Towards understanding exercise adherence in chronic obstructive pulmonary disease

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Chapter 5

Adherence to pulmonary rehabilitation during a 12-month period in Dutch and Flemish patients with prolonged COPD treatment; a prospective cohort study

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Abstract

Introduction: Chronic diseases lead to both financial and organizational burdens on the health system. One of the possible solutions to keep health care affordable is self-management. However, non-adherence is a recognized problem with regard to self-management, especially in long-term treatment. Once it is clear who is or is not adherent, care can potentially be tailored accordingly. To predict adherence over time, it may be useful to have an understanding of how this variable might change over time: It is unclear whether adherence is a constant, or rather increases or decreases or fluctuates. The aim of this study is to determine the course of exercise adherence over a 12-month period in patients with chronic obstructive pulmonary disease (COPD) receiving prolonged rehabilitation.

Methods: In this prospective cohort study participated 196 patients with COPD, who were undertaking pulmonary rehabilitation (PR), for at least one month, in 53 primary physiotherapy practices in The Netherlands and Belgium between January 2021 and August 2022. Outcomes were measured at baseline, and at 3, 6 and 12 months. The primary outcome was exercise adherence, and secondary outcomes were exercise capacity and health related quality of life. Multilevel regression analysis with adherence at the first level and patients at the second level were used for analyses of the data.

Results: There was no significant change in exercise adherence over time (p = 0.89). Also, exercise capacity (p = 0.59) and health related quality of life (p = 0.24) remained stable.

Conclusions: Adherence is constant over a period of 12 months in patients with COPD receiving prolonged pulmonary rehabilitation in a primary physiotherapy practice in The Netherlands and Belgium. Also, measured health outcomes remained constant in this same period. Possibly, this will allow for better tailored care over 12 months and lower health care costs.

Introduction

The prevalence of chronic diseases is rising across Europe, triggered by increasing life expectancy and changing lifestyles [1]. The resulting pressures on health systems to address chronic diseases, including chronic obstructive pulmonary disease (COPD), have become a concern for policymakers and -providers [2]. For example, in the Netherlands, in 2015, 50% of the population had at least one chronic disease. By 2040, it is expected that one in three Dutch people will have two or more chronic diseases, and almost one in five will have three or more chronic diseases [3]. In the medium term the cost of care is rising and a shortage of personnel is looming. In 2022-2025, healthcare costs increase by an average of 2.7% per year and annual healthcare employment growth over the same period is 2.1% [4]. COPD is one highly prevalent chronic disease that demands increasing care; it is already the third leading cause of death worldwide [5]. Thus, the challenge is to keep good quality, accessible, and affordable care [6].

One of the possible solutions to keep care affordable is 'self-management'. Self-management is defined as the partnering of health care providers with patients to support efforts to undertake long-term adherence to a preventive or therapeutic regimen that can improve functional status and health outcomes [7]. Self-management programs in primary care may improve health behaviors, health outcomes, and quality of life and, in some cases, have demonstrated effectiveness for reducing health care utilization and the societal cost burden of chronic diseases [8]. One of the biggest challenges here is long-term adherence [9]. Long-term adherence in self-management can be conceptualized by three components: 1. Initiation: When the patient starts a lifestyle behavior change in accordance with his health care provider; 2. Implementation: The extent to which a patient's behavior corresponds with agreed recommendations from his health care provider; 3. Persistence: The time from initiation to discontinuation [10]. Non-adherence can occur in any of these phases, and may change over time in patients. So, appropriate attention should be paid to patients' level of adherence, as reduced adherence attenuates the benefits of the behavior change, and may worsen health outcomes [3].

In supporting patients staying adherent, available resources should be used in ways that are both effective (desired outcomes) and efficient (that do so with the least amount of effort and cost) [6]. If, for example, it can be predicted who is at risk of non-adherence, then care maybe tailored. For this purpose, a prediction model could be helpful. Such a model is currently being developed. But to predict adherence over time, it is important to have an understanding of how this variable might change over time. Presently, it is unclear whether adherence is a constant factor over time, or rather increases or decreases or fluctuates. Understanding this

is important, because it may contribute to developing tailored health services to realize more affordable health care [11].

