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An innovative maintenance follow-up program after a first inpatient pulmonary rehabilitation

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Summary
Although the benefits of pulmonary rehabilitation (PR) have been demonstrated in patients with COPD, most studies suggest that short-term programs are insufficient to maintain the benefits beyond a post-discharge period of 6 months to 1 year. We were interested to evaluate the effects of an innovative maintenance intervention compared with a usual after-care.

Forty moderate to severe COPD patients, who had just completed their first inpatient PR, were consecutively included in either a maintenance group (MG) or a standard after-care group. The maintenance program was coordinated within a health-care network including self-help associations, and offered weekly activities. We measured the 6-min walk distance (6MWD), the quality of life using the St George Respiratory Questionnaire (SGRQ), the dyspnea, the maximal workload and the health-care utilization. Data were collected at respiratory clinic admission and discharge, and at 6- and 12-month visits after the PR.

After 12 months, we found statistically and clinically significant differences in favor of the MG in 6MWD (74 m; $p \leqslant 0.01$) and in the three domains of SGRQ: symptom (19%; $p \leqslant 0.01$), activity (27%; $p \leqslant 0.01$) and impact (32%; $p \leqslant 0.01$). The results showed no difference between groups in dyspnea and maximal workload. We also found that the number of days spent in hospital for respiratory disorders was significantly lower in the MG after 12 months ($p \leqslant 0.03$).

The multidisciplinary management of COPD patients in the post-rehabilitation period within a health-care network including self-help associations seems to be an effective strategy for maintaining, and even improving, the benefits of a first initial structured program.

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Introduction

Interest has arisen in strategies to maintain the benefits of pulmonary rehabilitation (PR) over time, such as repeated courses of rehabilitation treatment[1] or maintenance interventions: i.e., hospital consultations,[2–8] phone support,[9] nursing visits at home,[10–12] activities in self-help groups.[13] The benefits of these interventions are too heterogeneous to indicate the form a maintenance strategy should take or how it should be applied. However, some key points have emerged.

The supervision of activities appears to be one key element.[3,4,13–15] Interaction with health-care providers who shared information, built partnerships, and gave emotional support also led to greater adherence to health recommendations.[16] Guell et al.[13] reported that improvements in the dyspnea score, 6-min walk distance (6MWD) and quality of life (QoL) were maintained 18 months after discharge and suggested that a specific maintenance program including a self-help group was particularly effective. A maintenance program that provides a socially supportive environment can facilitate the adjustment process by encouraging adaptive thoughts and behaviors. Peer support among patients with other chronic diseases has consistently been reported as an important factor in adherence to therapy.[17,18] Moreover, the World Health Organization noted that truly collaborative follow-up is an effective means to ensure smooth coordination and greater partnership among health-care providers and between these providers and patients.[19] Last, when set within a collaborative network,[20] patient-run support groups reinforce social supports and promote exchanges between patients, encouraging them to take greater responsibility for their own care.[21]

Therefore, this controlled pilot study was designed to determine the 1-year effect of a multidisciplinary maintenance program after a first inpatient PR. The program, run in local patient self-help associations after PR, proposed weekly activities that were coordinated within a regional health-care network. The primary outcome measure was the 6MWD. The secondary outcome measures were QoL, dyspnea, maximal workload and health-care utilization assessments.

Methods

Subjects and experimental design

Patients with moderate to severe COPD[22] were recruited from three regional rehabilitation centers where they had just benefited from their first PR program. Inclusion criteria for the rehabilitation session were as follows: a post-bronchodilator forced expiratory volume in 1 second (FEV_1)/forced vital capacity (FVC) <0.7 and an FEV_1 30–79% predicted, no indication for home oxygen therapy, and no exacerbation or hospitalization in the previous 2 months. Exclusion criteria were significant medical or psychiatric disturbances that would interfere with full participation in the program. The patients participated in the 20 sessions of the 4-week inpatient PR.[23] Afterwards, the patients were consecutively included in standard after-care group (SG) or maintenance group (MG) after PR discharge. The consecutive assignment of eligible patients to the follow-up groups is based on the unpredictable occurrence of their domiciliation. The subjects assigned to the SG were those who lived in towns without existing self-help association. No information on the creation of a self-help association in the coming year was given to the patients. The study was approved by the medical ethics committees of all three centers, and all patients provided written informed consent.

Standard after-care group

The patients in this group had been given a letter on discharge outlining the recommended home care rehabilitation program. They then continued with their usual primary care follow-up for 1 year.

