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ORIGINAL ARTICLE

Patients recovering from exacerbations of COPD with and without hospitalization need: could ICF score be an additional pulmonary rehabilitation outcome?

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ABSTRACT

Objective: To compare disability changes measured with the Respiratory ICF Maugeri core set on COPD patients, recovering from acute exacerbation with and without hospitalization, submitted to pulmonary rehabilitation (PR).

Materials and methods: All COPD inpatients admitted for rehabilitation in 9 Respiratory Units (January–August 2019) were considered eligible. 2066 patients were included (540 discharged from an acute Hospital = Hospital group and 1526 coming from their home = Home group). Healthcare professionals filled, in a digitalized chart, the Respiratory ICF Maugeri core set (26 items), assessing ICF categories at admission and discharge.

Results: The baseline distribution of the more severe ICF qualifiers was higher in the Hospital group ($p < .001$) when compared to the Home group. After rehabilitation, all patients -irrespective of hospitalization need- statistically decreased the rate of the higher ICF qualifiers ($p < .0001$). Hospital group improved more both the rate of qualifiers ≥ 2 [Δ: −21.32 (22.41) vs −15.48 (17.32), $p < .001$] and the rate of qualifiers 0–1 [Δ: + 18.38 (24.67) vs 13.25 (19.13), $p < .001$] than Home group.

Conclusions: Disability measured with the "Respiratory ICF Maugeri core set" after PR improves in COPD patients recovering from acute exacerbation irrespective of hospitalization need. Its use an additional outcome remains to be further elucidated.

KEY MESSAGES

- Routine implementation of an ICF set for chronic respiratory diseases can enhance a patient-centered approach in rehabilitation for different severity conditions.
- Pulmonary rehabilitation (PR) seems to improve global disability measured with the Respiratory ICF Maugeri core set in COPD patients recovering from acute exacerbation irrespective of hospitalization need, suggesting the use of ICF set as additional PR outcome.
- The description, through the ICF language, of rehabilitative needs of patients, coming "from-Home" and "from-Hospital" settings, could help staff and instrument organization.

Introduction

Rehabilitation has been claimed to be the core health strategy of the twenty first century [1,2].

Pulmonary rehabilitation (PR) is recognized as an evidence-based treatment in improving dyspnoea and quality of life in patients with COPD. PR is very effective with a very low "number needed to treat" (i.e. about 2), irrespective of the severity of COPD [3].

PR has strong evidence of effectiveness in COPD with stable disease [4] or recovering from an exacerbation of COPD (AECOPD) [5], while the reduced risk of mortality at 1 year [6].

Well-established outcomes e.g. 6MWD, MRC score, CAT score, and Barthel index have been proposed to test the efficacy of PR [7].

The International Classification of Functioning, Disability, and Health (ICF) [8] sets represents a new methodological standard for the functioning (organs and diagnosis involved), disability (symptoms and signs), social participation restriction, and environment

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interaction assessment intending to provide interdisciplinary, holistic and patient-oriented interventions [9]. In practice, at iso-functional impairment, patients present a huge variability of disability and participation needs: ICF classification could be informative about the effect of chronic and acute diseases on individual and help to develop a more comprehensive treatment plan in the rehabilitation setting [8,9] to merge and not to replace well noted specific outcomes.

Our rehabilitative Maugeri network has identified different rehabilitation-based Cardio-Respiratory ICF sets integrating evidence from literature, information gathered from a Clinical Care Pathway (CCP) that implemented routine situations, and input from clinical experts [10,11]. The real-life application of this ICF classification has represented a valid background framework supporting the interdisciplinary nature of functioning itself to improve each step of the rehabilitation cycle [10,11].

Recently we have also shown a large implementation of a PR program based on the Respiratory ICF Maugeri core set discriminating the level of disability in different chronic respiratory diseases to enhance a patient-centered approach in rehabilitation [12]. The Respiratory ICF Maugeri core set administered at admission provided a tailored rehabilitation program according to an interdisciplinary and holistic perspective [13]; re-evaluation at discharge could assess improvements in functions pre to post-rehabilitation.