Although adherence to prescribed exercise has been described in studies in patients with COPD, the definition of adherence, units of measurement, and data analysis strategies vary considerably [12]. Validated measurements are hardly used [13]. Many studies used self-reports and logs [12] and some used pedometers [14]. Therefore, it is hard to deduce what the common course of adherence to COPD self-management exercises is over time.

The aim of this study was to determine the course of adherence to exercise over a 12-month period in patients with COPD receiving prolonged pulmonary rehabilitation in primary physiotherapy practices in the Netherlands and Belgium.

Materials and methods

Methods comply with the Strengthening The Reporting of Observational Studies in Epidemiology (STROBE) checklist for cohort studies.

Design and routing

Participants of this prospective cohort study were Dutch/Flemish-speaking patients aged ≥ 18 years from primary physiotherapy practices, and from the COPD patient-organizations from the Netherlands and Belgium.
Recruitment commenced in January 2021, and 12-month follow-up assessments were completed in August 2022. Physiotherapy practices were approached by e-mail and social media for participation and patients were recruited by their attending physiotherapist. Patients who were willing to participate were contacted by the researcher per email for further information on their participation, and to obtain informed consent. For patients without an e-mail address, this was done by their physiotherapist during their visit to the physiotherapy practice. Patients were also recruited via the COPD patient-organization in the Netherlands and Belgium who, in turn, invited their physiotherapists for participation. A detailed description of the recruitment process is described elsewhere [15].
The study was approved by the Ethical Committee Psychology of the University of Groningen (PSY-1920-S-0504).

Participants

Patients (≥ 18 years) with COPD, with airflow limitation stage GOLD II-IV, and having rehabilitation sessions for at least once a month, for at least one month, were potentially eligible for inclusion. The exclusion criteria were home-based rehabilitation, and insufficient mastery of the Dutch/Flemish language to complete the questionnaires.

Baseline procedures

After obtaining informed consent, patients provided baseline sociodemographic data, using an online (Qualtrics) or paper form, including age (years), gender (male/female), country (the Netherlands/Belgium), education (low/middle/higher), moderate (MPA) and vigorous physical activity (VPA) (days per week), exercise history (yes/no), physiotherapy history (yes/no), smoking status (never smoked/quit smoking/still smoking) and medication adherence (yes/no). Physiotherapists provided baseline data on the characteristics of the disease using an online form (Qualtrics), including classification of severity of airflow limitation (GOLD classification) (GOLD II/III/IV), degree of baseline functional disability due to dyspnea (MRC-score) (0/1/2/3/4/5), duration of COPD since diagnosis (years), and duration of physiotherapy (years).

Follow up

The outcome variables were assessed on four subsequent occasions: at baseline, and at 3, 6 and 12 months. All outcome variables were collected at each occasion. Patients reported the outcome data at home, and physiotherapists reported the outcome data at the physiotherapy practice when patients had an appointment. The Dutch version of the Rehabilitation Adherence Measure for Athletic Training (RAdMAT-NL) was completed by the physiotherapist, independent of the patient and not in their presence. Characteristics of the participating physiotherapists are summarized elsewhere [15].

Primary outcome variable

Clinic-based adherence measured by the RAdMAT-NL was the primary outcome. The RAdMAT-NL is a 16-item questionnaire that uses a 4-point rating scale (never = 1, occasionally = 2, often = 3, always = 4) to evaluate clinic-based adherence [15]. The RAdMAT-NL consists of 3 subscales: Attendance/participation, Communication, and Attitude/effort. The total scale range is 16-64, a higher score indicates a higher degree of adherence. According to the American College of Sports Medicine (ACSM) guidelines, a score of at least 85% must be achieved to be adherent to the rehabilitation program [16]. This means, a minimum total score of 55 or higher must be achieved on the RAdMAT-NL to be adherent.

Secondary outcome variables

Exercise capacity was assessed by the 6-minute walk distance (6MWD). The change in 6MWD is a potential patient-centered outcome measure for therapies aimed at improving exercise capacity [17]. Patients had to try to cover as much distance as possible in six minutes; the physiotherapist measured the walking distance [18]. Since the 6MWD was used as an evaluative tool, this outcome evaluated the change in the patient's exercise capacity at each measurement time.

Health-related quality of life (HRQL) was assessed [19]. Patients reported HRQL by answering a single question; 'can you indicate on a scale of 0 to 10 how you currently perceive your health-related quality of life, where 0 = very poor and 10 = very good' [20]. With this single question, longitudinal changes in HRQL within patients during 12 months could be measured.

