

# Differences in Use of a Exercise-based Tele-rehabilitation Service Delivered as Substitute of or Supplement to Conventional Care

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**Abstract:** The aim of this paper is to explore the use of an exercise-based tele-rehabilitation service in patients with mild or severe chronic obstructive pulmonary disorder (COPD). The service is delivered to the patients in two ways: as substitute of (a part of) their pulmonary rehabilitation or as supplement to their pulmonary rehabilitation. Given their reduced amount of conventional pulmonary rehabilitation, it is likely to assume that the use of the service is higher in the substitute group compared to the supplement group. Use is parameterized as the time between log-in and log-out time of patients interacting with the tele-rehabilitation service for each week. Next to this the number of weeks patients used the service to exercise as well as the average frequency of use per week and average duration of use per week were determined. Analyses were performed on a group and individual level. Results showed that patients of the substitute group (n=29) used the tele-rehabilitation service slightly more than the patients (n=15) of the supplement group, but these differences were not significant.

## 1 INTRODUCTION

It is known that compliance, defined as the extent to which a patient's behaviour coincides with the healthcare professional advice (Sackett & Haynes, 1976) to exercise treatment, has a positive effect on clinical outcomes (Cramer, Benedict, Muszbek, Keskinaslan, & Khan, 2008). To specify patient's compliance with a tele-rehabilitation service it is important to know if patients used the tele-rehabilitation for a sufficient amount of time (frequency and duration). The use of a tele-rehabilitation service by patients is easily to monitor, by investigating the time between log-in and log-out.

The use of exercise-based tele-rehabilitation is investigated in various papers. Van den Berg et al.

(van den Berg et al., 2006; van den Berg et al., 2007) showed that for a home-based physical activity intervention for patients with rheumatoid arthritis, the number of patients who logged on to the website declines during treatment. However, no information is given about the duration of use and whether patients used the website for the same amount of time during treatment despite of the decline of frequency of use. In addition Huis in 't Veld et al. (Huis in 't Veld et al., 2010) who examined the use of a tele-treatment application for chronic pain patients, showed a decline in use over time. They used the average time the service was used, as measure for use. In the first week the average use was 14.3 hours and this declined to 9.5 hours in the final week.

In both studies the tele-rehabilitation service is delivered to the patients as an autonomous treatment. Is the decline in use for this service configuration a pattern or a coincidence? And is this decline in use also shown in tele-rehabilitation service once integrated as a partially substitute of or supplement to conventional care? Information about the use of the tele-rehabilitation services is important and should be addressed properly since it could influence the results found for clinical effectiveness. To the best of our knowledge the use of a tele-rehabilitation service for the various service configurations, i.e. as substitute of or as supplement to conventional care has not been investigated yet. However, information about differences in use for different service configurations could provide valuable knowledge on how to optimally implement the service in conventional care.

In this paper the use of two different service configurations of an exercise-based tele-rehabilitation service will be investigated. This service, designed within the CLEAR (= Clinical Leading Environment for the Assessment of Rehabilitation protocols in home care) project (<http://www.habiliseurope.eu>), is implemented in the pulmonary rehabilitation of patients with mild/severe or severe chronic obstructive pulmonary disorder (COPD). The service is delivered to the patients in two ways: [1] as a substitute (of a part) of conventional rehabilitation for patients with mild/severe COPD. After an introduction period of four weeks, the service substitutes one of the three treatment days per week (group substitute) for ten weeks. Or [2] as supplement to conventional rehabilitation care in patients with severe COPD. After an introduction period of four weeks, the service was a supplement of the two treatment days per week (group supplement) for ten weeks.

It is our empirical hypothesis that patients are more willing to rehabilitate at home using the tele-rehabilitation services when the service is delivered to them as substitute of the pulmonary rehabilitation compared to when the service is delivered supplementary to their conventional pulmonary rehabilitation. For the first service configuration, we think that patients will use the tele-rehabilitation service for a sufficient amount of hours to deal with the substituted hours. For the second service configuration, we think that the service is maybe considered to be too much for patients next to their already intensive pulmonary rehabilitation program.

The aim of this paper is to explore the use (frequency and duration) of an exercise-based tele-rehabilitation service in patients suffering from

pulmonary disease and to explore the difference between the two service configurations (substitute or supplement).

## 2 METHODS

Subjects were recruited between September 2010 and December 2011, by rehabilitation centre Het Roessingh, Enschede, the Netherlands. Patients directed, by their rehabilitation physician, to the outpatient pulmonary rehabilitation for COPD patients were asked to use the exercise tele-rehabilitation service during their three months of rehabilitation. Subjects with COPD were included if they had sufficient understanding of the Dutch language and were aged above 18 years.

