Title: International Classification of Functioning, Disability and Health Domains of 60 Physical Functioning Measurement Instruments Used During Adult Intensive Care Unit Stay: A Scoping Review

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Background. There has been a recent surge in the creation and adaptation of instruments to measure physical functioning (PF) in the intensive care unit (ICU). A key step to selecting the right measurement instrument is to understand the core constructs that it is measuring in terms of the International Classification of Functioning, Disability and Health (ICF) domains.

Purpose. The purpose of this study was to map the ICF domains and subdomains included in the PF measurement instruments in adult patients during the ICU stay systematically.

Data Sources. A systematic search was carried out in Cochrane CENTRAL, PubMed, CINAHL and LILACS as well as a hand search up to May 17, 2017.

Study Selection. Study selection included all types of research articles that used at least 1 PF measurement instrument in adult patients within the ICU.

Data Extraction. Study design, year of publication, study population and the measurement instruments reported were recorded. A consensus of experts analyzed the ICF domains included in each instrument.

Data Synthesis. One hundred and eighty-one articles containing 60 PF measurement instruments used during the ICU stay were found. Twenty-six ICF domains were identified, 40 instruments included *Mobility*, and 13 included *Muscle Function*.

Limitations. Studies not written in English or Spanish were excluded.

Conclusions. There are numerous PF measurement instruments used in adult ICU patients. The most frequent ICF domain that is measured is *Mobility*. This study highlights the ICF domains contained in the instruments that can be used clinically, providing a complete database of instruments that could facilitate selection of the most appropriate measure based on the patients' needs.

Technological advances and interdisciplinary management in intensive care units (ICU) have led to higher survival rates of critically ill patients[1,2]; however, survival can be associated with deterioration in physical functioning (PF)[3,4], cognitive impairment and decreased quality of life long after ICU discharge[5,6].

Physical functioning is conceptualized as those physical abilities that allow functional independence and those related to movement[7,8]. In 2001, the World Health Organization (WHO) introduced The International Classification of Functioning, Disability and Health (ICF)[9]. The purpose of this document is to provide a unified and standard language as a conceptual framework for the description of health and health-related well-being. The ICF framework describes human functioning as an umbrella concept of the interaction of 4 basic components: (1) body functions and structures, (2) activities and participation, (3) environmental factors and (4) personal factors[9]. Each of these components systematically groups various domains and subdomains to describe PF[9]. For example Mobility, which is defined as bodily movement in daily activities; the subdomains of mobility include rolling over, sitting, standing, and walking, etc[9].

In clinical practice, physical function should be assessed early in order to identify changes in PF that occur during the ICU stay, to evaluate the success of the interventions, and to aid in discharge planning and identify patients with risk of subsequent physical deterioration[10,11]. This has led to the creation, clinimetric evaluation and adaptation of various PF measurement instruments for use in the ICU[12]. However, there is evidence of heterogeneity in the use of outcomes within clinical trials in ICU patients[13]. A recent systematic review by Parry et al identified 33 measurement instruments

designed to assess muscle mass, strength and physical function in critically ill patients, and evidenced considerable variability in the instruments used to measure different ICF domains[14]. This makes it difficult to know how to select the best measure for use in clinical practice and research.

A key step in correctly understanding the contents of the instruments is identifying the domains included in each one[10]. The aim of this scoping review was to identify the ICF domains and subdomains included in the PF measurement instruments used with adult patients during the ICU stay.

[H1] Methods

[H2] Study Design

A scoping review was conducted to identify the PF measurement instruments applied to adult ICU patients that have been reported in published scientific articles, and subsequently, identify the ICF domains included within these instruments. In this study, the Joanna Briggs Institute methodological guide to carry out scoping reviews was used[15].

[H2] Research Question

What are the ICF domains included in the PF measurement instruments used with adult ICU patients reported in the scientific literature?

[H2] Data Sources and Systematic Search

A systematic search was conducted in the Cochrane CENTRAL, PubMed, CINAHL and LILACS electronic database using a strategy with keywords and MeSH terms associated with "Measurement Instrument," "Intensive Care Units" and "Physical Function" (Appendix 1) from inception to May 17, 2017, to identify the PF measurement instruments of adult ICU patients reported in the scientific literature. It was filtered by language (English and Spanish), and all types of study design were considered. To incorporate the largest number of PF measurement instruments, database searches were supplemented by a hand search of articles related to ICU measurement instruments.

[H2] Selection of Articles

Articles were included if the full text described the use of at least 1 PF measurement instrument at any time point during the ICU stay in the methodology.

The following exclusion criteria were applied: (1) If the article did not report measuring PF in the ICU, such as those that assess long-term results, contextual factors or quality of life (ie, SF-36, EQ5D, satisfaction questionnaires, anxiety, cognitive deficiencies, among others); (2) articles that targeted populations other than adult ICU patients (ie, ICU survivors, post-ICU patients, out-patient, ward, emergency, pediatric, neonatal); (3) articles that did not specify if the measurements were completed during the ICU stay; and (4) laboratory articles (in vitro) or performed in animal models.

