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Original Article

Functional Decline Over 1-year Follow-up in a Multicenter Cohort of Polypathological Patients: A New Approach to Functional Prognostication

Máximo Bernabeu-Wittel*†, Manuel Ollero-Baturone†, Alberto Ruiz-Cantero†, Lourdes Moreno-Gaviño†, Bosco Barón-Franco†, Aurelio Fuertes†, José Murcia-Zaragoza†, Carmen Ramos-Cantos†, Antonio Alemán†, on behalf of PROFUND Researchers

Internal Medicine Department, Hospitales Universitarios Virgen del Rocío, Sevilla, Spain

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SUMMARY

Background: Little is known about the fitness of the available tools in predicting functional decline of polypathological patients (PPs). Our objective was to assess accuracy of the Triage Risk Screening Tool (TRST), the Variable Indicative of Placement risk (VIP) and to develop a specific functional prognostic index adjusted to this population in a multicenter cohort of hospital-based PP.

Methods: Prospective 12-month follow-up study of PPs from 36 hospitals. Functional decline was defined as loss of ≥20 points on Barthel's index (BI). Accuracy of TRST/VIP was assessed by calibration/discrimination tests. Development of the new score was performed by dividing into a derivation cohort (constructing the index by logistic regression), and a validation cohort (in which calibration/discrimination of the index were tested).

Results: Nine hundred and fifty-eight patients from the 1632 included survived during follow-up. Basal/12-month BI was 85/70, respectively. Mean fall in BI score was 11.7 ± 24 points [353 (36.8%) fell by ≥20 points]. The activities for daily living that declined most frequently were toilet use, grooming, dressing and bathing. TRST/VIP fitted well but their discrimination power was poor (area under the curve = 0.49 and 0.46, respectively). A simplified PROFUNCTION index was derived containing seven items (≥85 years, neurological condition, osteoarticular disease, III–IV functional class of dyspnea, ≥4 polypathology categories, basal BI < 60, and social problems). Functional decline risk ranged from 21% to 24% in the lowest risk group (0 items) to 38–46% in the highest (4–7 items). Calibration as well as discrimination power (area under the curve = 0.56–0.59) of this simplified index were good.

Conclusion: We developed and validated a new functional prognostic index specifically focused on these patients with better discrimination power than other tools available.

1. Introduction

Disability and dependence are, after death, two of the most worrisome health outcomes of all diseases. Disability is of even more concern in patients with complex chronic diseases, as well as in polypathological patients (PPs), because of the spiral deleterious effects of symptom loads and clinical vulnerability, which lead to progressive functional decline, and established dependence. Dependence also plays an independent role in poor outcomes and in informal caregiver overload once established[1–4].

PPs have become an emerging population in most clinical arenas[5–7]. Their prevalence in primary care, as well as in different medical and surgical hospital areas, is remarkably high and will probably increase in the forthcoming years[6–8]. Their complexity, burden of diseases and symptoms, clinical vulnerability, poor health-related quality of life, and an obvious trend towards functional deterioration, have been previously pointed out[1–3,9]. Nevertheless, functional transitions in prospective follow-up of PPs and their predictive factors have not yet been extensively addressed.

Functional outcome prognostication is a very useful tool for clinicians to plan specific strategies towards functionality preservation and preventive measures against the dependence cascade[2,10,11].

* Correspondence to: Dr Máximo Bernabeu-Wittel, Internal Medicine Department. Hospitales Universitarios Virgen del Rocío, Avenida Manuel Siurot, s/n. 41013 Sevilla, Spain.
E-mail address: maxbw@telefonica.net (M. Bernabeu-Wittel).
† All authors have contributed substantially to the work.

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This is especially important in a high-risk population like PPs, considering the deeper impact of functional decline on survival and other important outcomes in this population[1–4,6]. Some of the strongest predictors of functional decline are age, admission diagnosis, basal lower functional status, impaired cognitive status, comorbidity, polypharmacy, and length of hospital stay[12–14]. Various screening tools, encompassing (some of) these predictors are already available, and have been tested on different populations with varying overall accuracy, ranging from 49% to 76%. The most widely used instruments are the Triage Risk Screening Tool (TRST)[15,16], and the Variable Indicative of Placement risk (VIP)[17]; nevertheless, their accuracy has not yet been evaluated in PPs.