The study was approved by the appropriate ethics committee. All participants gave their informed consent prior to participation.

### 2.1 Exercise Tele-rehabilitation Service

The exercise tele-rehabilitation service is facilitated by a notebook with webcam, with newly developed software giving access to a database of exercise videos and a teleconference service to facilitate contact between the patient and healthcare professional. With this new service the healthcare professional can compose a tailored exercise program for his patient. The patient can carry out the program on a self-scheduled time at home. Every week the patient records an exercise with the webcam and the recorded exercise will be assessed by the healthcare professional. Patient and healthcare professional can contact each other by teleconference to discuss the rehabilitation progress. The healthcare professional can schedule, add and delete exercises in the exercise program of the patient during the rehabilitation. The exercise tele-rehabilitation service enables patients to exercise at home at moments preferred by patients, which fits in the current trend of self management of patients (Kennedy, Rogers, & Bower, 2007).

During the instruction period, four weeks, all subjects received an extended training on how to use the exercise tele-rehabilitation service.

The demographic characteristics of the two groups will be measured by means of a questionnaire asking for age, gender, height, weight, education level and the availability of a computer with internet access. In addition, symptoms (shortness of breath) prior to participation are measured by means of VAS scales (Gift, 1989).

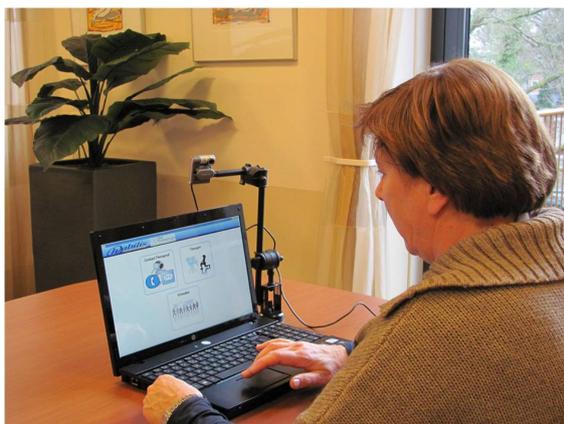


Figure 1: The exercise tele-rehabilitation service (1).



Figure 2: The exercise tele-rehabilitation service (2).

Patients are asked to rate their experienced level of shortness of breath during the past week. The VAS consists of a 10 cm horizontal line with 'no discomfort at all' on the left and 'as much discomfort as possible' on the right extremity of the line. Psychometric properties have proven to be sufficient.

## 2.2 Measurements

### Use of the Service: Frequency and Duration

The use of the service was determined by various parameters:

- The time between log-in and log-out of each single session, this is registered by the service automatically. Interval smaller than two minutes were excluded, because the average duration of an exercise video was two minutes and in smaller intervals patients were not able to exercise. The intervals larger than two hours were also excluded, because it is unlikely that

patients will exercise longer than two hours in one session. It was assumed that in these cases patients forgot to log-out.

- The number of weeks the patients used the service during their three months period conventional rehabilitation program.
- The average frequency and duration of use per week (in minutes).

### Usability

It is likely to assume that the actual use of the tele-rehabilitation service is influenced by the perceived usability of the service. Differences in perceived usability, between the two groups, might cause differences in use irrespective of the type of service configuration. For this reason we investigate the perceived usability of the exercise-based tele-rehabilitation service. All patients are asked to complete the System Usability Scale (SUS) (Brooke, 1995) after their pulmonary rehabilitation. This questionnaire includes 10 items which provide a global view of subjective assessment of service's usability. Each item was rated on a five-point scale from one (disagree totally) to five (agree totally). The items score were calculated to give an overall score ranging from 10 to 100 points. The SUS has been shown by the author to be a robust and reliable evaluation tool, but its psychometric properties are still under investigation. There is no validated Dutch version of the SUS. For this study the SUS is translated to Dutch.

## 2.3 Statistical Analyses

Analyses were performed using standard software (SPSS version 17). The normality of variables was evaluated by the Kolmogorov-Smirnov test. Descriptive statistics (means and SD) were calculated for all socio-demographic variables, shortness of breath and SUS score.

### Group Level

Differences in frequency and duration of use of the tele-rehabilitation service between groups were investigated by means of an independent t-test or Chi-square test in case of percentage. To investigate the use (duration and frequency) of the service per week, for the two groups, mixed-model analysis for repeated measures will be used. Treatment week was used as a within-subjects factor and type of service delivery as a between-subject factor. *Post hoc* comparisons were made when required and Sidak adjustments were used to correct for multiple test.