Covariates

The aim of this study was to determine the course of exercise adherence over a 12-month period in patients undergoing prolonged rehabilitation so, covariate of interest was; time points (baseline, 3, 6 and 12 months).

Statistical analysis

Data were analyzed using R version 4.0.3. For missing data first, the amount of missingness for each variable was calculated; the difference between the sample size and the number of useable observations. Second, Fisher exact tests were used to analyze differences in baseline characteristics between patients with missing and complete data. Finally, multiple imputation was used to create and analyze five multiple imputed datasets. Incomplete variables were imputed under fully conditional specification, using the default settings of the mice 3.0 package [21]. The parameters of substantive interest were estimated in each imputed dataset separately, and combined using Rubin's rules.

Considering the hierarchy in the data, with adherence (and 6MWD and HRQL) nested in patients, multilevel regression analysis [22] was used with adherence (and 6MWD and HRQL) at the first level and patients at the second level. All patients had different degrees of adherence at baseline and adherence may have changed differently over time for each patient [10] so, we let both the intercepts and slopes of the association between time and adherence vary at the patient level. This random intercept and random slopes analysis gives information about whether the association between adherence and time is different in each patient. Next, a model was developed to study the influence of time on adherence during twelve months.

Fixed effects

The results are shown as beta's (β) with *t*-values and degrees of freedom. Results were considered statistically significant when $p < 0.05$.

Random effects

Second level variance (variation between patients) was calculated regarding adherence (i.e., the intercepts in the multilevel regression), and the second level variance regarding the association between time and adherence (i.e., the slope variance in the multilevel regression). Covariance between intercept and slope residuals were also calculated. The covariance gives information about whether the

association time and adherence depended on adherence scores in the different patients.
The results are shown as beta's (β) with their standard error (SE) and 95% confidence intervals (CI).

The sample size used in this study was determined by the main study for which it collected the data (see chapter 6). Therefore, with regard to the present analyses a post hoc power analysis was protocoled, using G*Power 3.1 [23]. The null hypothesis was that there was no difference between the means at all four measurements. Post hoc power was calculated in G*Power with an ANOVA repeated measures within factors analysis, with a medium effect size (f = 0.25), α = 0.05, and a total sample size of n = 196.

Results

Participants

Patients from 53 different physiotherapy practices participated in the study. Out of 199 patients who gave informed consent, data from 196 patients were analyzed [15]. The percentage of missing values across the 17 variables varied between 0% and 8% from baseline to 12 months. In total 196-180 out of 196 patients had a complete data set. There was no association between participants with missing data and the pattern of baseline characteristics. Reasons for missing data were leaving the study; three patients died, three patients stopped physiotherapy because they were diagnosed with cancer or other medical reason, and six patients stopped physiotherapy for an unknown reason.

Table 1 summarizes the demographic and disease characteristics of the patients.

Table 1 Patient demographic and disease characteristics (n = 196)

Demographic characteristics	
Male gender (%)	51.5
Median age in years (IQR)	68.1 (64.0-73.0)
Resident of the Netherlands (%)	58.7
Education (%)	
- Low	21.4
- Middle	53.1
- Higher	25.5
Days of MPA per week (%)	
- Never	13.3
- 1-2 a week	41.8
- 3-4 a week	30.6
- ≥ 5 a week	14.3
Days of VPA days per week (%)	
- Never	54.1
- 1-2 a week	26.5
- ≥ 3 a week	19.4
Exercise in history (%)	62.2
Physiotherapy in history (%)	58.7
Smoking status (%)	
- Never smoked	1.5
- Quit smoking	84.7
- Still smoking	13.8
Adherent to medication (%)	88.8
Disease characteristics	
GOLD classification (%)	
- GOLD II	27.6
- GOLD III	36.2
- GOLD IV	36.2
MRC-score (%)	
- 0	0.5
- 1	5.1
- 2	18.4
- 3	36.7
- 4	27.0
- 5	12.3
Median time in years since diagnose (IQR)	10.5 (5.0-14.0)
Years of physiotherapy (%)	
- 0-3 months	14.8
- 3-6 months	7.7
- 6-12 months	6.6
- 1-5 years	30.6
- > 5 years	40.3

Note: IQR: Inter Quartile Range; Low = elementary education, Middle = secondary education, High = university of applied sciences or research university; MPA: moderate physical activity; VPA: vigorous physical activity; GOLD: Global Initiative for Chronic

Obstructive Lung Disease; MRC-score: Medical Research Council dyspnea scale as a measure of disability in patients with chronic obstructive pulmonary disease

Fixed effects

There was no significant change in adherence (RAdMAT-NL scores) over time, β = 0.01, *t*(587) = 0.14, *p* = 0.89 (Figure 1a and Table 2).

