and/or left quadriceps	Grade 4 in right and left quadriceps

[a]Correspond to infiltrates, pleural effusion atelectasis or other.
[b]Ultrasonic echogenicity was graded according to Heckmatt and colleagues [24,28]. More details of Heckmatt score in appendix.
Abbreviation: ICF: International Classification of Functioning, Disability and Health.

Table 3: Selected pre-ICU activities.

ICF Code	Activity	Instrument	No difficulty (0)	Mild difficulty (1)	Moderate difficulty (2)	Severe difficulty (3)	Complete difficulty(4)
d.	General tasks and demands, mobility, self-care and domestic life	Clinical Frailty Scale[a]	1-3 points	4-5 points	6 points	7 points	8-9 points

[a]Nine-point scale evaluating physical function, activities of daily living, instrumental activity of daily living and assistance for personal care (more details in appendix)
Abbreviation: ICF: International Classification of Functioning, Disability and Health

Influenza A/H1N1-ARDS.

She was admitted with continuous invasive mechanical ventilation, presenting severe respiratory impairment associated to widespread infiltrates on chest x-ray (complete lung structural impairment). The patient develops alteration of gas exchange associated with a PaO2/FiO2 ratio of 94 (severe ARDS) and OI of 20. In addition, she presents complete airway clearence impairment, moderate muscle structural impairment because she had 1,62/1,98 centimeters (left/right quadriceps) both grade 2 on Heckmatt score [24] (Figure 1).

ICU awakening: This time point started without cooperation level impairment, but still with IMV requirement. Four days after awakening is extubated but the respiratory impairment remains severe because she required continuous post-extubation NIV use.

Two days later she required reintubation due to complete airway clearence impairment and by the need for ventilatory support. It was decided to perform a tracheostomy due to difficult ventilatory weaning.

On awakening muscle strength was a MRC SS of 12/60, which describes the presence of ICU acquired weakness. This was related to muscle atrophy as evidence by measuring the quadriceps muscle width 1,65/1,55 centimeters (left/right quadriceps) both

Table 4: Functional mobility based on FSS-ICU score descriptions.

ICF score (points)	FSS-ICU score (description)		
	Points	For: Rolling, supine to sit transfer, sitting edge of bed and sit to stand transfer	For: Walking or wheelchair mobility
Complete difficulty (4)	**0**	Unable to attempt or complete the task due to weakness	
	1	Task is performed but the patient is unable to assist (Dependent)	*Walk <50 feet (15m) with assist of 1 or 2 person for any distance (Total assist)*
Severe difficulty (3)	**2**	Patient performs *≤25% (Maximum assist)*	*Walk ≥50 feet (15m) with assistance of only 1 person (Maximum assist)*
Moderate difficulty (2)	**3**	Patient performs between *26-74% (Moderate assist)*	*Patient performs between 50-75% to walk >150 feet (45m) (Moderate assist)*
Mild difficulty (1)	**4**	Patient performs *≥75% (Minimum assist)*	*Patient performs >75% to walk >150 feet (45m) (Minimum assist or contact guard assist)*
	5	Require cueing, coaxing or assistive device, but physically can perform the task without assistance (Supervision)	Require cueing but not physical assist, may use assistive device *to walk >150 feet (45m)*
	6	No assistance but require use of a rail/ assistive device (Modified Independence)	No assistance but requires the use of assistive device/gait aid/prosthetic device to walk *>150 feet (45m)*
No difficulty (0)	**7**	No assistance or assistive device needed (Complete independence)	*Walk >150 feet (45m) without assistance*

This table shows the FSS-ICU score and the definitions of each score correlated to the ICF score to describe the functional mobility assessments in ICU. Both scores describe the assistance required for each activity. All FSS-ICU activities have their respective ICF score. Full details of FSS-ICU, including description of the scoring scales are available at *www.ImproveLTO.com.*

Abbreviations: ICF: International Classification of Functioning, Disability and Health; ICU: Intensive Care Unit; FSS-ICU: Functional Status Score for the Intensive Care Unit

Table 5: Patients characteristics during their ICU stay.