For all of the above-mentioned reasons, we developed this multicenter project in a cohort of PPs to assess functional decline and its main determinants over a 12-month follow-up period, evaluate the accuracy of the aforementioned predictive tools, and develop a new functional predictive tool specifically designed with PPs in mind.

2. Methods

This was an observational, prospective, multi-institutional study carried out by researchers from the Polypathological Patient and Advanced Age Study Group of the Spanish Internal Medicine Society. The study inclusion period ranged from February 2007 to June 2008 (17 months). The present study has been approved by the ethics committee of Hospitales Universitarios Virgen del Rocío.

2.1. Reference population

All PPs treated in the Internal Medicine and Geriatric areas (in-hospital, as well as in outpatient clinics, and hospital at-home patients) from the 36 Spanish hospitals participated in the study (all participant centers are listed on the PROFUND Researchers list).

2.2. Inclusion criteria

Patients aged ≥18 years old, who met the criteria for PPs were consecutively included, after providing their written informed consent[5]. In-hospital patients were included at discharge, and those identified at outpatient clinics (internal medicine outpatient clinics, day hospital, and/or hospital at-home patients) were included during any one of their visits. Patients who died during their hospital stay or during 12 months follow-up and those who did not agree to enter the study were excluded.

2.3. Development of the study, data collection and follow-up

After receiving informed consent, a complete set of demographic, clinical, functional, analytical, pharmacological, as well as socio-familial data were collected from all included patients.

Demographic data included age, sex, residence, employment, and the main caregiver's profile; clinical data included the different diseases, the fulfillment of polypathology criteria, stage of different diseases (New York Heart Association and Medical Research Council dyspnea rates[18,19], and Child–Pugh stage[20]), assessment of Charlson's comorbidity index[21,22], different symptoms and signs, body mass index (BMI), assessment of basal as well as inclusion ability in performing activities of daily living (ADL) and instrumental activities (IAs) by means of Barthel's index (BI) and Lawton–Brody (L–B) index[23,24], assessment of basal cognitive impairment using the Spanish validated version of Pfeiffer's questionnaire (PQ)[25], and number of hospital admissions in the past 12 and 3 months, respectively; analytical data included plasma creatinine, hemoglobin, albumin, glycated hemoglobin, and ultrasensitive C-reactive protein; pharmacological data included number and type of chronically prescribed drugs at baseline; and socio-familial data included socio-familial risk determined using the Gijón scale (GS)[26]. The GS is a validated scale that assesses the overall socio-familial situation by exploring five specific dimensions (family, economics, housing, social relations and social network support) in a 1–5 Likert scale (score rank: 5–25 points); a score <10 confers low social risk; 10–16 confers risk of social claudication; and > 16 points defines an established social problem.

All included patients were followed-up during a 12-month period. After this time, survival was assessed and, in the case of death, the patient was excluded from analysis. Primary endpoint was functional status in the performance of ADL by means of the BI. Most dimensions of the BI count 5–10 points (5–10% from total index), therefore, we considered functional decline when the patient lost ≥10 points (1–2 activities), ≥20 points (2–3 activities), and ≥30 points (3–4 activities). We also considered the variable of becoming dependent, defined as patients with basal BI > 60 points, whose follow-up BI fell to <60 points.

2.4. Other definitions

Nutritional status was categorized by means of World Health Organization criteria for BMI values [overweight–obesity (BMI > 24.9), normal weight (BMI 18.5–24.9), underweight (BMI <18.5)][27]. Hypoalbuminemia was defined as albumin levels <3.5 g/dL (severe: <1.8 g/dL, moderate: 1.8–2.69 g/dL, and slight: 2.7–3.5 g/dL). Polypharmacy was defined as the chronic prescription of at least five drugs. Dependence in functional status for ADL and IAs was defined by BI <60 points and by L–B index <8 for women/<5 for men. Cognitive impairment was defined by ≥3 errors on the PQ (≥ 4 if the patient had not completed elementary school and ≥2 if the patient had a college education); this was categorized as mild–moderate impairment (3–7 errors), and severe impairment (≥ 8 errors). Socio-familial risk/problems were defined as a GS score ≥10. The need for a caregiver was defined when the patient was functionally dependent (BI <60) and/or cognitively impaired (PQ ≥3 errors).