### Individual Level

To investigate difference in use of the service between the groups on an individual level the parameters number of weeks, frequency and duration are categorized. Based on this categorization the percentages of patients in the various categories were assessed.

The categories for number of weeks used during treatment are: often (more than 8 weeks) regularly (between 7 and 4 week) and sometimes (less than 3 weeks). The categories for average frequency of use per week are: often (more than 1.5 times a week), regularly (between 1.4-1 time(s) a week) and sporadic (less than once a week). The categories for average duration of use per week are: long-term (more than 60 minutes a week), regularly (between 30-59 minutes a week), sometimes (between 10-29 minutes a week) and short-term (less than 10 minutes a week). These categories are arbitrary chosen and discussed with the health-care professionals. Group differences in category distribution are assessed by Chi-square testing.

## 3 RESULTS

In total, 85 COPD patients are informed about tele-rehabilitation service and 58 patients (68%) gave written informed consent to participate. Patients were instructed how to work with the tele-rehabilitation service. After this instruction period of four weeks, 54 patients started to use the tele-rehabilitation service as substitute of (group substitute, n=20) or as supplement of (group supplement, n=34) their rehabilitation program. In the time period between the start to use the tele-

rehabilitation service and the end of the rehabilitation program 10 patients (19%) dropped out because of technical problems with the equipment or personal circumstances, such as lack of time or motivation. Thus, 44 patients used the tele-rehabilitation service during the full length (10 weeks) of their rehabilitation program.

Of the 44 patients, 15 patients suffered from severe COPD and used the tele-rehabilitation as supplement of their rehabilitation program. Twenty-nine patients suffered from mild/severe COPD and used the tele-rehabilitation as substitute of their rehabilitation program. The demographic characteristic, shortness of breath and SUS score of the two groups (group substitute and group supplement) are shown in Table 1. Patients of group substitute are significant younger ( $p=0.045$ ) than the patients of group supplement. Beyond, there are no significant differences between the two groups.

Patients in both groups rated the usability of the exercise tele-rehabilitation service as acceptable with a SUS score of 70. For a product with a SUS score in the 60s and 70s, although promising, but do not guarantee high acceptability of the product in the field (Brooke, 1995). On usability there are also no differences between the two groups.

### Use of the Tele-rehabilitation Service

In total, 293 interval blocks (time between log-in and log-out time) were available on the server of the tele-rehabilitation service. Fourteen (5%) of the interval blocks were excluded, 11 blocks were smaller than two minutes and three blocks were larger than two hours.

Table 1: Demographic characteristic, shortness of breath and SUS score of the two groups.

	Group substitute	Group supplement	p-value
Number	29	15	
Pathology	mild/severe COPD	severe COPD	
Age	55 years (SD 11)	62 years (SD 9)	$p=0.045$
Height	177 cm (SD 11)	172 cm (SD 10)	$p=0.131$
Weight	87 kg (SD 19)	82 kg (SD 26)	$p=0.482$
Gender	Male: 66% Female: 34%	Male: 47% Female: 53%	$p=0.228$
Education			
- primary	3%	7%	$p=0.517$
- secondary	69%	79%	
- higher	28%	14%	
PC with internet available at home	Yes: 97%	Yes: 80%	$p=0.107$
Shortness of breath last week (VAS)	5.3 cm (SD 1.9)	6.1 cm (SD 2.0)	$p=0.224$
SUS score post-test	70 (SD 17)	70 (SD 20)	$p=0.985$

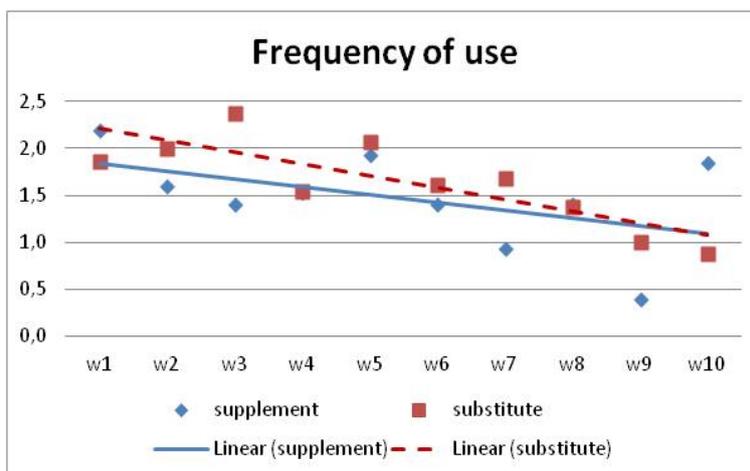


Figure 3: Frequency of use of the tele-rehabilitation service during the treatment weeks.