Characteristics	Case 1	Case 2
Age (years old)	85	63
Gender	Male	Female
Admission body-mass index (kg/m)	29.1	31
Admission Clinical Frailty Scale (points)	4/9	3/9
APACHE II score (points)	18	23
ICU length of stay (days)	20	51
Invasive mechanical ventilation (days)	13	46
Deep sedation[a] in ICU (days)	2	8
Deep sedation[a] % ICU days	10%	15.7%
ICU delirium (days)	2	4
Kinesiology assessment[b] (total number of times)	60	184
Days to first Kinesiology assessment[b]	0	0
Days to Awakening[c]	13	11
Days to first sit edge of bed	12	13
Days to first standing	17	32
MRC Sum Score on awakening (0-60 points)	26	12
MRC Sum Score at ICU discharge (0-60 points)	44	30

[a]Defined with Sedation-Agitation Scale less than 3 points (1 or 2 points) for more than 12 hours in the day.
[b]Includes respiratory and physical therapy.
[c]Defined as the first time that the patient was able to answer 5 simple orders.
Abbreviations: APACHE II: Acute Physiology and Chronic Health Evaluation II; ICU: intensive care unit; MRC Sum Score: Medical Research Council Sum Score.

grade 3 on Heckmatt score. The patient presented a FSS-ICU of 3/35 points, evidencing complete difficulty in all activities (Table 6).

ICU discharge: After 51 ICU days she achieve full cooperation with moderate respiratory impairment because she still only required intermittent NIV. For airway clearance she still had severe impairment, even with tracheotomy, and she had a moderate lung structure impairment. Regarding muscle structure presented decreased bone-fascia distance to 0,7/0,8 centimeters (left/right quadriceps) plus moderate muscle impairment as shown in (Figure 2). Despite the fact that she still has moderate muscle impairment as well as her ICU admission, the decrease in muscular thickness allows to identify that there is a big problem

Table 6: Results of kinesiological assessment based on ICF framework.

ICU TIME POINTS	CATEGORY	ICF CODE	ICF SCORE	
			CASE 1	CASE 2
PRE-ICU	Activity (Clinical Frailty Scale)	d.	1	0
ICU ADMISSION	Cooperation level (S5q)	b1102.	0	9
	Respiratory function (Respiratory support)	b440.	3	3
	Airway clearence (Assistance every 12 h)	b450.	0	4
	Lung structure (Chest x-ray)	s4301.	3	4
	Muscle structure (Muscle ultrasounds)	s75002.	---*	2
ICU AWAKENING	Cooperation level (S5q)	b1102.	1	0
	Respiratory function (Respiratory support)	b440.	3	3
	Airway clearence (Assistance every 12 h)	b450.	4	4
	Lung structure (Chest x-ray)	s4301.	---*	---*
	Muscle structure (Muscle ultrasound)	s75002.	---*	3
	Muscle strength (MRC SS)	b7304.	3	3
	Functional mobility (FSS-ICU)			
	Rolling	a4107.	4	4
	Supine to sit transfer	a4103.	4	4
	Sitting edge of bed	a4153.	4	4
	Sit to stand transfer	a4104.	8**	8**
	Walking	a4500.	8**	8**
ICU DISCHARGE	Cooperation level (S5q)	b1102.	0	0
	Respiratory function (Respiratory support)	b440.	2	2
	Airway clearence (Assistance every 12 h)	b450.	1	3
	Lung structure (Chest x-ray)	s4301.	2	2
	Muscle structure (Muscle ultrasound)	s75002.	---*	2
	Muscle strength (MRC SS)	b7304.	2	3
	Functional mobility (FSS-ICU)			
	Rolling	a4107.	1	2
	Supine to sit transfer	a4103.	2	2
	Sitting edge of bed	a4153.	1	0
	Sit to stand transfer	a4104.	3	1
	Walking	a4500.	8**	8**

This table shows the results of the kinesiology assessments on both cases framed in the clinical care process using the ICF framework.
*Not evaluated during ICU stay.
**Both patients could´t be evaluated due to important weakness and risk for walk.
Abbreviations: MRC SS: Medical Research Council Sum Score; S5Q: standardized five questions; FSS-ICU: Functional Status Score for the Intensive Care Unit; ICF: International Classification of Functioning, Disability and Health; ICU: intensive care unit; 12 h: twelve hours.