We used a modified Flemish version of the TRST instrument comprising five yes/no topics: cognitive impairment; difficulty in walking, transferring; living alone with no available caregiver; polypharmacy; and recent hospitalization. The presence of cognitive impairment or two or more risk factors designates the older person as "high risk"[15,16,28]. The VIP assesses older patients' degree of independence, with the aim of detecting patients with potential discharge problems[17]. With three yes/no questions, the patients' living situation, functional status and cognitive status were evaluated. A patient was considered at risk when at least two positive answers were reported.

2.5. Statistics

The dichotomous variables were described as whole numbers and percentages, and the continuous variables as mean and standard deviation (or median and rank in those with no criteria of normal distribution). The distribution of all variables was analyzed with the Kolmorogov–Smirnov test. All statistics were performed using the SPSS version 16.0.

Bivariate relationships between potential risk factors and functional decline in BI (≥10, ≥20, and ≥30 points, as well as becoming dependent) were established by χ^2 test and Fisher test if necessary. Significant variables ($p < 0.05$) were entered into a multiple backwards logistic regression model to refine independent risk factors for all endpoints.

To assess accuracy of the TRST and VIP indexes in the recruited PPs, we determined their calibration by comparing the predicted

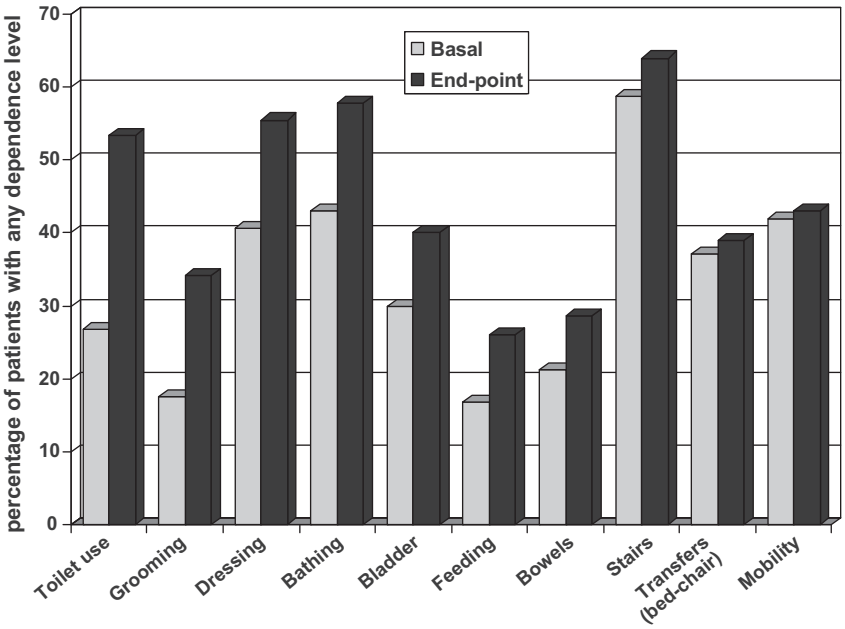

Fig. 1. Most affected dimensions in 12-month functional decline with respect to activities of daily living in a multicenter cohort of polypathological patients from Spain, by means of percentages of patients with any basal/end-point dependence level in the ten Barthel's index dimensions.

functional decline (divided into probability risk-quartiles) to the observed functional decline by calculating the Hosmer–Lemeshow goodness-of-fit test. Then, we evaluated their discriminatory power by applying the point scoring system, thereby determining risk scores for each participant, and calculating the area under the receiver operating characteristic (ROC) curve.

Our new PP functional scale was derived and validated as follows. We chose as the functional decline endpoint a loss of ≥20 points in BI (2–3 ADL) with respect to basal values. The included population was divided into a derivation cohort (containing approximately half of the participating hospitals, from western regions of Spain, and patients), and a validation cohort (containing approximately the remaining half of the participating hospitals, from eastern regions of Spain and islands). Bivariate relationships between potential risk factors and mortality were assessed in the derivation cohort using logistic regression models. Significant variables ($p < 0.05$) were entered into a multiple backwards logistic regression model. Risk factors that remained significant after adjustment ($p < 0.05$) were used to create the predictive model. The 1-year functional decline risk scoring system was created by assigning points to each risk factor [dividing each β coefficient in the model by the lowest β coefficient (presence of heart valve prosthesis; $\beta = 0.42$) and rounding to the nearest integer]. To test the stability of our final model, we tried alternate methods (forward and bidirectional selection techniques) to determine whether the resulting model would differ from our original model. After this, and knowing the narrow differences in prognosis weight of the predictor variables (lowest–highest weights were 4–5), we attempted to simplify the index by matching all predictive items to the unit.