The present study aimed to test responsivity and to compare disability changes measured with the Respiratory ICF Maugeri core set on COPD patients, recovering from acute exacerbation with and without hospitalization, submitted to pulmonary rehabilitation (PR).

Materials and methods

Population

This study was conducted on the Automated Integrated Health Care Record database of patients with COPD, consecutively admitted for in-hospital PR program after an AECOPD between January the first and 30th August 2019 to the hospitals of ICS Maugeri, Italy (Institutes of Pavia Veruno, Tradate, and Lumezzane), referral institutions for PR program, diagnosis and care of chronic patients (Figure 1). Diagnosis and severity of COPD were confirmed by spirometry according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines [14].
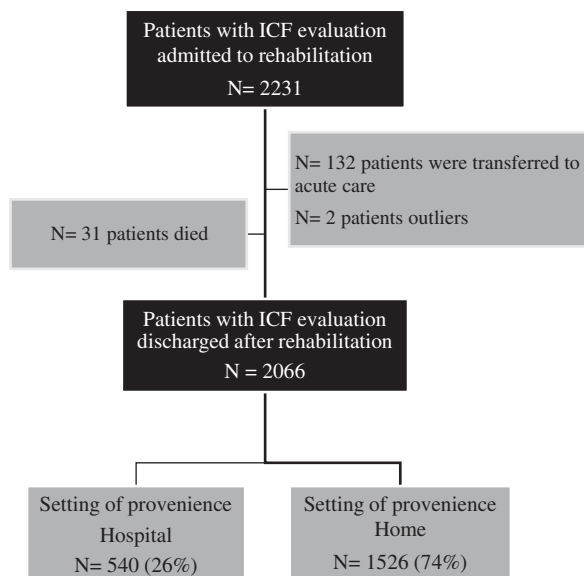

Figure 1. Flow chart of the study.

Patients were divided according to their anamnestic history before rehabilitation admission: Hospital group = patients discharged from an acute hospital and Home group = patients proposed to PR from the territory without acute hospital admission. Patients with less than 6 days and more than 90 days of rehabilitative stay were excluded because of clear outliers.

Patients gave written informed consent to use data for research at the time of hospital admission. The study was approved by the ICS Maugeri Local Review Board (Technical and Scientific Committee).

Intervention

At the time of rehabilitative in-hospital admission, each patient received a multidisciplinary pulmonary rehabilitation program (PRP) according to the Clinical Care Pathway (CCP) [7]. A multidisciplinary team consisting of chest physicians, nurses, physiotherapists, dieticians, and psychologists offered care. Our in-patient multidisciplinary program included the optimization of drug therapy, education, nutritional programs, and psychosocial counselling when appropriate, and at least 22 sessions for 3–4 weeks, of supervised incremental exercise training according to Maltais et al. [15], until performing 30 min of continuous cycling at 50–70% of the maximal load calculated based on the baseline 6MWD according to Luxton et al. [16]. Peripheral limb muscle activities, shoulder, and full arm circling were also performed. Supplemental oxygen for patients under LTOT and interval training for most compromised patients

weredelivered. Pulse oximetry and rate, and arterial blood pressure were monitored during exercise. The total daily time duration of activities was 2–3 h.

Measures

At admission and discharge, patients underwent evaluations of routine as a standard haematologic test, blood chemistries and gas analysis, lung function tests, chest X-ray, effort tolerance by 6-minutes walking distance (6MWD) test [17], questionnaire on respiratory symptoms (CAT score) [18], MRC score [19], Barthel dyspnoea score [20–21] and comorbidities with CIRS score [22].