A researcher (F.G.S.) carried out the article selection process in 3 stages, applying filter by title, abstract and full text according to the eligibility criteria. A second researcher (C.M.O.) performed a

quality control check by randomly selecting 12 (10%) excluded articles in each of the selection stages, which were reviewed in order to validate this filtering process. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement[16], and the "include rather than exclude" methodology was used to review the full text of potentially relevant articles[17]. This means that if at least one of the excluded articles was considered appropriate for inclusion after the quality control check (C.M.O.), all articles excluded at that stage were reviewed again (F.G.S.).

[H2] Data Extraction

The included articles were collated in a Microsoft Excel data extraction spreadsheet by F.G.S. A second researcher (C.M.O.) performed the same process as quality control check at this stage. These data were then inputted into a consensus matrix between the 2 researchers (C.M.O. and F.G.S.). The following study information was extracted: study design (observational, clinical trials, validation, others), year of publication (inception-1999, 2000-2009, 2010-2017), study population (Medical/Respiratory, Surgical, Neuro-critical care/Neurosurgical, Cardiothoracic/Cardio-surgical, Trauma, Burns and Mixed/General), and PF instruments used or named in the ICU setting, these include scales and scores (defined as instruments or tests that capture current physical performance measures through the evaluator observation and scoring), questionnaires (defined as self-report surveys, in which the patient or family must report their previous or current condition) and biophysical instruments (defined as technological devices that use concepts from physics to measure function, structure or activity).

[H2] Synthesis and Analysis of Measurement Instruments

The PF instruments used within ICU studies were extracted from the full text articles included in the review and were analyzed according to the following ICF domains and subdomains (available at http://apps.who.int/classifications/icfbrowser/) based on the definitions of the ICF components:

(1) *Body Functions*: defined as the physiological functions of body systems (including psychological functions);

(2) *Body Structures*: defined as anatomical parts of the body such as organs, limbs and their components;

(3) *Activities and Participation*: The activity corresponds to the execution of a task or action by an individual and participation is the involvement of a person in a life situation;

(4) *Environmental Factors*: is the physical, social and attitudinal environment in which people live and conduct their lives.

Two researchers (E.C. and F.G.S.) independently analyzed the content of the full version of PF measurement instruments to identify the ICF domains represented within in them. This was done using a pre constructed data spreadsheet in Microsoft Excel®; the presence or absence of each domain in the instruments according to the definitions of the ICF were recorded within the spreadsheet[9,18]. If the instruments included other ICF domains or subdomains, they were recorded and analyzed.

The classification of all PF instruments by both researchers (E.C. and F.G.S.) was then compared; any differences were resolved by discussion until a consensus was reached. Finally, another researcher (C.M.O.) performed a third quality control check on 15 (25%) randomly selected instruments to verify the classification of the domains and subdomains that had been identified.

[H1] Results

[H2] Study Selection

The initial search yielded 4,434 citations that were filtered through removal of duplicates and irrelevant articles (Fig. 1). The 181 full text articles that met the eligibility criteria were analyzed to extract the PF measurement instruments.

[H2] Characteristics of Included Articles

Table 1 summarizes the bibliometric information of the included studies. The first research article that included a measure of PF in the ICU (maximal inspiratory pressure) was in published in 1990. Articles published between 1990 to and 1999 represent only 2.8% of all the articles included in this scoping review; between 2000 and 2009 this increased to 10.5%, with the highest proportion of publications between 2010 and 2017 (86.7%).

Of the research articles included in this review, 42% were observational studies and 15% were clinical trials (8.7% of these were randomized clinical trials). The validation studies identified were on psychometric properties and cross-cultural adaptation of different instruments (15%). Forty percent (40%) of studies were conducted in a mixed or general ICU, while 36% did not explicitly report the type of ICU (Tab. 1).

[H2] Physical Functioning Measurement Instruments in the ICU

There were 60 PF measurement instruments used within the ICU setting discussed within the 181 selected articles. Thirty-three of the instruments were scales or scores, 18 were biophysical instruments and 9 were questionnaires. In addition, other 2 instruments were found, the *Swedish simple early mobility scale*[19] and *ICU Patient-Reported Functional Scale (PRFS)*[20], which do not yet have the full version available to identify the ICF domains and for this reason they were not included for the analysis.

The only measurement instruments reported in the burn intensive care unit (BICU) setting were the Chelsea Critical Care Physical Assessment Tool (CPAx), the Barthel Index (BI), the Functional Independence Measure (FIM) and goniometry. The instruments that were reported in the neurological/neurosurgical intensive care unit (NICU) setting were the Functional Status Score for the Intensive Care Unit (FSS-ICU), BI, Glasgow Outcome Score (GOS), Disability Rating Scale (DRS), handheld dynamometry (HHD), computed tomography muscle scan (CT muscle scan) and the Critical Care Functional Rehabilitation Outcome Measure (CcFROM). In the cardiovascular/cardio-surgical intensive care unit (CICU) setting the Medical Research Council Sum Score (MRC-SS), Perme Intensive Care Unit Mobility Scale (Perme IMS), Peripheral Muscle Ultrasound, handgrip dynamometry (HGD) and maximal inspiratory pressure were identified.