Table 2 Patient variance of adherence, 6MWD and HRQL in relation to time

	β	SE β	95% CI
RAdMAT-NL Time	0.01	0.10	-0.18, 0.20
6MWD Time	0.73	1.35	-1.93, 3.38
HRQL Time	-0.03	0.03	-0.09, 0.02

Note: β: beta coefficient; SE: standard error; CI: Confidence Interval; RAdMAT-NL: Rehabilitation Adherence Measure for Athletic Training the Dutch version; 6MWD: six-minute walk distance; HRQL: Health Related Quality of Life

Also, the health outcomes exercise capacity (6MWD) and health related quality of life (HRQL) did not significantly change over time (Figure 2a and 3a and Table 2). 6MWD: β = 0.73, *t*(587) = 0.54, *p* = 0.59. HRQL: β = -0.03, *t*(587) = -1.17, *p* = 0.24.

Random effects

The relationship between adherence and time showed significant variance in intercepts across patients, SD = 6.83 (95% CI: 6.04, 7.72), $\chi^2(1) = 832.32$, $p < 0.0001$ (Figure 1b). In addition, the slopes varied across patients, SD = 0.61 (95% CI: 0.36, 1.05), $\chi^2(9) = 53.84$, $p < 0.0001$, and the slopes and intercepts were negatively and significantly correlated, cor = -0.39 (95% CI: -0.62, -0.10). The negative covariance between intercepts and slopes suggested that the associations between time and adherence in the 196 patients depended on different adherence scores in the different patients.

The relationship between 6MWD and time and between HRQL and time also showed significant variance in intercepts and slopes across patients (Figure 2b and 3b). 6MWD intercept: SD = 94.29 (95% CI: 84.23, 105.56), $\chi^2(1) = 956.71$, $p < 0.0001$; slopes: SD = 13.97 (95% CI 11.55, 16.90), $\chi^2(2) = 43.72$, $p < 0.0001$. Slopes and intercepts were negatively and significantly correlated, cor = -0.35 (95% CI: -0.51, -0.17). HRQL intercept: SD = 1.62 (95% CI: 1.43, 1.83), $\chi^2(1) = 623.04$, $p < 0.0001$; slopes: SD = 0.26 (95% CI: 0.21, 0.33), $\chi^2(2) = 34.50$, $p < 0.0001$, and the slopes and intercepts were negatively and significantly correlated, cor = -0.64 (95% CI: -0.75, -0.49).

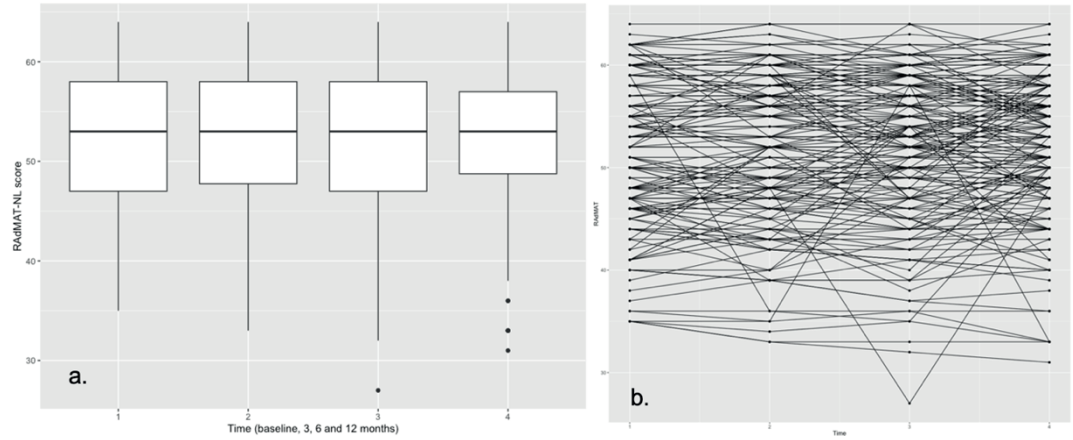

Figure 1 Change in RAdMAT-NL score from baseline. a: mean score over time; b: change of the RAdMAT-NL scores per patient over time