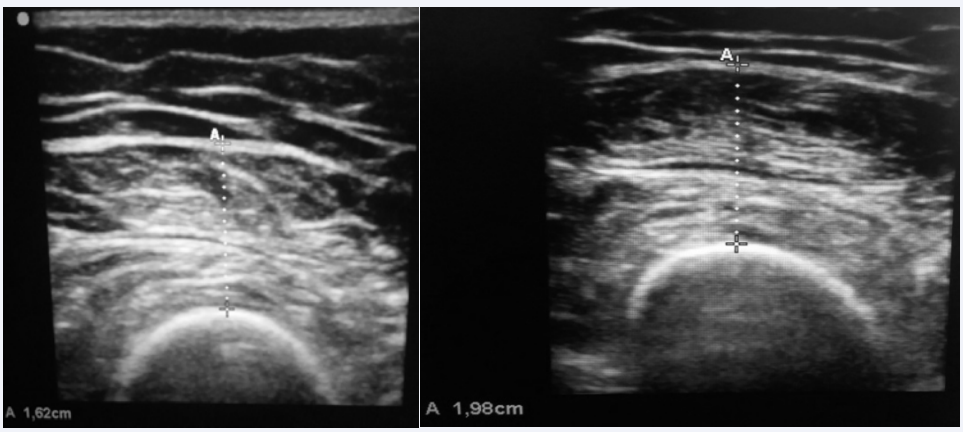

Figure 1 Cuadriceps ultrasound at ICU admission of case 2.
The images show the quadriceps muscle ultrasonography of case 2 at ICU admission. Left image shows the left quadriceps (1.62 centimeters) and right image shows the right quadriceps (1.98 centimeters). Both images evidence a moderate muscle structural impairment, because she had Heckmatt scale grade 2.
Abbreviation: ICU: Intensive Care Unit.

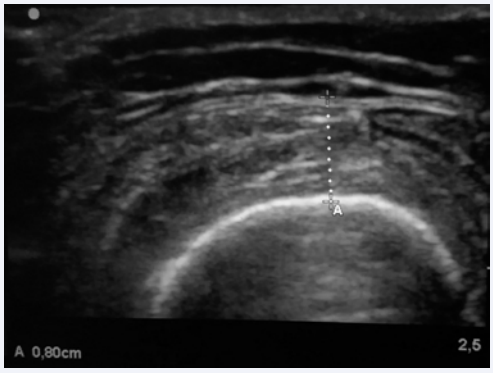

Figure 2 Cuadriceps ultrasound at ICU discharge of case 2.
The image shows a moderate muscle structural impairment of case 2 right quadriceps at ICU discharge (The information obtained from the left and right quadriceps image were similar). It can be observed that muscle mass decreased from 1.98 (figure 1) to 0.8 centimeters on Heckmatt scale grade 2.
Abbreviation: ICU: Intensive Care Unit.

in the muscular structure. The decrease in muscle thickness probably is associated with amaintained severe muscle strength impairment with a MRC SS of 30/60. However, functional mobility had better results in all activities except on walking because it could not be assessed due to weakness (Table 6). The FSS-ICU at ICU discharge improved to 14/35 points.

DISCUSSION

This case report demonstrates that using a standardized language with clear objectives is feasible and helpful during daily clinical assessment of functional mobility in critically ill patients. One study established that the goals of physical therapy based on ICF framework predominated those associated with functional mobility [25]. This is very important because 5 of the 12 categories selected in our work correspond to activities associated with functional mobility.

This case report includes a novel approach to a model that despite being recommended by WHO and which has been more than 16 years since its first publication, has not yet been standardized or massively used in the area of critical care.

In the clinical process of the critical patient the International Classification Diseases (ICD) [26] is usually considered as a reference frame to explain the patient's problem but functional/structural impairment and functional mobility difficulty are not objectified. Working within the framework of the ICF allows us to have relevant information describing the problem in a more comprehensive way to address the objectives and the appropriate treatment to the context of the patient thus improving the quality of care delivered. In this way the ICF is a necessary complement to address the critical patient problem for the whole interdisciplinary team, facilitating the clinical utility of the ICF language.

H1N1 pneumonia is associated with high mortality and morbidity, regardless of age and individual comorbidities [27]. For this reason it is interesting to analyze the evolution and health condition in the functional outcomes. Cases presented in this study have the same etiological diagnosis (A/H1N1-ARDS) according to ICD-10, but their health situation is different. This justifies the use of ICF framework to describe the real state of health.

We consider it important to generate a practical instrument based on the ICF framework, which considers a small number of categories with a clear proposal of instruments to score. The efforts of research groups should aim at this goal by simplifying and explaining such instruments. The ICF applied in different ICU time points (pre-ICU, ICU admission, ICU awakening and ICU discharge) allows to evaluate the clinical intervention in an objective way and offers the possibility of generating results indicators. According to our experience, the first step in the use of the ICF framework in ICU is that the categories selected and the ways to score each one must be based on the consensus and agreement of the professionals of each center.

Future studies should aim to describe the health conditions based on the ICF framework attempting to use similar assessment tools among different centers. These studies should be performed including a larger sample size of patients and moreover it is suggested that include the assessment of ICF categories at hospital discharge and even after hospital discharge.

One of the limitations of this study is that contextual factors, whether personal or environmental factors, were not considered. There is a great gap of knowledge even in relation to these categories. Another limitation is that the instruments used to evaluate each impairment or difficulty were chosen according to the clinical experience of a single center.

In conclusion the application of ICF framework in this case report was feasible and had clinical utility in two critical patients because it provides order, synthesis and scored the impairment that limit functional mobility in critical patients. Futures clinimetric studies are now required to validate the psychometric properties of ICF-based score in ICU.

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