The global impairment of patients was measured through the ICF language, according to the ICF qualifiers and to the linking procedure previously achieved [8,9]. The comprehensive ICF core set can collect more information and it is indicated to guide multidisciplinary assessments in the rehabilitation process [23]. In particular, the Respiratory ICF Maugeri core set used in the study refers to a selection of 26 items defining a respiratory set among the ICF components of body functions (b letter) and activity and participation factors (d letter) (Table 1). It has been previously published [10] and here is briefly described.

The ICF language and the respiratory ICF Maugeri core set

The respiratory ICF Maugeri core set follows the ICF categories which are designated by specific letters, i.e. "b" for Body functions, "s" for Body structures, "d" for Activities and participation, and "e" for Environmental factors. These categories are followed by a numeric code (ICF code) which the first digit represents the ICF chapter number. Further details are given through adding a second (two digits), third and fourth levels (one digit each). The qualifier scale of the ICF factors component (ICF qualifiers) ranged from 0 to 4, according to the increasing severity of the problem (0 no influence, 1 mild, 2 moderate, 3 severe, and 4 complete). Additionally, qualifiers "8 – not specified" and "9 – not applicable" were used when the available information was not sufficient to quantify the severity of the problem, or when a category did not apply to a specific patient, respectively. Specific ICF categories/codes were previously selected for the Respiratory ICF Maugeri core according to an internal consensus process, either by recoding the established pulmonary rehabilitation outcome measures or, if the first option was not possible, by applying a semi-quantitative methodology [10] (see Table 1).

At the time of admission and discharge, each healthcare professional (pulmonologist, physiotherapist, nurse, psychologist, occupational therapists) had to

Table 1. Respiratory ICF Maugeri core set.

RESPIRATORY ICF core Set		ICF category description
b130	#	Energy and drive functions
b134	@	Sleep functions
b139	@	Global mental functions, other specified and unspecified
b152	#	Emotional functions
b235	@	Vestibular functions
b280	#	Sensation of pain
b440	@	Respiration functions
b445	@	Respiratory muscle functions
b449	@	Functions of the respiratory system, other specified and unspecified
b450	@	Additional respiratory functions
b455	@	Exercise tolerance functions
b460	@	Sensations associated with cardiovascular and respiratory functions
b530	#	Weight maintenance functions
b730	#	Muscle power functions
b810	#	Protective functions of the skin
b820	#	Repair functions of the skin
d230	@	Carrying out daily routine
d415	#	Maintaining a body position
d429	@	Changing and maintaining body position, other specified and unspecified
d450	@	Walking
d455	@	Moving around
d4551	@	Climbing
d5	#	Self-care
d570	@	Looking after one's health
d760	@	Family relationships
d850	@	Remunerative employment

First column: ICF codes. Symbols in the second column refer to the evaluation used for each code: @ according to semi-quantitative methodology; # according to defined and used rehabilitative outcomes indices [10].

Table 2. Characteristics of patients at admission.

	Overall N = 2066	Home group N = 1526	Hospital group N = 540	p
Age, years	71.1 (10.2)	71.0 (10.1)	71.4 (10.5)	.4288
Male, n (%)	1255 (61%)	942 (62%)	313 (58%)	.1234
Rehabilitative LOS, days	24.5 (10.2)	23.8 (9.7)	26.4 (11.4)	**<.0001**
CIRS, score*	4.0 (1.9)	4.0 (2.0)	4.0 (1.8)	.9002
Barthel Dyspnoea Index, score	33.3 (21.0)	31.5 (20.2)	38.3 (22.3)	**<.0001**
6MWD, metres*	275 (131)	298 (126)	217 (125)	**<.0001**
CAT, score*	19.9 (7.8)	19.2 (8.0)	22.1 (7.0)	**<.0001**
MRC, score *	2.8 (1.2)	2.7 (1.2)	3.0 (1.1)	**.0003**
ICF qualifiers 0–1, cumulative % of click yes	53.2 (25.3)	57.3 (23.8)	41.9 (25.8)	**<.0001**
ICF qualifiers ≥ 2, cumulative % of click yes	38.6 (24.1)	35.0 (23.2)	48.7 (23.7)	**<.0001**