We found 26 domains related to the PF within 60 instruments: 14 *Body Functions*, 8 *Activities and Participation*, 3 *Body Structures* and 1 domain related to *Environmental Factors.* In addition to the 12 ICF domains related to PF, 14 other domains were identified (Tab. 2). The most frequently

identified domains in the PF measurement instruments are: *Mobility* (n = 38, 63.3%), *Muscle function* (strength, resistance and tone) (n = 13, 21.7%) and *Movement functions* (postural reactions, reactions of balance, walking pattern and sensations related to muscles) (n = 12, 20%). Of the 60 instruments described in this review, none of them include all 4 components of the ICF (*Body Functions* and *Structures*, *Activities and Participation*, *Environmental Factors* and *Personal Factors*). Table 3 shows the ICF domains included in the 42 scales, scores and questionnaires, and Table 4 shows the ICF domains included in the 18 biophysical instruments.

[H2] Mobility Measurement Instruments in the ICU

As mobility was the most commonly reported domain, the description of 19 *Mobility* subdomains identified in the instruments has been included (Tab. 5). The subdomain identified most frequently was *Walking short distances* (n = 26), and the subdomains identified the least (ie, in only 1 instrument) were *Reaching* (on Berg Balance Scale [BBS]) *Jumping* (on the de Morton Mobility Index [DEMMI]) and *Walking on different surfaces* (on Functional Ambulation Categories).

In 7 instruments (Clinical Frailty Scale, Karnofsky Performance Scale, Glasgow Outcome Score/extended Glasgow Outcome Score, Disability Rating Scale, accelerometry, Sensewear armband mini-fly motion sensor [SWA-MF] and Noninvasive Mobility Sensor) the *Mobility* subdomain could not be identified, so “not specified” was used.

The biophysical instruments capable of measuring *Mobility* in the ICU were accelerometry, the SWA-MF and the Noninvasive Mobility Sensor. Of all instruments that measure *Mobility*, those that include the most *Mobility* subdomains (10 subdomains each) are the Intensive Care Unit Mobility Scale (IMS), the Acute Care Index of Function (ACIF) and DEMMI.

Of the 38 instruments that measure *Mobility*, eleven measure this domain exclusively, while others integrate different Function and Activities in the same measurement instrument, such as the CPAx, Physical Function in Intensive Care Test-scored (PFIT-s), Short Physical Performance Battery (SPPB), DEMMI, CcFROM, BBS and Perme IMS. All instruments that measure *Mobility* exclusively measure *Walking short distances* and only the FSS-ICU, IMS and Mini-Modified Functional Independence Measure Score (mmFIM) include the *Moving around using equipment* subdomain (ie, wheelchair mobility). The detailed results of the *Mobility* subdomains are shown in Table 5.

[H1] Discussion

This scoping review aimed to identify the ICF domains and subdomains included in the PF measurement instruments used in adult patients during the ICU stay. The purpose of this was to provide a quick reference guide for researchers and clinicians when selecting measures of PF in practice.

Sixty PF measurement instruments were identified, covering 26 ICF domains and 19 *Mobility* subdomains. Of the 181 articles selected, 2.8% (n = 5) were published between 1990 and 1999, while 86.7% (n = 153) were published in the last 7 years. This highlights the rapid increase in the number of publications of articles that include PF measurement instruments in the adult ICU since the beginning of the 21st century. This is consistent with the increasing interest in morbidity as an important outcome from critical illness, and not merely mortality[6,21]. The multiple constructs included within these instruments also demonstrates how multi-faceted and complex the physical

impairments of ICU patients are, and the variation in tools reflects the lack of consensus on the most robust and important measurement instruments[10,22].

This scoping review provides a quick reference guide to assist clinicians and researchers in the selection of PF measurement instruments available based on the ICF framework. The WHO and the World Confederation for Physical Therapy (WCPT) have proposed the use of the ICF as a universal framework for interdisciplinary teams and physical therapy practice[8,23]. The ICF can be used for clinical, educational and/or research purposes and as a planning tool for service level decision makers[18]. Therefore, using measurement instruments mapped to the ICF domains will be beneficial in both clinical practice and research[22]. No studies to date have mapped *all* PF measures used in critical care research to the ICF domains. Parry *et al*. published a systematic review that identified 33 instruments that measure muscle mass, strength and physical function at any point in the recovery from critical illness (from ICU to post-hospitalization)[14], but this was not mapped against the specific ICF domains and subdomains for each instruments. Subsequently, in 2017 Parry *et al.* identified the ICF domains included in eleven of the best-known PF instruments (all of them included in our review), and highlighted that there are important differences in the contents of the instruments when the ICF subdomains are considered[24], however this was not an exhaustive list.

The most frequent domain identified in this study was *Mobility* (included in 38 instruments), which reflects the importance placed on mobility in the ICU. M*obility* includes more than 80 subdomains[9], 19 of which were included in the PF measures in ICU. Systematic reviews have shown the importance of the measurement of *Mobility* in acute hospital settings and in elderly patients, because independence in mobility is a key factor in determining the discharge after acute hospitalization and has been identified as a predictor of many important outcomes[25,26].