To validate both the original PROFUNCTION index and the SIMPLIFIED PROFUNCTION, we determined the calibration of the indexes by comparing the predicted functional decline (divided into probability risk-quartiles) from the derivation/validation cohort to the observed functional decline, by means of the Hosmer–Lemeshow goodness-of-fit test. Then, we evaluated the discrimination of the indexes by applying the point scoring system created in the derivation cohort to the validation cohort, thereby determining risk scores for each participant, and calculating the area under the ROC curve, for the final model in both the derivation and validation cohorts. We chose to validate our predictive indexes in a different region of the country from where it was developed to test geographic transportability as well as diagnostic accuracy.

3. Results

A total of 1632 PPs (75% hospitalized, 17.5% outpatients, and 7.5% at-home patients) were included in the study, and 93.44%

Table 1
Main features of the TRST and VIP indexes in a multicenter sample of hospital-based polypathological patients from Spain.

Index feature	Median (IQR)/N (%)
TRST	
Median/mean score	2 (2–3)/2.3 ± 0.9
Patients at low/high risk	34.6%/65.4%
Calibration (H–L test)	
Loss of ≥10 points in BI	$p = 0.48$
Loss of ≥20 points in BI	$P = 0.65$
Loss of ≥30 points in BI	$P = 0.35$
Discrimination (AUC)	
Loss of ≥10 points in BI	0.48 (0.43–0.52)
Loss of ≥20 points in BI	0.46 (0.41–0.5)
Loss of ≥30 points in BI	0.41 (0.37–0.46)
VIP	
Median/mean score	1 (1–2)/1.22 ± 0.6
Patients at low/high risk	71%/29%
Calibration (H–L test)	
Loss of ≥10 points in BI	$p = 0.28$
Loss of ≥20 points in BI	$p = 0.22$
Loss of ≥30 points in BI	$p = 0.23$
Discrimination (AUC)	
Loss of ≥10 points in BI	0.504 (0.47–0.54)
Loss of ≥20 points in BI	0.49 (0.45–0.53)
Loss of ≥30 points in BI	0.476 (0.43–0.52)

AUC = area under the curve; BI = Barthel's index; H–L = Hosmer–Lemeshow; IQR = interquartile range; TRST = Triage Risk Screening Tool; VIP = Variable Indicative of Placement risk.

($n = 1525$) completed the 12-month follow-up. We finally included in the analysis the 958 patients who survived during follow-up (global mortality rate was 37.2%). The main demographic, clinical, and care features of the whole inclusion cohort have already been described elsewhere[29].

Basal as well as 12-month BI of included PPs were 85 (interquartile range = 35) and 70 (interquartile range = 40), respectively. Mean fall in BI score was 11.7 ± 24 points [477 (49.8%), 353 (36.8%) and 266 (27.8%) patients developed falls of ≥10, ≥20 and ≥30 points, respectively]. A total of 166 patients (25% of the 739 with basal BI ≥60) became dependent during follow-up. Most affected dimensions in ADL functional decline (patients with any dependence level at baseline/follow-up) are detailed in Fig. 1.

Median TRST and VIP scores were 2 (range: 2–3) and 1 (range: 1-2), respectively. In qualitative scoring, 627 patients (65.4%) were at functional risk according to the TSRT index, and 278 (29%) according to VIP. The detailed description of these scores is shown in Table 1. Calibration and discrimination power of both indexes with respect to the three endpoints (functional decline in BI ≥10, ≥20 and ≥30 points) are also detailed in Table 1.

3.1. Development of the PROFUNCTION INDEX and SIMPLIFIED PROFUNCTION

Division of the cohort was performed with the patients who completed follow-up. The compared main basal features of patients in the derivation ($n = 493$) and validation ($n = 465$) cohorts are detailed in Table 2.

Global functional decline rate in the derivation cohort was 30.4%. Seven factors (one demographic, four clinical, one functional, and one socio-familial) were independently associated with the primary endpoint, and for this reason were used to develop the index (Table 3). Other possible risk factors (sex, profession, caregiver's age and sex, inclusion criteria, all other inclusion categories, other comorbidities, number of other comorbidities per patient, need for chronic home oxygen therapy, individual as well as global IAs by means of L–B index, number of prescribed drugs, polypharmacy, all analytical parameters, and hospital admissions) were not associated with functional decline.