LOS: Length of Stay in Rehab Centre; CIRS: Cumulative Illness Rating Scale; 6MWD: Six minutes walking distance; CAT: COPD Assessment Test; MRC: Medical Research Council; ICF: International Classification Functioning. *Available data on less than 2066 patients [CIRS (N = 1265), 6MWD (N = 957), CAT (N = 891), MRC (N = 1246)]. Unpaired T test was applied for statistical analysis.

fill in the ICF, for each inpatient, using a two-step digitalized chart: (a) at admission, to identify the personalized rehabilitation project as well as the critical areas from a clinical point of view; (b) at discharge, to assess changes in functioning according to the ICF qualifiers expressed on the ICF categories. The relative frequency of each ICF qualifier was expressed as the percentage of click "yes" calculated on each patient. The final ICF qualifier was described by the mean of the percentage of clicks "yes" in each level of severity (qualifiers from zero to 4), independently from the ICF category. Moreover, to compare ICF changes observed in a different setting, we defined low ICF severity levels (0 and 1) and higher severity level (≥2), thus cumulative % of click yes for ICF qualifier 0–1 and ≥2 were calculated as well.

Data analysis

Data were analysed by specific software (STATA 13, Stata Corp LP TX, USA). Continuous variables were shown by mean (standard deviation), while binary and categorical variables by percentage. The degree of functioning impairment evaluated by ICF before and after rehabilitation was calculated as percentage of clicks "yes" in each level of severity and pre-to-post difference tested by paired t-test. The analysis was performed on the whole group of patients admitted to rehabilitation, and according to 2 different settings of provenience: patients needing previous hospital admission = Hospital group and patients proposed to PR from the territory = Home group. Comparisons between the 2 different settings of provenience were assessed by unpaired t-test: (1) on the same ICF qualifier (percentage of clicks "yes") at admission and discharge for each setting; (2) on the pre-to-post difference (Δ) calculated on the cumulative percentage of clicks "yes" for ICF qualifiers ≥2 (high severity) and cumulative percentage of clicks "yes" for ICF qualifiers

0–1 (low severity). For all tests, p was considered significant for value <.05

Results

As shown in Figure 1, during the study period, 2231 COPD inpatients were admitted to the respiratory units. Thirty-one patients died during the study period, while 132 were transferred to acute care, 2 patients were excluded as outliers. The final analysis was conducted on 2066 survived patients who completed the PR program: 540 of them came from the hospital (due to their need of assistance) and 1526 patients came from their homes. Table 2 shows the characteristics of the studied patients considering usual evaluations and cumulative ICF qualifiers: as expected, the patients coming from Hospital presented worse values for Barthel dyspnoea, 6MWDT, CAT, MRC, a longer LOS, and a parallel worse global disability according to a higher percentage of click "yes" in ICF qualifiers ≥2.

The whole group improved 6MWD, CAT, MRC, and Barthel Dyspnoea score of 58 ± 94 metres, −7.1 ± 4.6 points, −0.93 ± 0.91, and −11.9 ± 11.4 points respectively. Patients with previous acute hospitalization (Hospital group), when compared to patients without acute hospitalization (Home group), significantly improved 6MWD (83.6 ± 79.9 vs 48.4 ± 97.8, $p < .0001$), Barthel Dyspnoea score (−14.72 ± 13.20 vs −10.89 ± 10.54, $p < .0001$), CAT score (−7.72 ± 4.27 vs −6.93 ± 4.75, $p = .0255$) and MRC score (−1.07 ± 0.99 vs −0.87 ± 0.86, $p = .0006$).