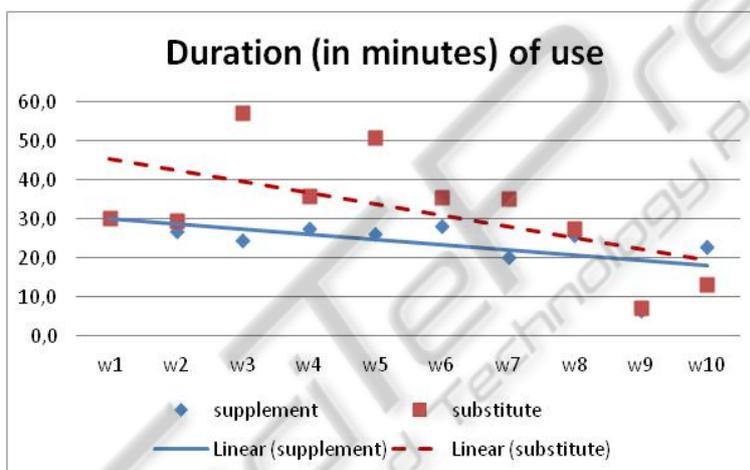


Figure 4: Duration of use of the tele-rehabilitation service during the treatment weeks.

*Group Level Analyses*

Patients of group substitute used the service average 6.6 weeks (SD2.4) out of the maximum of 10 weeks. The average frequency of use is 1.7 times a week (SD1.1) with an average duration of 33 minutes per week (SD22). Patients of group supplement used the service average 6.2 weeks (SD2.6) with an average frequency of 1.4 times a week (SD1.1) and with an average duration of 24 minutes per week (SD16). In line with our hypothesis the average use of the tele-rehabilitation service of the group substitute is higher than the use of the tele-rehabilitation service of the group supplement. However this difference failed to reach significance ( $p \geq 0.155$ ).

Figure 3 shows the average frequency of use during the treatment weeks of the two groups over the treatment weeks. The average frequency of the use of the service declines in both groups. The frequency of use declines for group substitute from

1.9 times a week for the first week to 0.9 times a week for the final week of treatment. The frequency of use declines for group supplement from 2.2 times a week for the first week to 1.9 times a week for the final week of treatment, notice the frequency of use in the pre final treatment week was only 0.4 times a week.

Mixed-model analysis for repeated measures showed that frequency of use declines significant over time ( $p=0.002$ ), without additional effects for service configurations (substitute or supplement) (0.424).

Figure 4 shows the average duration of use during the treatment weeks of the two groups. The average duration of the use of the service declines during treatment for both groups. The duration of use declines for group substitute from 30 minutes a week for the first week to 13 minutes times a week for the final week of treatment. The duration of use

Table 2: Use of the tele-rehabilitation service in total number of days, average frequency per week and average duration per week in percentages of patients.

		Group substitute n=29	Group supplement n=15	p-value
Number of weeks of use during treatment period	Often	48%	47%	p=0.957
	Regularly	42%	40%	
	Sometimes	10%	13%	
Average frequency per week	Often	24%	33%	p=0.382
	Regularly	55%	33%	
	Sporadic	21%	33%	
Average duration per week	Long-term	7%	0%	p=0.703
	Regularly	45%	40%	
	Sometimes	34%	40%	
	Short-term	14%	20%	

declines for group supplement from 30 minutes a week for the first week to 23 minutes a week for the final week of treatment, notice the duration of use in the pre final treatment week was only 7 minutes a week.

Mixed-model analysis for repeated measures showed that duration of use declines significant over time ( $p=0.001$ ), without additional effects for service configurations ( $p=0.273$ ).

#### Individual Level Analyses

Table 2 shows that approximately 50% of the patients used the tele-rehabilitation service eight or more weeks during their treatment period of three months. 40% of the patients used the tele-rehabilitation service four to seven weeks during their treatment period. Only a small amount of patients (10%) seem to have used the tele-rehabilitation sporadically, i.e. less than three week during their treatment period of three months. About one-third of the patients (24-33%) used the tele-rehabilitation service more than 1.5 times a week; 33-55% of the patients used the tele-rehabilitation service between 1.4 and 1 time(s) a week; and 21-33% of the patients used the tele-rehabilitation service less than 1 time a week.