Mobility is measured in different ways within the instruments, by either measuring the duration of a position or activity (ie, BBS, SPPB, DEMMI), the achievement of the specific mobility level (ie, IMS, Manchester Mobility Score, PFIT-s), the distance or time walked (ie, 6-minute walking distance, 2-minute walking distance, 4-meter walking test, Time Up & Go), or the level of assistance required by the patient for a specific activity (ie, FSS-ICU, CPAx, Perme IMS). Selecting the most appropriate measurement instrument will depend on available clinical resources/expertise, and the reason for assessment (ie, research, education, clinical practice)[27].

Rolling over is a fundamental component of *Mobility* in the ICU as it is one of the first activities that can be performed by a critical care patient safely. *Rolling over* requires good trunk control and limb strength[28], and its execution has repercussions on higher activities, such as standing and walking[29]. Despite this only 8 instruments measure *Rolling over* (CPAx, DEMMI, CcFROM, ACIF, MRMi, FSS-ICU, IMS and Mobilization Scale).

Walking has been shown to improve lung function in mechanically ventilated patients and can facilitate ventilatory weaning, and minimize the problems associated with prolonged bed rest[30]. In the present study, *Walking short distances* (<1km) is the *Mobility* subdomain most frequently identified, (n = 26), which demonstrates the importance of walking as part of the evaluation in the ICU[31].

It has been argued that measurement through scores or ordinal scales can present problems in the accuracy of the results, so it is necessary to use biophysical instruments to better quantify *Mobility* in the ICU[32], and of these only 3 such instruments were identified in this review (accelerometry, SWA-MF and Noninvasive Mobility Sensor).

The second domain most frequently identified in this study was *Muscle function* (n = 13) The development of muscle weakness of the extremities is associated with a prolonged duration on mechanical ventilation, a prolonged stay in the ICU, and an increased risk of morbidity and mortality[33,34]. The evaluation of muscle strength is important in order to select the "dosage" of physical exercise and to evaluate the effect of clinical interventions[35]. The *Muscle function* domain includes mainly the measurement of *Muscle strength functions* (ie, MRC-SS, HHD, HGD, PFIT-s, CPAx), *Muscle tone functions* (ie, Modified Ashworth Scale) and *Muscle endurance functions* (ie, Perme IMS, SPPB). Unlike the other instruments, the CPAx includes domains of *Mobility*, *Balance* (nonvestibular), *Respiration Function* (respiratory support) and *Additional respiratory functions* (cough effectiveness), with this being the only scale that includes the measurement of muscle strength through a biophysical instrument (HGD), which makes it possible to quantify grip strength in kilograms[28].

[H2] Strengths and Limitations

The consensus to identify the ICF domains was carried out via e-mail and not in-person, and the researchers had no formal training on the ICF framework. However, in this scoping review, the application of quality control check by a third researcher[36] ensured that the selected domains were chosen according to the ICF definitions. Another weakness of this review was that studies not written in English or Spanish were excluded. This may mean that relevant studies were omitted. The strengths are that it is the first study that includes the largest number of PF measurement instruments used in adult ICU, and classifies in detail the ICF domains included. This study reveals the domains most commonly used in critical adult patients to facilitate the use of measurement instruments in clinical practice.

[H2] Recommendations for Future Research

The ICF tool adds structure to the description and understanding of PF-related domains in acute care settings[37–39]. Despite its wide applicability, the ICF framework has not been integrated into common practice in the ICU[40], this may be because not all of the ICF domains are considered relevant within the ICU. Core outcome measurement set work is currently underway[41–43], so future studies or consensus could define an ICF core set relevant in critical illness[44].

Currently, it is not known whether a single instrument is capable of covering all of the relevant domains within the ICF and retain robust measurement properties, so it is likely that more than 1 instrument will be needed at any given time to measure PF[24,45]. When selecting a PF measurement instrument for the ICU, it is recommended that future studies carefully choose the instruments and outcomes to be evaluated[13] based on the core constructs that the researchers wish to measure in terms of ICF domains and subdomains[22]. For future research, not only will several outcome measures likely be required to capture patients' recovery trajectory, but questionnaires, scores, scales and biophysical instruments capture a different aspect of PF.

[H2] Conclusion

There are numerous PF measurement instruments used in the adult ICU that contain different ICF domains, the most frequent being *Mobility*. This scoping review categorizes PF measures and their ICF domains, providing a quick reference guide for clinicians and researchers to assist in instrument selection.

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Concept/idea/research design: F. González-Seguel, C. Merino-Osorio

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Disclosures

The authors completed the ICMJE Form for Disclosures of Potential Conflicts of Interest. E.J. Corner was the primary developer of the Chelsea critical care physical assessment tool (CPAx). No further conflicts of interest were disclosed.