Figure 2 shows the frequency distribution of the single qualifiers severity rating (from zero to four) chosen by healthcare professionals (HP) on the entire Respiratory ICF set available: Panel "a" shows the percentage of clicks "yes" performed by HP in the whole patients, Panels "b" and "c" represent respectively the percentage of clicks in the Home group and the
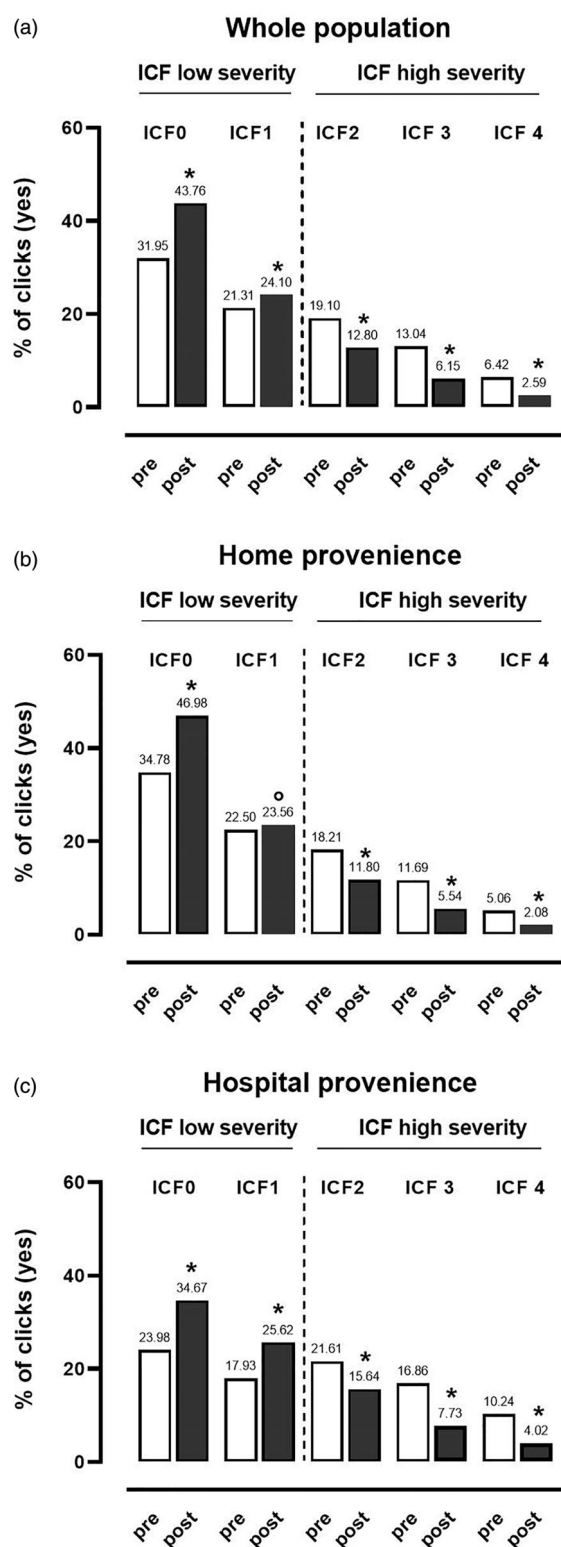
Figure 2. Frequency distribution of the ICF qualifiers severity ratings (from zero to four) chosen by healthcare professionals (HP) on the entire Respiratory ICF set available, in the whole sample of patients, admitted to rehabilitation (Panel a), coming from Home (Panel b) and Hospital (Panel c). White bars refer to ICF qualifiers at admission (pre) and black bars refer to those at discharge (post). Paired T-test between data at admission and discharge was performed and statistical significance was reported: * indicates $p < .0001$ and ° $p < .05$.

Hospital group, both at admission (white bars) and discharge (black bars) from rehabilitation.

Both at admission and discharge, the distribution of single ICF qualifiers was statistically different between Hospital and Home groups being in the Hospital group lower for the qualifier 0 and 1 and higher for qualifiers $\geq$ 2 (all $p < .001$).