With respect to basal ADL, we developed different models including the global basal BI, its 10 dimensions, and both. The two latest models obtained poorer results in the validation cohort when compared with the model, which included the basal global BI. For this reason, and because the BI is a universally extended and easy-to-perform tool in clinical practice, we finally chose the model with this factor. The alternative strategies (forward and bidirectional selection techniques) resulted in no differences in the resulting prognostic variables of the modeling.

After dividing in functional decline probability quartiles in the PROFUNCTION index and SIMPLIFIED PROFUNCTION, functional decline ranged from 21% in the lowest, to 36% in the highest risk quartile. The obtained calibration in the derivation cohort was good

Table 2
Comparative main basal clinical features of the derivation and validation cohorts of polypathological patients from Spain.

Clinical features [mean ± SD/median (IQR)/N (%)]	Derivation cohort ($n = 493$)	Validation cohort ($n = 465$)
Age	78 ± 9	77.6 ± 10
Sex (males)	273 (56%)	241 (52%)
Requiring caregiver	200 (41.6%)	198 (43.4%)
Number of defining categories/patient	2.62 ± 0.7	2.59 ± 0.77
Patients with ≥3 categories	234 (47.5%)	207 (44.5%)
Prevalence of defining categories in recruited PPs		
Category A (heart diseases)	395 (80.1%)	368 (79.1%)
Category C (lung diseases)	229 (46.5%)	225 (44.1%)
Category E (neurological diseases)	162 (33%)	172 (37%)
Category B (kidney/autoimmune diseases)	156 (31.6%)	136 (29.2%)
Category F (peripheral arterial disease/diabetes with neuropathy)	138 (28%),	114 (24.5%)
Category G (chronic neoplasia/anemia)	104 (21.1%)	99 (21.3%)
Category H (degenerative osteoarticular disease)	73 (14.8%)	75 (16.1%)
Category D (liver disease)	34 (6.9)	36 (7.7)
Number of other comorbidities/patient	2.9 ± 1.6	3.1 ± 1.7 ($p = 0.03$)
Patients with ≥4 other comorbidities	246 (33.5 %)	287 (41%) ($p = 0.017$)
Most frequent other comorbidities		
Hypertension	381 (77.3%)	345 (74.2%)
Arrhythmias	165 (33.5%)	174 (37.7%)
Atrial fibrillation	159 (32.3%)	167 (36%)
Other arrhythmias	6 (1.2%)	7 (1.7%)
Diabetes without visceral involvement	133 (27%)	150 (32.3%)(p = .07)
Dyslipidemia	168 (34.1%)	149 (32%)
Anxiety and depressive disorders	66 (13.4%)	66 (14.2%)
Charlson index/Charlson index adjusted by age	3.8 (2)/7.6 (2)	3.6 (1.8)/7.4 (1.9)
Mean hemoglobin level (g/dL)	12.05 ± 2.2	11.8 ± 2.1
Albumin (g/dL)/body mass index	3.43 (0.6)/29 ± 6.4	3.31 (0.7)/28.9 ± 6.7
Albumin <3 g/dL	83 (17%)	97 (20.7%)
Body mass index <25	121 (24.5%)	121 (26.5%)
Patients with basal III–IV class of NYHA and/or MRC	171 (34.7%)	164 (35.3%)
Patients with one or more falls in last 12 mo	61 (12.5%)	105 (22%) ($p < 0.001$)
Hospitalizations in last 12/3 months	1.64 ± 1.5/0.87 ± 0.8	1.75 ± 1.4/0.82 ± 0.8
Patients with delirium in last hospital admission	27 (5.5%)	58 (12.5%) ($p < 0.001$)
Basal Barthel's Index / Basal Lawton–Brody index	77 ± 26/F = 3 (5); M = 4 (4)	76 ± 28/F = 3 (5); M = 4 (6)
End-point (12 mo follow-up) Barthel's index	67 ± 30	61 ± 32
Inclusion Pfeiffer scale/Gijón's socio-familial risk scale	1 (4)/10.4 ± 3.5	1 (4)/10.2 ± 3.2
Number of prescribed drugs at inclusion/patients with polypharmacy	7.8 ± 3.3/394 (84%)	8 ± 3.2/384 (87%)

F = female; IQR = interquartile range; M = male; MRC = Medical Research Council; NYHA = New York Heart Association; PP = polypathological patient; SD = standard deviation.