Experimental maintenance group

On discharge, all patients in this group joined a regional health-care network that included three local self-help associations of patients who had ever completed a PR program. Each local multidisciplinary team in the network provided the similar 96 coordinated sessions. To ensure the quality and the consistency of the maintenance program, all professionals participated in a training on PR, during which they were taught all components of the program as follows: (a) individualized exercise training (3.5 h/week; 72 sessions) supervised by a teacher of adapted physical activities in a town gymnasium including breathing exercises, interval training (in circuit and in team sport—in line with the patients interest's), strength training, upper limb training (with free weights, elastic bands), and endurance training with nature walking at the ventilatory threshold[24]; (b) health education provided alternatively by all professionals of the health-care network (2 h/month; 12 sessions) in a municipal conference room; and (c) psychosocial support (with discussion group 1 h/month; 12 sessions) supervised by a psychologist in the same room. The self-help associations could obviously decide to add discretionary leisure activities desired by members, such as museum visits, restaurant outings or inter-group meetings. These groups were entirely run by the patients. The self-help associations are federated in a larger association—the healthcare network. They benefit from resources provided by the regional network financing the 96 sessions supervised by the health professionals in the 1-year maintenance program (for more information on the organization of the health-care network, see www.airplusr.fr).

Assessments

All the patients were evaluated before and after PR, and 6 and 12 months after the completion of the PR. Utilization of health-care resources was also assessed first before and then 12 months after the PR. To ensure uniform assessments in this multicentric study, the medical and scientific committee of the health-care network developed recommendations for a standard protocol for instrument use and patient assessment.

Primary outcome measure

6MWD. The 6MWD test was performed twice with more than 30 min between tests to allow heart rate and dyspnea to return to their initial rest values.[25] Subjects were asked to

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walk at their own maximal pace along a perimeter of 30 m. No encouragement was given, and subjects were informed each minute of the time remaining. A dyspnea score was measured on a visual analog scale (VAS) before and at the end of the test. We considered a difference of $\geqslant$54 m as clinically important.[26]

Secondary outcome measures

Quality of life. Disease-specific QoL was assessed by the French version of St George Respiratory Questionnaire (SGRQ). This validated 50-item questionnaire[27,28] has been widely used in patients with COPD.[9,10,29–31] The SGRQ is composed of three domains: *symptoms*, *activities* and *impacts*. Scores range between 0 (no impairment) and 100 (worst possible health). A difference $\geqslant$4.0 is considered as the minimum clinically important difference.[32]

The short version of the QoL questionnaire validated by the World Health Organization (WHOQOL-Brief)[33] was used as a generic measure. The WHOQOL-Brief has 26 items that assess the consequences of illness on daily life along six domains: *physical*, *psychological*, *social*, *environmental*, *global QoL* and *health satisfaction*. The scores were calculated on a scale from the raw item scores, which range from 4 to 20, with lower scores reflecting deteriorated QoL.

A six-item questionnaire with a VAS was administered to measure the functional consequences of COPD on daily life. Under each item, a single 10-cm horizontal line without formal indications can be scored from ''not at all'' (0 cm) to ''absolutely'' (10 cm). This questionnaire includes six domains on satisfaction concerning *respiratory control behavior*, *physical activity*, *sleep*, *fatigue*, *physical condition* and *dyspnea*. The *physical condition* item was validated by previous research.[34]

Maximal exercise test. Maximal exercise test was performed on a cycle ergometer following the individualized protocol usually used in our laboratory[35] and recommended by the American Thoracic Society.[36]

Physical activity. The Voorrips provides a reliable and valid method for classifying the activity level of older subjects as high, medium or low with a score of 9 or more indicating a low physical level, thus classifying the subject as being sedentary.[37]

Health-care utilization. Utilization of health-care services in the year before and after rehabilitation was assessed from self-reports. The patients provided information on the number of hospital admissions, the days spent in hospital, the number of consultations with a general practitioner and with a lung specialist, and the number of home visits by the general practitioner. The information was checked by inspection of the patient files.

Attendance. Attendance to the multidisciplinary follow-up program was recorded for each participant in the MG by the health providers during each session. Percent of compliance for attendance was defined as the number of sessions that the participant attended, divided by the number of sessions proposed in each self-help association, multiplied by 100.

Pulmonary function tests. According to European Respiratory Society guideline[38] lung function measurements were performed using a plethysmograph (V6200 Autobox; SensorMedics, Yorba Linda, CA) to determine total lung capacity (TLC), FVC and FEV_1. The Tiffeneau ratio (FEV_1/FVC) was then calculated.

Statistical analysis

Pre-(T1) and post-(T2) rehabilitation data were compared with a repeated measure ANOVA for all eligible subjects. Both experimental groups were also compared using independent *t*-test for the continuous variable and Pearson Chi square (χ^2) tests for the discrete variables.

Afterwards, the effects of the maintenance program were evaluated in a two-way repeated measures ANCOVA (Time-Group), with the corresponding baseline value of follow-up program (T2) treated as a covariate. Data from 6-month (T3) to 12-month assessments (T4) were used to evaluate the changes of primary and secondary outcome measures over time and the differences in these changes across both groups. The effect sizes of the maintenance program were estimated by the partial eta square (η_P^2) for each outcome measure.