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FIGURE CAPTION

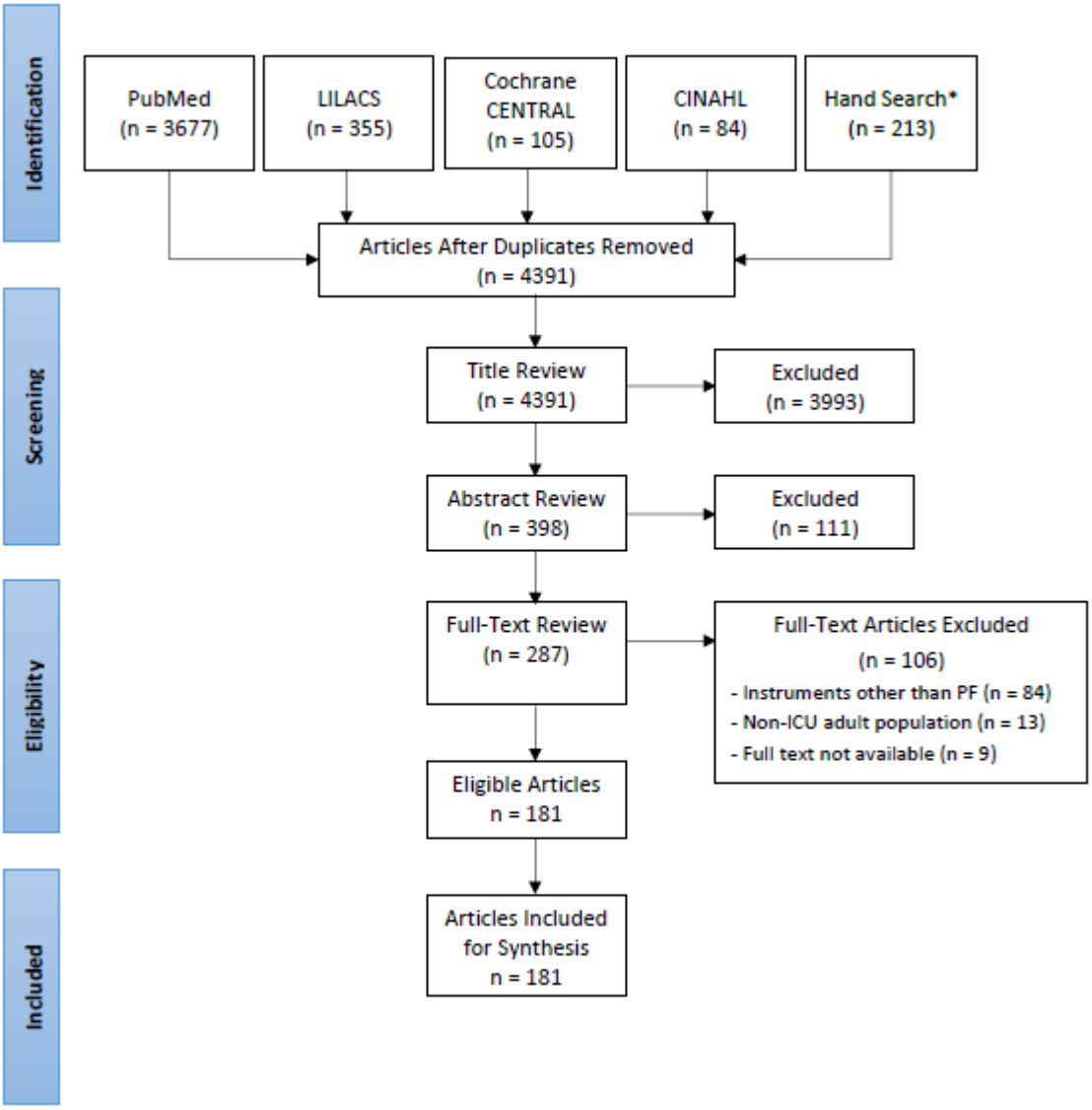

Figure. Flow diagram of the included articles. *Twenty-seven articles were selected by hand search from author`s personal files reviewed by title (see supplementary material at https://academic.oup.com/ptj). CENTRAL = Cochrane Controlled Trials Registry, CINAHL = Cumulative Index of Nursing and Allied Health Literature, LILACS = Literatura Latinoamericana de Información en Ciencias de la Salud, PF = physical functioning, ICU = intensive care unit.

Table 1.

Characteristics of the Articles Included in this Scoping Review (n = 181)

Characteristic	n (%)
Year of Publication	
1990-1999	5 (2.8)
2000-2009	19 (10.5)
2010-2017	157 (86.7)
Study Design	
Observational study	76 (42)
Clinical trial	27 (15)
Validation study	27 (15)
Other[a]	51 (28)
Type of Intensive Care Unit	
Mixed/general	72 (40)
Medical/respiratory	15 (8.3)
Surgical	13 (7.2)
Neurocritical/neurosurgical	7 (4)

Cardiothoracic/cardiosurgical	5 (2.8)
Burn	2 (1.1)
Traumatology	1 (0.6)
Intensive Care Unit not specified	65 (36)

[a]Includes systematic reviews, narrative reviews, editorials, surveys, pilot studies, consensus and expert recommendations.

Table 2.