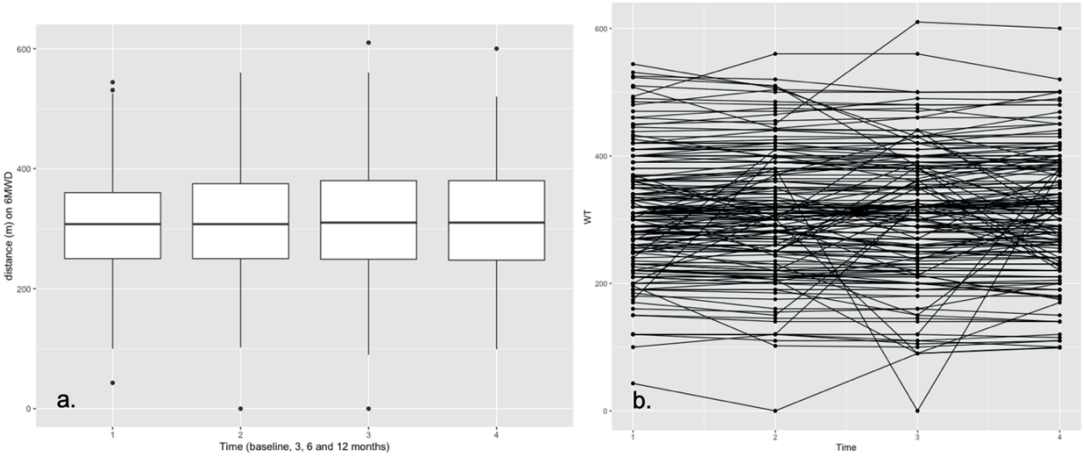

Figure 2 Change in 6MWD from baseline. a: mean score over time; b: change of 6MWD per patient over time

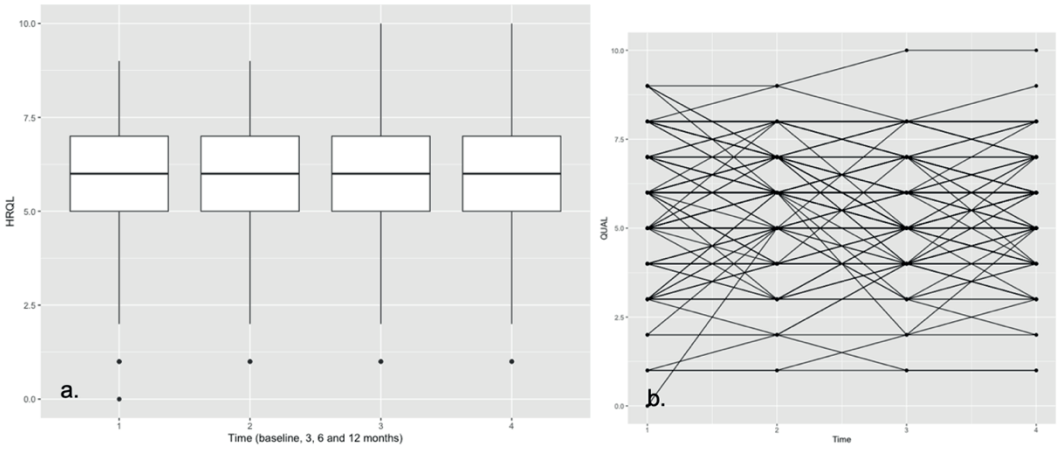

Figure 3: Change in HRQL from baseline. a: mean score over time; b: change of HRQL per patient over time

Post hoc power analysis

With an α level of 0.05, a sample size of 196, and a medium effect size of 0.25, achieved power for the study was 0.99.

Discussion

Main findings

This study shows that adherence is constant over a period of 12 months in patients with COPD receiving prolonged pulmonary rehabilitation in a primary physiotherapy practice in the Netherlands and Belgium. Also, the health outcomes 6MWD and HRQL were constant in this same period.