For the significant Time $\times$ Group interactions, group differences at T2, T3 and T4 were examined with by independent-sample *t*-tests at each time point. In these follow-up analyses, mean differences, confidence intervals around this difference, and least significant different (LSD) Fisher tests were examined.

Because the health-care utilization's data were not normally distributed, we used (1) a Wilcoxon sign-rank test to compare data 1 year before and after enrollment in the PR program, and (2) a Mann–Whitney *U* test to compare data between MG and SG. Significance for all analyses was accepted at $p \leqslant 0.05$, and the approach was two sided.

Results

Initial PR program

Out of the 650 COPD patients rehabilitated during the last 2 years in our centers, only 50 patients were domiciled in our region and had completed their first PR program (Figure 1). Therefore, they were eligible for the study. Of these, the 40 with complete discharge data who agreed to participate were consecutively admitted to either the experimental MG ($n = 14$) or to a SG ($n = 26$) for 1 year.

Table 1 summarizes selected descriptive characteristics and changes after PR in all 40 eligible COPD patients. Rehabilitation improved measures of exercise performance (6MWD, maximal workload, $\dot{V}_{O_2max}$ and workload at ventilatory threshold) and QoL, according to the three domains of SGRQ. There were no significant differences at the time of discharge in the subgroup analyses.

Follow-up period

At 1 year of individual follow-up, 13 subjects had not completed the scheduled sessions of assessment (Figure 1). In the SG, six patients had dropped out at the 6-month point for the following reasons: three exacerbation crises, one inpatient psychiatry admission, one death due to cardiac failure and one infectious arm. At 1-year, further four control subjects had dropped out because of acute

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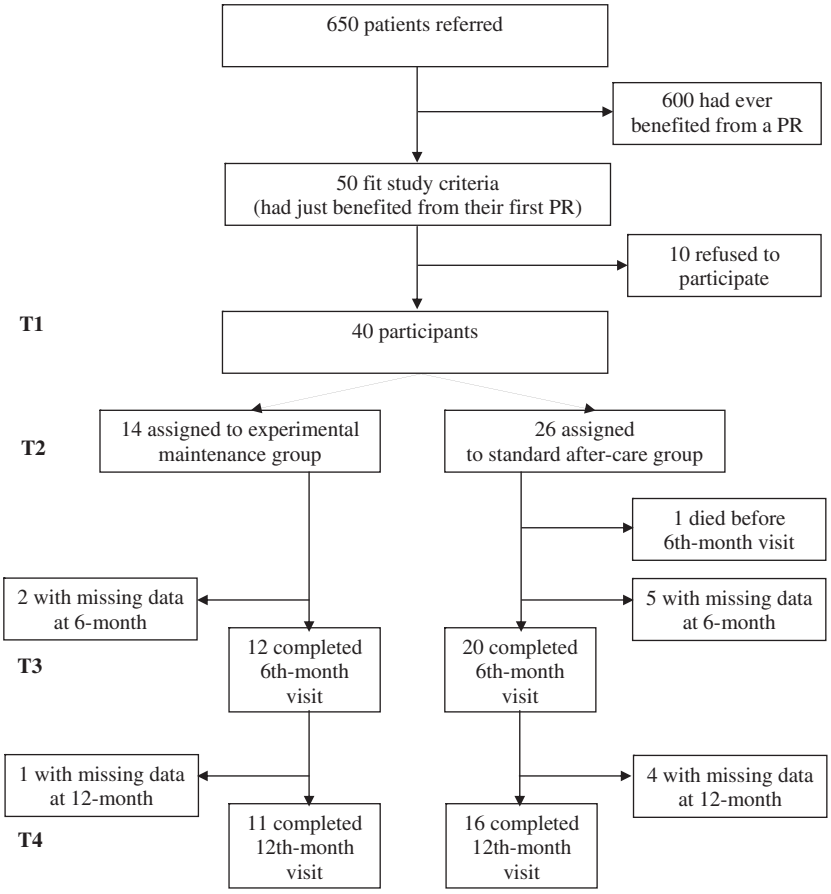

Figure 1 Trial profile. *Notes*: based on completion of all assessments; PR: pulmonary rehabilitation.

Table 1 Results before and after the initial pulmonary rehabilitation in the 40 eligible patients.