International Classification of Functioning, Disability and Health Domains Included in the Measurement Instruments of this Scoping Review (n = 26)

Related to Physical Functioning (n = 12)	Other ICF domains (n = 14)
Body Functions	
Respiratory muscle functions [b445] Exercise tolerance functions [b455] Functions of joints and bones [b710-b729] Muscle functions [b730-b749] Movement functions [b750-b789]	Mental functions [b1] Sensory functions and pain [b2] Maintenance of blood pressure [b4202] Respiration functions [b440] Additional respiratory functions [b450] Ingestion functions [b510] Defecation functions [b525] Urinary functions [b610-b639] Functions of the skin [b810-b849]
Body Structures	
Muscles of respiration [s4303] Structures related to movement [s710-s799]	Structure of areas of skin [s810]
Activities and Participation	
General tasks and demands [d2] Mobility [d4] Self-care [d5] Domestic life [d6]	Learning and applying knowledge [d1] Communication [d3] Major life areas [d8] Community, social and civic life [d9]

Environmental Factors	
Products and technology for personal use in daily living [e115]	

[a]ICF = International Classification of Functioning, Disability and Health

Table 3.

ICF Domains of the 42 Physical Functioning Scales, Scores, and Questionnaires used in the Adult ICU[a]

		Functions of the Joints and Bones (b71-b729)	**Muscle Functions** (b73-b749)	**Movement Functions** (b75-b789)	**Respiratory Muscle Functions** (b445)	**Exercise Tolerance Functions** (b455)	**Respiration Functions** (b44)	**Other Body Functions**[b]	**Structures Related to Movement** (s7)	**Muscles of Respiration** (s433)	**General Tasks and Demands** (d2)	**Mobility** (d4)	**Self-Care** (d5)	**Domestic Life** (d6)	**Community, Social and Civic Life** (d9)	**Other Activities and Participation**[c]	**Products and Technology for Personal Use in Daily Living** (e115)
Scales / Scores	MRC Sum Score/MMT		x														
	MRC 4-point Scale		x														
	FSS-ICU											x					
	DEMMI			x								x					
	SOMS											x					
	MMS											x					
	ICU Mobility Scale											x					
	5-point Mobility Scale											x					
	Mobilization Scale											x					
	CPAx		x	x			x	x				x					
	PFIT		x			x						x					
	PFIT-s		x			x						x					
	Perme ICU Mobility Scale		x	x		x	x	x				x					x
	CcFROM		x	x								x					

	ACIF		x				x			x				x	
	mRMI		x							x					
	FAC									x					
	SPPB	x	x							x					
	6MWD				x					x					
	2MWD				x					x					
	4-m Walking Test									x					
	30-s Sit to Stand Test	x			x					x					
	FTSST	x								x					
	Time Up & Go									x					
	COMHON Index					x	x			x					
	FIM						x			x	x		x	x	x
	mmFIM									x					
	NSA[d]		x				x								
	Modified Ashworth Scale	x													
	Berg Balance Scale		x							x					
	Modified Rankin Scale								x	x	x	x	x		
	Borg Scale			x	x										
	Fatigue Resistance Index			x	x										
Questionnaires	Barthel Index						x			x	x				x
	ERBI					x	x			x	x			x	x
	Clinical Frailty Scale								x	x	x	x	x	x	

KPS					x	x	x	x	x		
Katz ADL Scale			x		x	x	x				
Lawton IADL Scale					x			x		x	
GOS/eGOS					x	x	x	x	x		
Disability Rating Scale		x	x		x	x	x	x	x	x	
HACC			x		x	x	x	x	x	x	

[a]ICF = International Classification of Functioning, Disability and Health, ICU = intensive care unit, ACIF = Acute Care Index of Function, ADL = Activities of Daily Living, CcFROM = Critical Care Functional Rehabilitation Outcome Measure, COMHON = Conscious level, Mobility, Hemodynamics, Oxygenation, Nutrition Index, CPAx = Chelsea Critical Care Physical Assessment Tool, DEMMI = de Morton Mobility Index, ERBI = Early Rehabilitation Barthel Index, FAC = Functional Ambulation Categories, FIM = Functional Independence Measure, FTSST = Five Times Sit to Stand Test, FSS-ICU = Functional Status Score for the Intensive Care Unit GOS/eGOS = Glasgow Outcome Score/extended Glasgow Outcome Score, HACC = Home And Community Care functional assessment scale, IADL = Instrumental Activities of Daily Living Scale, ICU = intensive care unit, KPS = Karnofsky Performance Scale, mmFIM = mini-modified Functional Independence Measure Score, MMS = Manchester Mobility Score, MMT = manual muscle test, MRC = Medical Research Council, mRMI= Modified Rivermead Mobility Index, MWD = minute walking distance, NSA = Modified Nottingham Sensory Assessment, PFIT-s = Physical Function in Intensive Care Test Score, SOMS = SICU Optimal Mobilisation Score, SPPB = Short Physical Performance Battery.

[b]Other *Body functions* were identified in the following measurement instruments: *Mental functions* (b1): Perme IMS, ACIF, COMHON, FIM, ERBI and Disability Rating Scale; *Sensory functions and pain [b2]:* NSA and Perme ICU Mobility Scale; *Maintenance of blood pressure [b422]:* COMHON; *Additional respiratory functions [b450]:* CPAx (cough); *Ingestion functions [b510]:* COMHON and ERBI; *Defecation functions [b525]:* FIM, Barthel Index, ERBI, Katz ADL scale and HACC; *Urinary functions [b610-b639]* and *Functions of the skin [b810-b849]:* NSA.