The boxplots and individual graphs in Figure 1-3, show that there is a small number of patients in whom the measured variables vary over time. Overall, the figures show constant values. Direct comparison of these findings with those published in previous studies of exercise adherence is limited by the use of different units of measurement and different chronic diseases. Nevertheless, a study describing adherence to a home-walking prescription in patients with COPD, found similar results [12]. Participants walked an average of three days per week initially, with a decline to two and a half days per week over one year. On average, participants walked longer than the prescribed duration of 20 minutes per session. They also showed that physical benefits were related to constant adherence [12]. A study concerning adherence to physical activity two years after stroke, found that physical activity levels remained constant, but that adherence to other cardiovascular risk

recommendations decreased over time [24]. All these results emphasize the importance of tailored made care and target services.

Post hoc power analysis

The sample size of this study was calculated for the main study (manuscript in preparation) and thus not specifically for this study. If no difference is found between groups, this may be the result of a type II error [25]. To ensure that this is not the case, a post hoc power analysis was performed. The results showed that the study had sufficient power to demonstrate any significant difference between the different measurement times, if any.

Strengths and limitations

The strengths of this study are inclusion of patients from different physiotherapy practices and from patient-organizations in the Netherlands and Belgium. In this way, a representative sample of COPD patients attending a PR program participated in this study, which enhances the generalizability of the study results. It must be taken into account, however, that these are patients who receive rehabilitation for a prolonged time (70% of patients in this cohort followed PR for ≥ 1 year). This is important to notice because it is plausible that in patients who have been attending a PR program for a prolonged time, and in whom no intervention is offered in terms of adherence, adherence will be relatively stable. This is in contrast to patients who have just started attending a PR program.

Another strength of the study is that missing data was examined and imputed, although multilevel analysis can deal with missing data [26]. Multiple imputation was used in this process. Methodologists currently regard multiple imputation as a state-of-the-art technique because it improves accuracy and statistical power relative to other missing data techniques [21].

This study also has some limitations. This study was conducted during the COVID-19 pandemic and may have affected motivation of patients for rehabilitation. This was demonstrated by the study by Menting et al. In their research group, one in five people reported having modified their self-management during the pandemic, both positively and negatively, out of fear of becoming ill [27]. If patients have been more consistently adherent or non-adherent, this may have led to a slightly biased result; adherence is less constant over 12 months than this study has shown. However, not comparing well, previous studies also came up with similar results.

Furthermore, the results showed that there were some patients with variation in adherence. This variation was not further explored. For this study, this was not necessary, as the aim was to understand mean adherence over 12 months. Chapter 6 is trying to understand the factors that predict adherence in this population and thus may be able to explain the variation in adherence.

Implications

The current study demonstrates that adherence to pulmonary rehabilitation remained constant during 12 months of prolonged pulmonary rehabilitation in patients with COPD. This means that people in this target group, who are non-adherent remained so without intervention, as did patients who are adherent. This finding has important clinical implications and indicates that target services can be delivered and that universal services are not always necessary, leading to differing levels of reduced health service utilization and possibly more affordable health care [11]. A significant proportion of the unnecessary health care utilization costs and poor health outcomes associated with the treatment of chronic diseases result, in large part, from the failure of patients to effectively self-manage their condition in response to recommended medical therapy [8]. Since exercise adherence of COPD patients with prolonged pulmonary rehabilitation was constant over 12 months, counselling can possibly focus on patients who need it the most, the ones who are non-adherent. Patients who are adherent require less counselling; their self-management ensures stable health outcomes. Both healthcare providers and patients gain substantial benefits; less time and costs spent and placing the patients central to address their needs leading to improved health behaviors, health outcomes, and quality of life. According to the results of this study, improvements in adherence (RAdMAT-NL scores) should coincide with subsequent improvements in health outcomes (6MWD and HRQL).

Conclusions

Adherence is constant over a period of 12 months in patients with COPD receiving prolonged pulmonary rehabilitation in a primary physiotherapy practice in The Netherlands and Belgium. Also, the health outcomes 6MWD and HRQL were constant in this same period. By determining whether someone is adherent or non-adherent, care may be better tailored over 12 months. Follow-up research on adherence and/or health outcomes in patients with COPD can also take advantage of the fact that the course of adherence is constant over 12 months in this target group.

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