	Admission (T1)	Discharge (T2)	Mean difference between groups (95% CI)	α
Sex (male/female)				
Group S		21/5		0.50*
Group M		10/4		
Age (year)				
Group S		59.7±9.6	2.9 (−2.8 to 9.1)	0.29†
Group M		62.9±7.4		
Single/marital status				
Group S		10/16		0.79*
Group M		6/8		
Body-mass index (kg/m^2)				
Group S	24.9±5.0	24.6±5.2	1.1 (−2.2 to 4.4)	0.51
Group M	25.9±4.8	25.8±4.7		
Pulmonary function				
FEV_1 (% predicted)				
Group S	46.7±19.2	46.8±18.2	4.2 (−7.3 to 15.6)	0.47
Group M	52.6±16.4	49.3±14.9		
FEV_1/FVC (%)				
Group S	52.1±15.4	51.7±16.8	2.6 (−6.3 to 11.6)	0.55
Group M	54.9±10.7	54.2±10.1		

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Table 1 (*continued*)

	Admission (T1)	Discharge (T2)	Mean difference between groups (95% CI)	α
TLC (% predicted)				
Group S	121.5±18.3	122.5±19.5	−10.1 (−21.8 to 1.6)	0.09
Group M	111.0±18.8	112.7±15.9		
Six-min walking test				
Distance (m)				
Group S	401.9±106.6	454.2±102.6‡	18.5 (−46.8 to 83.7)	0.57
Group M	424.1±94.5	468.8±95.4‡		
Dyspnea (0–10)				
Group S	5.5±2.3	5.1±2.7	−0.4 (−1.8 to 1.1)	0.60
Group M	4.9±2.5	4.9±2.4		
Maximum ergocycle exercise				
Maximal workload (W)				
Group S	67.9±32.6	77.9±35.7‡	0.2 (−23.3 to 23.7)	0.99
Group M	71.1±35.5	75.1±41.6		
V_{Emax} (L/min)				
Group S	47.9±19.7	49.5±20.2	−1.5 (−14.4 to 11.4)	0.82
Group M	46.7±16.7	47.8±17.1		
$\dot{V}_{O_2max}$ (mL/min/kg)				
Group S	14.9±5.3	15.9±5.3‡	−0.6 (−4.1 to 2.9)	0.74
Group M	14.3±4.1	15.4±5.7		
Workload at ventilatory threshold (W)				
Group S	42.0±21.8	51.5±20.4‡	6.9 (−8.7 to 22.5)	0.37
Group M	51.1±25.0	56.2±29.6‡		
SGRQ scores				
Symptoms				
Group S	65.7±18.7	58.8±19.7‡	2.5 (−9.1 to 0.1)	0.66
Group M	68.1±15.5	61.6±16.7‡		
Activities				
Group S	71.2±14.0	64.5±22.8‡	−2.1 (−0.1 to 9.7)	0.72
Group M	67.5±16.4	64.6±17.9‡		
Impacts				
Group S	45.1±17.0	35.9±16.8‡	−4.3 (−0.1 to 6.3)	0.42
Group M	40.4±14.8	32.6±15.6‡		

Notes: values are expressed as mean±S.D.; Group S: standard after-care group; Group M: maintenance group.
*Significance level of the Pearson χ^2.
†Independent-samples *t*-test.
‡$p<0.05$ (Fisher test).

exacerbation. In the MG, three patients were lost to follow-up evaluation (two because of acute chest exacerbation crises at 6-month, and one with myocardial aneurysm at 1 year). The discharge data for the 13 patients who did not complete the follow-up evaluations were comparable across the board to those of the 27 subjects who completed both the 6- and 12-month assessments (Table 2).

The results of the patients who completed all assessment are presented in Table 3. They presented a comparable level of physical activity measured by the Voorrips in the year before rehabilitation ($p = 0.28$). The χ^2-test showed no difference in the proportion of male to female patients between subgroups ($p = 0.67$).

Primary outcome measure

The ANCOVA showed a significant interaction effect for 6MWD ($p \leqslant 0.01$) (Table 3). We observed a significant deterioration of distance at 6-month ($p \leqslant 0.03$) and 12-month visit ($p \leqslant 0.03$) for the SG. For the MG, the distances walked at 1 year were higher than at PR discharge ($p \leqslant 0.04$). After 1 year, the difference between groups exceeded the

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Table 2 Data for all recruited patients at discharge (T2) of the initial pulmonary rehabilitation.