After rehabilitation, all patients -irrespective of their hospitalization need- statistically increased the rate of ICF qualifiers 0 and 1 (low severity, $p < .0001$) and decreased the rate of the higher ICF qualifiers (high severity ≥ 2; $p < .0001$). The Hospital group improved more both the rate of cumulative ICF qualifiers ≥ 2 [Δ: -21.32 (22.41) Hospital vs -15.48 (17.32) Home, $p < .001$] and the rate of cumulative ICF qualifiers 0 and 1 [Δ: $+$ 18.38 (24.67) Hospital vs 13.25 (19.13) Home, $p < .001$] than Home group, showing a positive effect of the clinical intervention on patients' disability.

Details on the frequency (shown as mode value) of the 26 ICF codes, as chosen by health staff, at baseline assessment and after rehabilitation have been represented in Figure 3 in the two setting of provenience: Home (panel a) and Hospital group (panel b).

Discussion

An in-patient PRP clinically improved International Classification of global Functioning disability in a huge cohort of patients recovering from AECOPD, independent of their severity as assessed by the need of acute hospitalization. However, acute hospital admission influenced the magnitude of PRP success.

The ICF ontology, differently from the already established outcome measures for pulmonary rehabilitation, is not disease-specific, therefore it allows a more fluid and intelligible exchange of information among pulmonary rehabilitation specialized health care professionals and health care professionals working on the territory [24]. Integrated care is still considered a difficult and complex issue for health care and ICF could smooth the process by sharing a common language, facilitating the comparative evaluation of changes in functioning and standardizing the reports on rehabilitation interventions [25].

The patient's functioning information, thanks to the joint use of the ICD diseases classification and International Classification of Functioning frameworks, could play a crucial role in rehabilitation medicine, aligning patient care with evidence-based guidelines, optimizing the workflows, and facilitating healthcare benchmarking [26]. The development of an
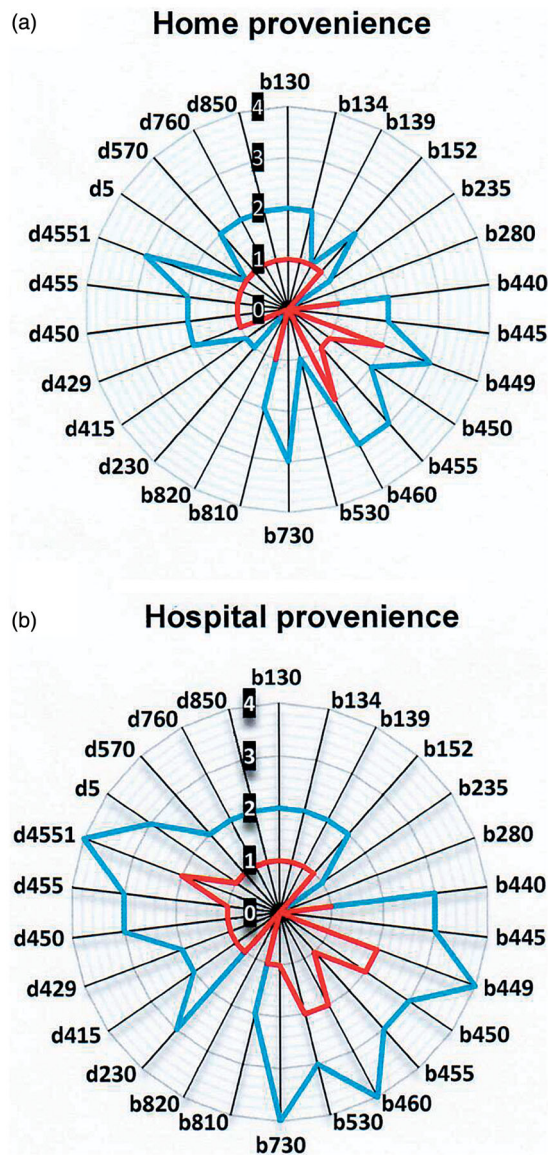
(a)

Home provenience

(b)

Hospital provenience

Figure 3. Mode values at admission (blu continuous line) and discharge (red continuous line) for each code belonging to the Respiratory ICF Maugeri core set. Black numbers (0–4) at the centre of the circumference define ICF qualifiers, codes out the circumferences identify ICF categories.