[c]Other *Activities and participation* were identified in the following measurement instruments: *Learning and applying knowledge [d1]:* ACIF, FIM and Clinical Frailty scale; *Communication [d3]:* FIM, ERBI, Lawton IADL Scale, Disability Rating Scale and HACC; *Major life areas [d8]:* Lawton IADL Scale and Disability Rating Scale.

[d]Includes *Structure of areas of skin [s810]*.

Table 4.

ICF Domains of 18 Physical Functioning Biophysical Instruments Used in the Adult ICU[a]

		Functions of the Joints and Bones (b71-b729)	**Muscle Functions** (b73-b749)	**Movement Functions** (b75-b789)	**Respiratory Muscle Functions** (b445)	**Exercise Tolerance Functions** (b455)	**Respiration Functions** (b44)	**Other Body Functions**	**Structures Related to Movement** (s7)	**Muscles of Respiration** (s433)	**General Tasks and Demands** (d2)	**Mobility** (d4)	**Self-Care** (d5)	**Domestic Life** (d6)	**Community, Social and Civic Life** (d9)	**Other Activities and Participation**	**Products and Technology for Personal Use in Daily Living** (e115)
Biophysical Instruments	Goniometry	x							x								
	Dynamometry[b]		x														
	Peripheral Muscle Ultrasound								x								
	Diaphragm Ultrasound				x					x							
	Accelerometry[c]			x		x						x					
	SWA-MF			x		x						x					
	Noninvasive Mobility Sensor											x					
	MIP/NIF				x												
	Maximal Expiratory Pressure				x												
	DxA								x								
	Bioimpedance Spectroscopy								x								
	CT Muscle Scan								x	x							
	Muscle Circumference								x								
	Muscle Biopsy								x								
	Electromyography[d]								x								

	PdiTw	x			
	Quadriceps Twitch Tension	x			
	Peroneal Nerve Test		x		

[a]ICF = International Classification of Functioning, Disability and Health, ICU = intensive care unit, SWA-MF = Sensewear armband mini-fly motion sensor, MIP = maximal inspiratory pressure, NIF = negative inspiratory force, DXA = Dual-energy X-ray absorptiometry, CT = computed tomography, PdiTw = Transdiaphragmatic pressure in response to phrenic nerve stimulation.

[b]Includes handgrip and handheld dynamometry.

[c]Includes sensor movement, accelerometry, and physical activity monitor.

[d]Includes electromyography, nerve conduction studies, and electrophysiological studies.

Table 5.

ICF Mobility Subdomains of 38 Physical Functioning Instruments Used in the Adult ICU[a]

		Lying Down (d4100)	**Sitting** (d4103)	**Standing** (d4104)	**Bending** (d4105)	**Shifting the Body's CoG** (d4106)	**Rolling Over** (d4107)[b]	**Maintaining a Lying Position** (d4150)	**Maintaining a Sitting Position** (d4153)	**Maintaining a Standing Position** (d4154)	**Transferring Oneself While Sitting** (d4200)	**Transferring Oneself While Lying** (d4201)	**Fine Hand Use - Picking Up** (d4400)	**Reaching** (d4452)	**Walking Short Distances** (d4500)	**Walking on Different Surfaces** (d4502)	**Walking, Other Specified** (d4508)[c]	**Climbing** (d4551)	**Jumping** (d4553)	**Moving Around Using Equipment: Wheelchair** (d465)
Measure modality	CPAx	x	x	x			x		x	x	x						x			
	DEMMI	x	x	x	x		x		x	x			x		x				x	
	PFIT			x													x			
	PFIT-s			x													x			
	Perme ICU Mobility Scale	x	x	x					x	x	x				x					
	CcFROM	x		x			x		x	x	x				x		x			
	ACIF	x	x	x			x		x	x	x				x			x		x
	MRMi	x	x	x			x		x	x	x				x			x		
	SPPB		x	x		x				x					x					
	6MWD														x					
	2MWD														x					
	30-s Sit to Stand Test		x	x																
	FTSST		x	x																

	COMHON Index	x		x				x	x		x			x			
	FIM	x		x							x			x	x		x
	Berg Balance Scale		x	x	x	x			x	x	x	x	x				
	Modified Rankin Scale													x			
	Barthel Index	x							x		x			x	x		x
	ERBI	x							x		x			x	x		x
	Katz ADL Scale										x						
	HACC										x			x	x		x
	Clinical Frailty Scale	Not specified															
	KPS	Not specified															
	GOS/EGOS	Not specified															
	Disability Rating Scale	Not specified															
	Accelerometry[d]	Not specified															
	SWA-MF	Not specified															
Mobility Measure	FSS-ICU	x	x	x			x		x					x			x
	SOMS	x		x				x	x					x	x		

	MMS	x		x			x	x		x	x			x					
	ICU Mobility Scale	x	x			x	x		x	x	x			x			x		x
	5-point Mobility Scale	x					x	x		x				x					
	Mobilization Scale	x				x	x	x	x					x			x		
	FAC													x	x				
	mmFIM									x				x					x
	4-m Walking Test													x					
	Time “Up & Go”		x	x										x					
	Noninvasive Mobility Sensor	Not specified																	