	Group S			Group M			Group S+M		
	Completed	Withdrawn	α^*	Completed	Withdrawn	α^*	Completed	Withdrawn	α^*
N	16	10		11	3		27	13	
Age (year)	57.1±8.8	63.8±9.7	0.11	64.6±6.1	56.3±9.3	0.12	60.2±8.6	62.1±9.7	0.61
Body-mass index (kg/m^2)	25.3±5.1	23.5±5.3	0.30	26.9±4.0	21.6±5.9	0.19	26.0±4.7	23.1±5.2	0.08
Pulmonary function									
FEV (% predicted)	48.9±16.0	43.4±21.8	0.48	51.6±11.7	40.7±24.8	0.35	50.0±14.2	42.8±21.5	0.24
FEV/FVC (% predicted)	51.6±19.0	51.9±13.6	0.65	52.3±6.7	61.3±18.6	0.35	51.9±15.0	54.1±14.6	0.57
TLC (% predicted)	121.6±16.1	124.0±24.8	0.71	114.9±16.4	104.7±13.6	0.27	118.8±16.2	119.5±23.8	0.89
Six-min walking test									
Distance (m)	473.4±81.9	420.0±130.2	0.20	471.3±89.1	459.7±138.8	0.59	472.6±83.2	429.9±127.1	0.17
Dyspnea (0–10)	4.8±2.4	5.5±3.3	0.61	4.9±2.3	5.1±3.2	0.58	4.8±2.3	5.4±3.1	0.56
Maximal ergocycle exercise									
W_{max} (W)	81.4±28.5	72.2±46.1	0.37	78.3±36.1	63.3±66.6	0.31	80.1±31.2	75.7±40.5	0.75
V_{Emax} (L/min)	49.9±12.8	48.8±30.3	0.36	49.2±11.3	43.0±30.4	0.40	49.6±12.0	47.3±29.8	0.22
$\dot{V}_{O_2max}$ (mL/min/kg)	16.3±4.1	15.4±7.3	0.53	15.4±5.7	15.3±6.6	0.86	15.9±4.7	15.4±6.9	0.54
$W_{threshold}$ (W)	51.0±16.6	52.4±27.8	0.76	57.8±24.2	50.3±51.9	0.40	53.8±19.9	50.5±27.2	0.67
SGRQ scores									
Symptoms	61.5±21.2	54.4±17.0	0.43	59.0±17.7	71.4±7.9	0.31	60.5±19.5	58.4±16.8	0.78
Activities	63.5±17.4	66.0±30.5	0.56	62.3±18.9	73.0±12.8	0.35	63.0±17.8	67.7±27.8	0.29
Impacts	34.8±14.4	37.7±20.7	0.60	29.6±12.7	43.5±23.2	0.31	32.7±13.7	39.1±20.3	0.26

Notes: values are expressed as mean±S.D.; Group S: standard after-care group; and Group M: maintenance group.
*Independent-samples *t*-test.

minimum clinically important difference of 54 m (75.8 m; $p \leqslant 0.01$) (Table 3). For a comparable VAS dyspnea score between groups at the end of exercise, the MG walked thus 75.8 m farther than the SG at the 12-month visit.

Secondary outcome measures

We observed a significant clinically difference between groups for *symptoms* ($p \leqslant 0.01$), *activities* ($p \leqslant 0.01$) and *impacts* domain of SGRQ ($p \leqslant 0.01$), 1 year after completion of PR (Table 3). In addition, the score in the MG improved between 6-month and 12-month for *symptoms* ($p \leqslant 0.02$) and from PR discharge to 6-month for *activities* ($p \leqslant 0.01$) and *impacts* ($p \leqslant 0.02$).

The MG showed improvement in the scores of the *physical* domain (of WHOQOL-Brief), with higher scores at 6-month ($p \leqslant 0.03$) and 1 year ($p \leqslant 0.04$) compared with PR admission values. Also, subgroup analyses revealed a significant difference after 6 months ($p \leqslant 0.05$) and 1 year ($p \leqslant 0.01$) with higher scores for the MG. Similarly, ANCOVA indicated an interaction effect for the *perceived physical condition* domain (of VAS) ($p \leqslant 0.02$). Scores improved between PR discharge and 6-month ($p \leqslant 0.01$) and remained higher at 12 month ($p \leqslant 0.01$) for the MG compared with the SG. No interaction effect was found for the *general's QoL*, *psychological*, *social*, *environmental* and *health satisfaction* domains of WHOQOL-Brief.

The post-hoc test indicated a decline from discharge to 6-month visit for the W_{max} of the SG ($p \leqslant 0.02$). The MG showed higher W_{max} values at 6-month ($p \leqslant 0.04$) and 1 year ($p \leqslant 0.05$) than the workload developed at baseline, before the completion of PR (Table 3). Last, the $\dot{V}_{O_2max}$ values were maintained in the MG and declined in the SG after PR discharge.

There were no significant differences between the MG and the SG in measures of lung function over the follow-up period.

After 1 year of follow-up, the *total* Voorrips score improved significantly for the MG (Table 3), from a low to a moderate level of daily physical activity. On the other hand, the SG did not show any significant change at the 12-month visit, with lower scores than MG ($p \leqslant 0.01$).

The 11 subjects of the MG who completed all follow-up measures attended on average 65.8±16.0 (68.6%) out of a maximum of 96 sessions.