Only 7% of the patients of group substitute used the tele-rehabilitation service more than 60 minutes per week. None of the patients of the group supplement used the tele-rehabilitation service for this amount of time. Most patients (40-45%) used the tele-rehabilitation service between 30-59 minutes per week. 34-40% of the patients used the tele-rehabilitation service between 29-10 minutes per week and 14-20% of the patients used the tele-rehabilitation service less than 10 minutes per week. However, the differences between the two groups

could not be supported by statistical analysis ( $p \geq 0.382$ ).

## 4 CONCLUSIONS

The aim of the current paper was to explore use (frequency and duration) of an exercise-based tele-rehabilitation service in patients suffering from pulmonary disease and to explore the difference between the two service configurations (substitute or supplement). Almost 50% of all patients (both groups) used the tele-rehabilitation service during most weeks of their rehabilitation program, with a frequency of at least once a week and an average duration of more than 30 minutes on a basis of voluntariness of use.

In line with our hypothesis, the patients where the tele-rehabilitation service was delivered as substitute of their pulmonary rehabilitation, substitute group ( $n=29$ ), used the tele-rehabilitation service slightly more than the patients of the supplement group ( $n=15$ ). The difference between the two groups is small, on average frequency per week the delta score between the groups is 0.3 and on duration this delta score is 9 minutes per week and failed to reach significance. Furthermore, it is beyond our expectations to think that these small differences will be addressed as clinically relevant by health-care professional either.

A decline in use, frequency and duration of use per week, is observed in the results of the current study. The decline of use of our tele-rehabilitation service can be clarified in two ways. A first clarification is the possibility that patients' motivation to use the tele-rehabilitation service declines. For instance after a couple of weeks patients are not motivated the use the service and

reduce the amount of use or do not use the service anymore. A second clarification is the possibility that the patients' need to use the tele-rehabilitation service declines. After a couple of weeks using the tele-rehabilitation service patients are aware of the various exercises and do not need the exercise videos to perform those exercises. In other words, thanks to the service patients have become very well capable of performing their exercises independently and no longer have to rely on the service. There are only a small number of papers addressing the use of exercise-based tele-rehabilitation service. As described in the introduction of the current paper, the results of these papers show also a decline in use (Huis in 't Veld, et al., 2010; van den Berg, et al., 2006; van den Berg, et al., 2007).

In the current study the use of the service by the patients was based on voluntariness of use. Patients were not asked by their healthcare professionals to use the tele-rehabilitation for a certain amount of time. Following the Unified Theory of Acceptance and Use of Technology (UTUAT) (Venkatesh, Morris, Davis, & Davis, 2003), voluntariness of use is a key moderator to the determinant social influence and influences the behavioural intention of patients to use a tele-rehabilitation service.

Non-mandatory use could be an explanation of finding no significant differences in the use of the tele-rehabilitation service between the two service configurations. Replacing one treatment day (three hours) of the pulmonary rehabilitation by the tele-rehabilitation service does not motivate patients to exercise for the same amount of time per week. So, patients need an extra motivation, like minimum use thresholds imposed by the healthcare professional, to use the tele-rehabilitation service for a sufficient amount of time.

These thresholds for minimum use should be determined based on the empirical knowledge of healthcare professionals or based on the relation between use and clinical outcome.

Concerning the patient groups in this paper, the two groups significantly differed on age. Patients of group supplement were proximally seven years older than the patients of group substitute. It is unknown if in the current study age influenced the use of the tele-rehabilitation service. Despite of this age differences it can be stated that both patient groups belong to the same generation 55 to 65 years. Based on UTUAT (Venkatesh, et al., 2003), age is one of the mediators that influence the use intention and actual use of the tele-rehabilitation.

In addition, the two groups also differ in severity of pathology; mild/severe versus severe COPD.

Prior to use of the service the shortness of breath score of group supplement are slightly higher than the score of group substitute. However this difference did not reach significance

Other limitations of the current paper were the relatively small sample size (n=43) and the imbalance in groups size (n=29 vs. n=15) of the two groups.

Given the results of the current paper clinical implications can be made. First, healthcare professionals should be aware of the fact that different configurations of the same tele-rehabilitation service do not result in different patterns of use. Second, the amount of use of a tele-rehabilitation service can explain possible disappointing clinical outcome of tele-rehabilitation services. Third, to find the cause, decline of use should be addressed between healthcare professional and patient, to result in optimization of the tele-rehabilitation service.

This paper focused on the use of the tele-rehabilitation service but for a future paper it is recommendable to investigate the relation between use of this tele-rehabilitation service and the clinical outcome.

In conclusion, the use (frequency and duration) of the exercise-based tele-rehabilitation service declines during treatment. In contrast to our expectations, there is no difference in use between two different configurations of the same tele-rehabilitation service in patients suffering from pulmonary diseases.

## ACKNOWLEDGEMENTS

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