[a]ICF = International Classification of Functioning, Disability and Health, ICU = intensive care unit, ACIF = Acute Care Index of Function, ADL = Activities of Daily Living, CcFROM = Critical Care Functional Rehabilitation Outcome Measure, CoG = center of gravity, COMHON = Conscious level, Mobility, Hemodynamics, Oxygenation, Nutrition Index, CPAx = Chelsea Critical Care Physical Assessment Tool, DEMMI = de Morton Mobility Index, FIM = Functional Independence Measure, ERBI = Early Rehabilitation Barthel Index, FAC = Functional Ambulation Categories, FTSST = Five Time Sit to Stand Test, FIT-s = Physical Function in Intensive Care Test Score, FSS-ICU = Functional Status Score for the Intensive Care Unit, GOS/eGOS = Glasgow Outcome Score/extended Glasgow Outcome Score, HACC = Home And Community Care functional assessment scale, ICU = intensive care unit, KPS = Karnofsky Performance Scale, mmFIM = mini-modified Functional Independence Measure Score,

MMS = Manchester Mobility Score, mRMI= Modified Rivermead Mobility Index, MWD = minute walking distance, SPPB = Short Physical Performance Battery, SOMS = SICU Optimal Mobilisation Score, SWA-MF = Sensewear armband mini-fly motion sensor.

[b]Implemented ICF Update Proposals 2012 (https://extranet.who.int/icfrevision/nr/loginICF.aspx).

[c]Includes: marching on the spot, stepping, or steps-in-place

[d]Includes: sensor movement, accelerometry, and physical activity monitor.

APPENDIX

Appendix 1

Search terms for the identification of articles eligible for scoping review

Database	Search Terms	Results
PubMed (May 17, 2017)	(("Outcome Assessment (Health Care)"[Mesh] OR "Patient Outcome Assessment"[Mesh] OR “measurement instrument” OR psychometrics OR clinimetric OR “functional outcomes” OR validity OR validation OR reliability OR "cross cultural" OR “clinicophysiologic evaluation” OR) AND ("Intensive Care Units"[Mesh] OR “critical care” OR “critical patient” OR “intensive care” OR "Critical Illness"[Mesh]) OR “mechanically ventilated patients”)) AND ("Early Ambulation"[Mesh] OR “physical funct*” OR “functional status” OR rehabilitation OR "Mobility Limitation"[Mesh] OR Mobili* OR “exercise capacity” OR “functional capacity” OR “functional independence” OR muscle OR “physical impairment” OR disability OR walking OR "Activities of Daily Living"[Mesh] OR “limb strength”) **Limits:** to present **Language filters:** English and Spanish	**3,677**
LILACS (May 17, 2017)	("Evaluación del resultado del paciente" OR "instrumento de medición" OR psicometría OR "resultados funcionales" clinimétricos OR validez OR validación OR confiabilidad OR "adaptación transcultural" OR "evaluación clinicofisiológica") AND ("unidad de cuidado intensivo" OR "cuidado crítico" OR "paciente crítico" OR "cuidado intensivo" OR "enfermedad crítica" OR "pacientes ventilados mecánicamente") AND ("deambulación temprana" OR "función física" OR "estado funcional" OR rehabilitación OR "Limitación de movilidad" OR Mobili* OR "capacidad de ejercicio" OR "capacidad funcional" OR "independencia funcional" OR músculo OR "impedimento físico" OR discapacidad OR caminar OR "Actividades de la vida diaria" OR "fuerza de la extremidad") **Limits:** from inception to present **Language filters:** English and Spanish	**355**
Cochrane CENTRAL (May 17, 2017)	("Patient Outcome Assessment" OR “measurement instrument” OR psychometrics OR clinimetric OR “functional outcomes” OR validity OR validation OR reliability OR "cross cultural" OR “clinicophysiologic evaluation”) AND ("Intensive Care Units" OR “critical care” OR “critical patient” OR “intensive care” OR "Critical Illness" OR “mechanically ventilated patients”) AND ("Early Ambulation" OR “physical funct*” OR “functional status” OR rehabilitation OR "Mobility Limitation" OR Mobili* OR “exercise capacity” OR “functional capacity” OR “functional independence” OR muscle OR “physical impairment” OR disability OR walking OR "Activities of Daily Living" OR “limb strength”)	**105**

	Limits: from inception to present **Language filters:** English and Spanish	
CINAHL (May 17, 2017)	("Patient Outcome Assessment" OR “measurement instrument” OR psychometrics OR clinimetric OR “functional outcomes” OR validity OR validation OR reliability OR "cross cultural" OR “clinicophysiologic evaluation”) AND ("Intensive Care Units" OR “critical care” OR “critical patient” OR “intensive care” OR "Critical Illness" OR “mechanically ventilated patients”) AND ("Early Ambulation" OR “physical funct*” OR “functional status” OR rehabilitation OR "Mobility Limitation" OR Mobili* OR “exercise capacity” OR “functional capacity” OR “functional independence” OR muscle OR “physical impairment” OR disability OR walking OR "Activities of Daily Living" OR “limb strength”) **Limits:** from inception to present **Language filters:** English	**84**