Regarding health-care utilization, the number of days spent in hospital for respiratory causes significantly differed ($p \leqslant 0.03$) between groups after 1 year (Table 4). Also, in the SG, there were fewer home visits by a general practitioner ($p \leqslant 0.04$) in the 12 months following the PR than in the year before rehabilitation.

Discussion

This study indicates that a 1-year maintenance program, after the completion of the PR, within a health-care network including patient self-help associations is a feasible approach to significantly improve functional exercise capacity, QoL and health-care utilization variables compared

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Table 3 Results in patients who completed all follow-up evaluations.

Outcome measure	Discharge (T2)	Δ (95% CI)[#]	α	6-month (T3)	Δ (95%CI)	α	12-month (T4)	Δ (95%CI)	α	$F(3.75)$	η_p^2
Sex (male/female)											
Group S	12/4		0.67*								
Group M	9/2										
Pulmonary function											
FEV_1 (L)											
Group S	1.38±0.49	0.1 (−0.2 to 0.9)	0.49	1.18±0.43			1.25±0.38				
Group M	1.43±0.33			1.31±0.45			1.31±0.40				
Six-minute walk											
Distance (m)											
Group S	473.4±81.9*	−22.6 (−61.2 to 16.0)	0.24	435.8±78.9†	74.2 37.7–110.5)	0.01	436.3±82.1†	75.8 (32.0–119.6)	0.01	10.58	0.31
Group M	471.3±89.1			508.4±68.9*			510.6±80.2†				
Dyspnea (0–10)											
Group S	4.8±2.4	0.7 (−1.1 to 2.4)	0.44	4.9±2.0			5.4±2.2				
Group M	4.9±2.3			5.5±2.0			6.3±2.2				
Maximum ergocycle exercise											
Maximal workload (W)											
Group S	81.4±28.5	−9.6 (−22.6 to 3.4)	0.14	69.9±26.8†	19.1 (2.1–36.1)	0.03	75.3±23.3	13.44 (−1.4 to 28.3)	0.07	4.05	0.15
Group M	78.3±36.1			86.5±44.8*			86.1±41.3*				
V_{Emax} (L/min)											
Group S	49.9±12.8	−2.1 (−8.4 to 4.3)	0.51	44.7±12.3			46.0±10.7				
Group M	49.2±11.3			47.3±17.5			47.2±16.7				
$\dot{V}_{O_2max}$ (mL/min/kg)											
Group S	16.3±4.1	−0.5 (−2.8 to 1.8)	0.66	14.6±3.5†	3.8 (1.2–6.4)	0.01	14.4±4.0†	2.4 (−0.3 to 5.1)	0.08	5.23	0.18
Group M	15.4±5.7			17.7±6.7*,†			16.2±5.6*				
Quality of life measures											
SGRQ (MCID = 4.0)											
Symptom											
Group S	61.5±21.2*	−0.1 (−11.0 to 9.5)	0.88	64.5±15.7	−6.7 (−16.2 to 2.7)	0.15	65.3±17.4	−18.5 (−30.9 to −6.2)	0.01	6.86	0.22
Group M	59.0±17.7			56.2±17.6*			45.5±8.6*,†,‡				
Activity											
Group S	63.5±17.5*	5.6 (−3.7 to 14.8)	0.22	67.3±18.7	−20.2 (−33.4 to −7.1)	0.01	73.7±12.9†	−27.0 (−40.0 to −14.0)	0.01	9.69	0.29
Group M	62.3±18.9			46.3±22.1*,†			46.2±23.6*,†				
Impact											
Group S	34.7±14.4*	2.2 (−4.3 to 8.6)	0.49	40.6±20.3†	−17.0 (−28.1 to −5.8)	0.01	50.2±14.1†	−32.4 (−42.0 to −22.8)	0.01	21.68	0.47
Group M	29.6±12.8			19.6±10.7*,†			16.0±9.3*,†				
WHOQOL-BRIEF											
Physical											
Group S	10.5±2.4	0.8 (−0.5 to 2.1)	0.21	10.4±2.8	2.2 (0.4–4.0)	0.02	9.4±2.2	3.4 (1.4–5.4)	0.01	7.15	0.26
Group M	12.4±2.6			13.5±2.0*			13.4±1.9*				
Psychological											
Group S	13.2±2.0	0.6 (−0.9 to 2.1)	0.43	13.7±1.7			12.6±2.5				
Group M	14.4±1.9			15.5±2.3			15.2±2.1				

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Table 3 (*continued*)