International Classification Functioning core set for COPD involved a series of formal decision-making and consensus processes that incorporate the results of preliminary research, including Delphi expert consultation [10,11].

A brief and comprehensive International Classification Functioning core set for chronic obstructive pulmonary disease (COPD) was established in 2004 and has been proven to be a comprehensive framework covering the symptoms and functions of patients with COPD and a useful tool for measuring their health [27].

The "activity and participation" of brief International Classification Functioning core sets for COPD has been demonstrated to present good reliability and validity to test the daily activities of patients with COPD [28].

Although these important methodological studies, no robust data have been presented on the routine implementation of an International Classification Functioning set for chronic respiratory diseases to enhance a patient-centered approach in rehabilitation. As previously shown [10–13], our respiratory International Classification Functioning set explored different and multidisciplinary disability items as energy, sleep, mental, emotional, muscles, exercise tolerance, straight, ADLs, self-care in adjunction to specific cardio-respiratory disabilities. The COPD population studied was aged, disabled with important symptoms as dyspnoea, with reduced effort tolerance and significant impact on the quality of life as demonstrated by traditionally used tests. Our study shows that this identified International Classification Functioning set in COPD patients – which were recovering from exacerbation, having different severity with or without hospitalization need – is applicable and responsive; in this manner our team assessed with usual items combined to the global functional assessment measured with the International Classification Functioning classification. It is interesting to note that, at admission, in the 38.6% of cases International Classification Functioning qualifiers were ≥ 2 indicating a severe global impairment: as expected, the group of patients with acute hospitalization before rehabilitation presented more frequently qualifiers ≥ 2 in the International Classification Functioning set (48.7% click yes).

The responsiveness of global disability to PR program has been demonstrated by the important reduction of the rate of International Classification Functioning qualifiers ≥ 2 in all sample, in particular in the Hospital group.

Practical implications

The study described how a routine implementation of an International Classification Functioning set for chronic respiratory diseases, based on a comprehensive biopsychosocial function model and standardized descriptions of function and disability, can enhance a patient-centered approach in rehabilitation for different severity conditions. The use at admission and discharge of this International Classification Functioning set to classify patients guided a rehabilitation program according to an interdisciplinary perspective and could

be an additive PR outcome measure. The ICF implementation implies in its essence the necessity to be interdisciplinary adopted since it encompasses codes and area of assessment which are covered by different expertise within the rehabilitation team. This holistic view gives separated "silos" but following a clinical care pathway where the patient is at the centre. By describing a patient's disability through the ICF ontology, clinicians have the unique possibility to share within the team not a fragmented patient but a person with impairments and strengths, limitations, and resources.

Study limitations

Like all retrospective studies, it suffers from missing data. Therefore, we included only International Classification Functioning set data as primary outcomes.

Conclusion

Disability, measured with the "Respiratory International Classification Functioning Maugeri core set" after pulmonary rehabilitation, improves in COPD patients recovering from acute exacerbation irrespective of acute hospitalization need. Its use as an additional PR outcome remains to be further elucidated.

Acknowledgments

Disclosure statement

No potential conflict of interest was reported by the author(s).

Author contributions

MV and AG contributed to the design of the study; MV, LC, and AO wrote the original draft preparation; GC performed electronic reporting; MP performed statistical analysis; LC performed graphical representation. All authors discussed the results and commented on the manuscript. All authors revised and approved the final draft of the manuscript.

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Data availability statement

Data available on request from the authors.

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