Table 3
Multivariate analysis of risk factors associated with 12-month functional decline in performing daily living activities (≥20 points fall in Barthel's index with respect to basal score), in the derivation cohort of polypathological patients from Spain.

Characteristic	Odds ratio (confidence interval)/*p*	PROFUNCTION Index	SIMPLIFIED PROFUNCTION
Demographics ≥85 yr	1.7 (1.032–2.81)/0.037	4	1
Clinical features			
Chronic neurological condition (CAT E)[a]	1.6 (1.001–2.56)/0.049	4	1
Chronic osteoarticular disease (CAT H)	2.1 (1.13–3.9)/0.019	5	1
III–IV class in NYHA and/or MRC	1.75 (1.18–2.7)/0.014	4	1
Four or more polypathology categories	2.05 (1.1–3.8)/0.024	5	1
Functional-socio-familial features			
Basal Barthel's Index <60	2.27 (1.24–4.14)/0.008	5	1
Risk or established social problem[b]	1.52 (1.001–2.34)/0.048	4	1
TOTAL SCORE ITEMS=7		0–31 points	0–7 points

[a] Cerebrovascular disease and/or any neurological diseases with significant functional/cognitive impairment.
[b] by means of Gijón socio-familial risk score. MRC = Medical Research Council; NYHA = New York Heart Association.

($p = 0.34/p = 0.13$) in the Hosmer–Lemeshow goodness-of-fit test, respectively.

All patients were assigned their respective PROFUNCTION index (range: 0–31) and SIMPLIFIED PROFUNCTION scores (range: 0–7), and divided into four different score groups. One-year functional decline rates with respect to both indexes are detailed in Table 4. Discrimination power of the PROFUNCTION index and SIMPLIFIED PROFUCTION obtained in the derivation cohort was acceptable [ROC curve area under the curve (AUC) = 0.574 (range: 0.52–0.629) and 0.59 (range: 0.526–0.635), respectively].

3.2. Validation of PROFUNCTION index

Global functional decline rate in the validation cohort was 42%. The obtained calibration in the derivation cohort was good ($p = 0.11/p = 0.09$) in the Hosmer–Lemeshow goodness-of-fit test, respectively. One-year functional decline rates with respect to both indexes in the validation cohort are detailed in Table 4. Discrimination power of the PROFUNCTION index and SIMPLIFIED PROFUCTION obtained in the derivation cohort was acceptable [ROC curve AUC = 0.52 (range: 0.48–0.64), and 0.56 (range: 0.51–0.641), respectively] as showed in Fig 2.

3.3. Comparison of PROFUNCTION index and SIMPLIFIED PROFUNCTION with TRST and VIP indexes

Comparative discrimination power (AUC in the ROC curves) of all evaluated and developed indexes are detailed in Fig. 2.

4. Discussion

In this study, we detected high rates of functional decline in a multicenter sample of PPs during 1 year of follow-up. These rates were higher than those detected in other studies handling geriatric clinic patients of similar ages[9,12,13,15,30]. As a matter of fact, only 29% of the PPs included remained alive and maintained their basal functional status for ADL; a similar rate to that obtained in the Sanfeliu study, which included patients aged ≥90 years[14]. The reason behind this more severe functional disability of PPs probably lies in their disease burden. Disease burden and clinical complexity are some of the most characteristic issues of PPs, as reflected in previous studies[1,3]. The functional data of this multicenter cohort reveals that the new concept of polypathology is capable of detecting vulnerable patients not only in terms of risk of death, but also in terms of risk of dependence. The ADL which most frequently declined were those related to self care (toilet use, grooming, dressing and bathing), and probably are the result of motor, balance, and cognitive decline. Additional explanations of this pattern of functional decline probably lie in the high prevalence of basal disability with respect to mobility, transfers, and climbing stairs, which allowed only narrow rates to worsen in these dimensions.

We detected poor discrimination power of recent tools specifically designed for functional prognostication. In fact, both TRST and VIP fitted well, but their AUC in discriminating 1-year functional deterioration was <0.5 in all three endpoint considerations (falls of ≥10, ≥20 and ≥30 points in BI). We believe that this scarce discrimination relies on three factors. The first could be the original endpoints in their development (TRST was developed with the aim of screening older patients' risk of hospitalization, functional decline, nursing home admission or readmission to an emergency department; and VIP assesses older patients' degree of independence, with the aim of detecting patients with potential discharge problems), which were quite different from ours (1-year functional decline in ADL)[15–17]. The second reason probably relies on the main features of PPs, which differ clearly from those of general geriatric populations; in fact, one of the main and homogeneous characteristics is their clinical complexity derived from the concurrence of complex chronic diseases. This differential profile points towards the importance of including disease stratification and burden, as well as symptom load, as key and additional predictors of functional decline. These important variables are not incorporated in

Table 4
Calibration of PROFUNCTION index and SIMPLIFIED PROFUNCTION in the derivation and validation cohorts by functional-decline risk groups according to subgroups scores, in a multicenter sample of polypathological patients from Spain.