Outcome measure	Discharge (T2)	Δ (95% CI)[#]	α	6-month (T3)	Δ (95%CI)	α	12-month (T4)	Δ (95%CI)	α	$F(3.75)$	η^2_P
Social											
Group S	14.8±1.4	0.2 (−1.2 to 1.6)	0.79	14.1±2.3			14.6±3.4				
Group M	14.8±2.5			15.0±2.2			14.3±2.5				
Environment											
Group S	13.6±1.3	0.5 (−0.7 to 1.6)	0.41	13.5±1.9			13.0±1.5				
Group M	14.6±1.9			15.7±1.9			15.4±1.4				
General's quality of life											
Group S	12.3±2.7	0.5 (−1.6 to 2.7)	0.60	12.0±4.2			11.7±4.0				
Group M	13.1±3.1			15.6±2.2			15.3±2.4				
Health satisfaction											
Group S	10.7±3.9	−2.1 (−4.6 to 0.4)	0.10	10.7±3.1			9.7±4.0				
Group M	11.6±4.2			13.1±3.1			12.5±3.8				
VAS											
Respiratory control											
Group S	4.9±2.8	1.1 (−1.0 to 3.2)	0.30	4.2±2.8			3.8±2.7				
Group M	6.4±2.3			6.4±2.2			6.7±2.4				
Physical activity											
Group S	4.0±2.4	1.7 (−0.5 to 3.9)	0.12	4.3±2.8			4.1±3.2				
Group M	6.1±2.4			7.2±2.1			7.1±1.1				
Sleep											
Group S	5.4±2.9	0.3 (−1.5 to 2.2)	0.70	5.6±2.6			4.5±2.8				
Group M	6.4±2.4			6.9±2.7			6.8±2.0				
Fatigue											
Group S	5.7±2.5	−0.8 (−3.2 to 1.7)	0.51	5.4±3.2			4.9±3.0				
Group M	4.6±2.9			4.8±2.4			5.6±2.7				
Physical condition											
Group S	4.1±2.6	−0.6 (−2.8 to 1.5)	0.54	4.2±2.5	1.5 (−0.3 to 3.4)	0.10	3.2±2.8	2.7 (0.6–4.7)	0.01	6.89	0.26
Group M	4.2±2.6			6.4±2.0[*,†]			6.6±2.1[*,†]				
Dyspnea											
Group S	2.7±2.3	−0.1 (−1.3 to 1.1)	0.86	3.5±3.5			4.0±3.0				
Group M	1.7±1.0			2.6±1.5			1.3±1.2[‡]				
Voorrips											
Group S	4.2±3.6	1.6 (−1.4–4.7)	0.28				5.1±4.9	6.9 (2.7–11.2)	0.01		
Group M	5.8±4.0						12.0±5.8*				

Notes: values are expressed as mean±S.D.; PR: pulmonary rehabilitation; Group S: standard after-care group; Group M: maintenance group; Δ (95% CI): difference between maintenance and control group adjusted for T2 (# for T1) (95% confidence interval); α: significance level of the Pearson χ^2; $F(3.75)$: two-way repeated measures ANCOVA (Time × Group); and η^2_P: effect size estimated by the partial eta square.

[*] $p<0.05$ (Fisher test) vs. admission (T1).

[†] $p<0.05$ vs. discharge (T2).

[‡] $p<0.05$ vs. 6 months (T3).

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Table 4 Results of self-reported health-care utilization over the 1 year before and after the inpatient pulmonary rehabilitation.[#]

	One-year pre-rehabilitation	One-year post-rehabilitation
Hospital days		
Respiratory causes		
Group S	2.7±6.2	6.4±14.5[§]
Group M	3.0±4.0	0.0
All causes		
Group S	5.6±12.2	7.9±16.1
Group M	3.5±5.2	1.5±3.4
Consultations with general practitioner		
Group S	7.7±4.7	7.8±4.6
Group M	6.1±3.7	6.2±3.2
General practitioner's home visits		
Group S	1.7±5.1	0.9±3.0*
Group M	0.0	0.0
Consultations with lung specialist		
Group S	3.3±2.8	2.5±0.4
Group M	4.7±6.6	3.8±5.6

Notes: Group S: standard after-care group and Group M: maintenance group.

[#]In patients who completed all follow-up evaluations.

[§]$p<0.05$ (Mann–Withney test).

*$p<0.05$ (Wilcoxon test).

with standard after-care. Although some studies advocating maintenance follow-up programs[4,7,8,12–14,29,39] have reported maintained benefits of PR as the best result, ours is the first to indicate actual improvement after a 12-month maintenance program.

Limitations of the study

We see several important implications of our pilot study. Before discussing them, we consider some potential limitations. Without a randomized controlled design, the benefits of the maintenance program cannot be concluded in this study. Other factors may have contributed to change. Further randomized controlled clinical trials are needed to confirm these hypotheses. This potential bias is, however, minimized by the consecutive assignment of patients to SG or MG after PR discharge in function of unpredictable occurrence of their domiciliation. Each patient was included in one of the two groups according to the presence of a local self-help association. The low number of participants in each group also merits comment. While 650 patients had completed a PR over the 2-year period of inclusion, only 40 patients fit study criteria and were enrolled in the follow-up evaluation. Note that our follow-up study is the first to impose the participation in a first PR as an inclusion criterion. Then, this criterion improves the internal validity of our study and reduces the potential weakness of the sample size which parallels those of previous follow-up studies with COPD.[39–42]

Standard-after-care group

The statistically significant decline in 6MWD occurred earlier, after PR discharge, than in most studies.[8,40,43–47] These studies consistently demonstrated that benefits in exercise tolerance were well maintained for a period of up to 12 months. One reason for this discrepancy is that our patients had benefited from their first PR and had thus not incorporated all of the recommendations into their daily living activities. The higher number of drop-outs in the SG due to exacerbation increased physical deconditioning.

Paradoxically, the QoL benefits were significantly maintained. As demonstrated by previous studies[8,29,41,48] the benefits in functional dimensions of QoL, like *symptoms* (SGRQ), *physical condition* (VAS), and *physical* domains (WHOQOL-Brief), were sustained for 1 year. The patients have rediscovered their own abilities to tolerate exercise in their usual environment. They better controlled their dyspnea during daily routines.[49] The affective theory of Brown et al.[50] predicts that functional self-perceptions, which are related to the way that people appraise their particular abilities, are less likely to be affected after life events. Thus, patient avoided to recognize objective deterioration in exercise performance. The group showed a doubling of hospital days between the year before and after inpatient PR session, and a significant decrease of exercise participation.[51]

The *impacts* domain of SGRQ, which covers opinion on disease, panic and pessimism about disease, conversely showed deterioration at 1 year. Our results support those of Griffiths et al.[29] who noted that the *anxiety* score (HAD scale), the *emotional* domain (CRDQ) and the *social*, *emotional* and *mental* domains of SF-36 showed improvements made during the PR period that were less robust than the functional ones, 12 months after being discharged. The failure to maintain the emotional dimensions can be explained by these global self-perceptions which, based on affective beliefs, are more exposed to fluctuations caused by mood variations and daily life events.[50] Therefore, further intensive PR sessions could be needed to influence substantively these emotional self-perceptions, and perhaps the status of COPD on daily life.

Maintenance group

The improvement in exercise tolerance and the overall ratings of QoL in the MG, with statistically and clinically significant differences between groups, 1 year after PR discharge, indicates the effectiveness of the maintenance strategy. In terms of health-care utilization, the number of days spent in hospital for respiratory disorders was significantly lower in the MG at 1 year. In fact, no admission for respiratory reasons was noted in the MG during the post-rehabilitation year. Two major explanations can be the interdisciplinary approach to managing chronic disease and the social support found in the self-help associations of a health-care network.

First, the multidisciplinary approach of the maintenance program seems to be effective. The complementary and coordinated services and the collaboration of practitioners, including the lung specialist, contributed to a coherent

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strategy for efficiently responding to the chronic nature of the COPD, its systemic manifestations, and the unpredictability of symptoms. Monthly educational sessions associated with weekly exercise training enhanced practical knowledge and behavior.[52] The correspondence between the technical language of medicine and what the patients felt and imagined about their disease was even strengthened. This reduction of semantic discrepancy facilitates the long-term maintenance of healthy behaviors and could be a potent source of motivation for patients to become active and responsible participants in their own care.[19] The knowledge of regularity and the enhancement of motivation in health behaviors may explain the continuing improvement in exercise performance and QoL over the entire post-rehabilitation year. In addition, a monthly psychosocial group session led by a clinical psychologist would be an opportunity for the patients to integrate the functional progress made during exercise sessions and to improve overall well-being and self-esteem.[53]

Secondly, belonging to a health-care network with a self-help association, after PR discharge, contributed to the feeling of being included in a community.[20,54] The high adherence with the maintenance program ($>2/3$ of sessions), observed in the patients who completed all scheduled follow-up evaluations, illustrates this active engagement in the care process. The community is likely to respond to psychological isolation with coordinated activities and collective projects, thereby decreasing depressive, morbid thoughts.[55] The social support of other COPD participants and the greater partnership with health professionals might encourage individual initiative and attempts to reduce emotional reactions and choose adapted behaviors. The patients viewed themselves as active partners in the treatment process.[19]

To conclude, this pilot study suggests that, for COPD patients, a combination of services coordinated within self-help associations federated in a collaborative health-care network is an innovative and efficient maintenance program, not only for maintaining but also for improving the benefits of a first successful inpatient PR. Note that the situation may be complicated in the future with not only the low number of PR centers, but also by a poor turnover of patients. Thus, this feasible maintenance program which increases the collaboration among health providers would not be a substitute of PR but might allow to extend the period between two intensive PR sessions[56] and so to facilitate the inclusion of new patients in PR centers.

Conflict of interest statement

None of the authors have a conflict of interest to declare in relation to this work.

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