Risk groups	PROFUNCTION Index		SIMPLIFIED PROFUNCTION	
Cohort	Derivation	Validation	Derivation	Validation
First	0 points = 21%	0 points = 17%	0 points = 21%	0 points = 24%
Second	1–2 points = 23.2%	1–2 points = 25.4%	1–2 points = 30.2%	1–2 points = 33%
Third	3–4 points = 34.5%	3–4 points = 38.5%	3 points = 34.2%	3 points = 39%
Fourth	≥ 5 points = 39%	≥ 5 points = 42%	4–7 points = 38%	4–7 points = 46%

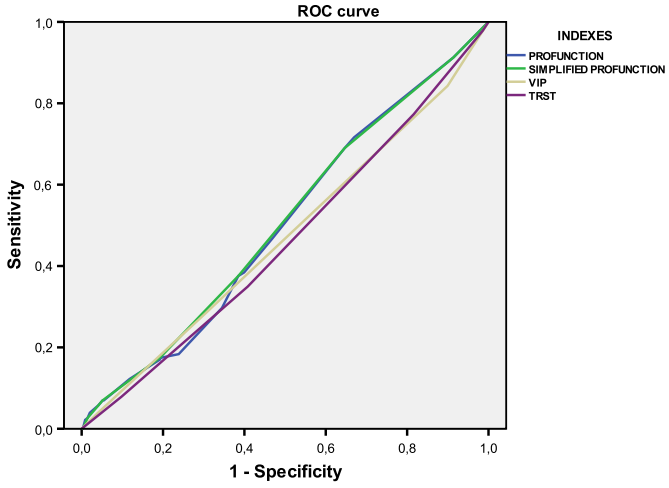

Fig. 2. Comparative discrimination power of PROFUNCTION index, SIMPLIFIED PROFUNCTION, TRST, and VIP indexes in predicting 12-month functional decline (loss of ≥20 points in Barthel's index), in a multi-institutional sample of polypathological patients from Spain, by means of ROC curves and determination of area under the curve. ROC = receiver operating characteristic; TRST = Triage Risk Screening Tool; VIP = Variable Indicative of Placement risk.

TRST or VIP indexes. Finally, the qualitative character of both scores dividing patients into only two risk groups (low and high risk for functional decline) predispose these indexes to adjustment losses with respect to the groups of patients with intermediate risk, who are classified with low or high functional decline risk.

Both indexes developed in our study, PROFUNCTION and SIMPLIFIED PROFUNCTION proved a good calibration and acceptable discrimination power in the derivation as well as in the validation cohorts. Because of the slight prognostic-weight differences among the initial score items, we performed a simplified version by making all items uniform in weight. After this simplification, we obtained very similar fitness and discrimination values, therefore, we suggest using the easier-to-perform simplified version. Our SIMPLIFIED PROFUNCTION successfully stratified the patients into four groups of functional decline risk, ranging from 21–24% in the lowest stratum to 38–46% in the highest.

In reviewing the seven score items, there are two important considerations upon which to remark. First, all of them have been demonstrated as predictors of functional decline in previous studies[2,31–33]; age is one of the main factors of functional status; among diseases, the number of illnesses as well as specifically neurological and osteoarticular disorders are narrowly correlated with functional disability[34,35]; with respect to symptoms, the level of dyspnea is probably one of the most disabling; finally both basal functional status and socio-familial support are key predictors of functional outcomes in all clinical and health-care scenarios[32,33]. Second, their multidimensional nature confers strength to the index, because of its ability to detect alterations or determinants of future functionality in determined areas (demographic, clinical, functional, or socio-familial), that are currently undetectable in others. Many of the available tools are centered exclusively or partially on only one area (e.g., clinical or functional), therefore, they could be prone to lose accuracy, because they lack this multidimensional integral approach.

In conclusion, functional decline is very prevalent in hospital-based populations of PPs. We developed and validated a new functional prognostic index specifically focused on PPs using seven simple measures of different clinical areas that can be easily achieved with a routine patient integral evaluation. The index had an acceptable calibration and discrimination power and was successfully validated in a geographically different cohort. It effectively stratified PPs into groups at varying risks of functional decline, and its fitness was better than other available functional prognostic tools.

Conflict of interest

The authors have no conflicts of interest to report.

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Appendix 1. List of researchers from the PROFUND Project

Máximo Bernabeu-Wittel[1], Aurelio Fuertes-Martín[2], Bosco Barón-Franco[3], José Murcia-Zaragoza[4], Carmen Ramos-Cantos[5], Antonio Alemán[6], Antonio Fernández-Moyano[7], Manuel Ollero-Baturone[1], Javier Galindo-Ocaña[1], Alberto Escalera-Zalvide[3], María Sanchez-Ledesma[2], Antonia Mora-Rufete[8], José Barbé Gil-Ortega[9], Lourdes Moreno-Gaviño[1], Virginia Rodríguez-Martínez[10], Carolina Luque-Amado[11], Manuel Romero-Jiménez[12], María Maiz-Jiménez[11], Ma Ángeles Soria-López[13], Manuel Rincón-Gómez[1], Manuel Bayón-Sayago[1], Pilar Retamar[14], Jesús Medina[15], Nieves Ramírez-Duque[1], Pilar Giner[16], Beatriz Massa[17], Tomás Martínez[3], Manuel Francisco Fernández-Miera[18], Sixto Ruiz[19], José Manuel Machín-Lázaro[20], Ignacio Novo Valeiro[2], Guillermo Ternavasio[2], Montserrat Godoy[11], Jordi Aligué[21], Luis Feliu-Mazaria[22], Manuel Cassani-Garza[1], Francesc Formiga[23], Emilio Sacanella[24], Ma Luisa Rodríguez-Benedito[25], Manuela Castillo-Blasco[26], Manuel Montero Pérez-Barquero[27], Eulalia Villegas-Bruguera[28], Blanca Pinilla[29], Lucy Abella-Vázquez[30], Jordy Forteza-Rey[31], Jesús Díez-Manglano[32], Clotilde Morales[21], Alicia Tejera-Concepción[30], Pedro Tenllado-Doblas[26], Francisco Medrano-González[33], MaDolores Nieto-Martín[1], Alberto Ruiz-Cantero[11], Felipe Díez[10], Mariano Aguayo-Canela[14], Carlos Sanromán[5], Cristina de la Calle-Cabrera[2], Hernán Llorente-Cancho[2], Sandra Gómez-Lesmes[2], Antonio Sanjosé-Laporte[9].

[1]Hospitales Virgen del Rocío, Sevilla; [2]Hospital Universitario, Salamanca; [3]Hospital Juan Ramón Jiménez, Huelva; [4]Hospital General de Alicante; [5]Hospital de la Axarquía, Málaga; [6]Hospital Morales Meseguer, Murcia; [7]Hospital San Juan de Dios del Aljarafe, Sevilla; [8]Hospital General de Elche; [9]Hospital Vall d'Hebrón, Barcelona; [10]Hospital de Torrecárdenas, Almería; [11]Hospital de la Serranía, Málaga; [12]Hospital Infanta Elena, Huelva; [13]Clínica Virgen de la Vega, Murcia; [14]Hospital Virgen Macarena, Sevilla; [15]Hospital 12 de Octubre, Madrid; [16]Hospital San Cecilio, Granada; [17]Hospital de Villajoyosa, Alicante; [18]Hospital Marqués de Valdecillas, Santander; [19]Hospital de Inca, Mallorca; [20]Hospital de Guadalajara; [21]Hospital de Manresa, Barcelona; [22]Hospital General de Palma, Mallorca; [23]Hospital de Bellvitge, Barcelona; [24]Hospital Clínico, Barcelona; [25]Hospital General de Requena, Valencia; [26]Hospital Dr Moliner, Valencia; [27]Hospital Reina Sofía, Córdoba; [28]Hospital Dos de Maig, Barcelona; [29]Hospital Gregorio Marañón, Madrid; [30]Hospital Nuestra Sra. de la Candelaria, Tenerife; [31]Hospital Son Dureta, Mallorca; [32]Hospital Royo Villanova, Zaragoza; [33]Hospital de Albacete.

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