Long-Term Telerehabilitation or Unsupervised Training at Home for Patients with Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial

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Short running head: Long-term telerehabilitation or unsupervised training in COPD.

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At a Glance Commentary

Scientific Knowledge on the Subject: Despite the evidence of the benefits of pulmonary rehabilitation, many patients with chronic obstructive pulmonary disease (COPD) do not access or complete pulmonary rehabilitation, and long-term maintenance of exercise is difficult. Efforts to reduce hospital readmissions in COPD must be made to decrease the societal burden and improve patient outcomes. Long-term telerehabilitation and unsupervised training at home represent promising alternatives to traditional pulmonary rehabilitation and maintenance strategies.

What This Study Adds to the Field: Long-term unsupervised exercise training at home is an effective treatment strategy which can reduce hospital readmissions for patients with COPD, similarly to the effect of a supervised telerehabilitation strategy. These interventions have the potential to improve uptake and access to pulmonary rehabilitation and support long-term exercise maintenance strategies. Unsupervised training at home could be offered to patients with COPD who do not access PR or maintenance programs. Telerehabilitation may be useful for patients who are unsuitable for unsupervised training and need a closer follow-up.

This article has an online data supplement, which is accessible from this issue's table of content online at www.atsjournals.org.

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Abstract

Rationale: Despite the benefits of pulmonary rehabilitation in chronic obstructive pulmonary disease (COPD), many patients do not access or complete pulmonary rehabilitation, and long-term maintenance of exercise is difficult.

Objectives: To compare long-term telerehabilitation or unsupervised treadmill training at home with standard care.

Methods: In an international randomized controlled trial, patients with COPD were assigned to three groups (telerehabilitation, unsupervised training, control) and followed up for 2 years. Telerehabilitation consisted of individualized treadmill training at home supervised by a physiotherapist and self-management. The unsupervised training group performed unsupervised treadmill exercise at home. The control group received standard care. The primary outcome was the combined number of hospitalizations and emergency department presentations. Secondary outcomes included time free from first event; exercise capacity; dyspnea; health status; quality of life; anxiety; depression; self-efficacy; subjective impression of change.

Measurements and Main Results: 120 participants were randomized. The incidence rate of hospitalizations and emergency department presentations was lower in telerehabilitation (1.18 events per person-year, 95% CI: 0.94, 1.46) and unsupervised training group (1.14, 95% CI: 0.92, 1.41) than in the control group (1.88, 95% CI: 1.58, 2.21; $P < 0.001$ compared to intervention groups). Telerehabilitation and unsupervised training groups experienced better health status for 1 year. Intervention participants reached and maintained clinically significant improvements in exercise capacity.

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Conclusions: Long-term telerehabilitation and unsupervised training at home in COPD are both successful in reducing hospital readmissions and can broaden the availability of pulmonary rehabilitation and maintenance strategies.

Keywords: COPD, exercise, telemedicine, clinical trial

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Introduction

Chronic obstructive pulmonary disease (COPD) imposes a substantial burden on patients, healthcare providers and society [**1,2**]. Patients with COPD experience frequent exacerbations which, in the most severe cases, may result in hospital admissions [**3,4**]. COPD exacerbations are commonly characterized by acute worsening of symptoms, including dyspnea, cough, sputum production and sputum purulence [**5**]. Patients with COPD also experience impaired exercise capacity, difficulty with activities of daily living, poor quality of life [**6**], anxiety and depression [**7**]. Chronic respiratory diseases contribute 7% to the global burden of disease, with COPD accounting for 56% of the costs of chronic respiratory diseases [**8**]. Hospitalizations alone account for up to 70% of all COPD-related costs [**9**]. Moreover, discharge from hospital after a severe exacerbation is associated with an increased risk of readmission [**10**]. Efforts to reduce recurrent exacerbations and hospitalizations must be made to improve patient outcomes and reduce societal burden [**11**].

Pulmonary rehabilitation (PR) is widely recognized as a core component of the management of COPD [**12,13**]. PR aims to improve the physiological and psychological condition of participants through exercise training accompanied by education and behavior change [**14**]. PR leads to clinically important gains in exercise and functional capacity, dyspnea, health status and health-related quality of life [**12-14**]. PR has also been proven to be effective in reducing the use of healthcare utilization [**15**].

Despite the evidence of the benefits of PR for patients with COPD, there are several barriers to PR participation, including patient travel [**16**] and a severe shortage of programs due to lack of knowledge, underfunding and poor institutional support [**17**]. The majority of PR programs are located in urban areas, thus limiting access for rural patients [**18**]. Referral rates to PR following an exacerbation are low [**17**]. Only 1.5% of patients are reported to initiate PR within

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90 days of discharge [**15**], and fewer than 10% of patients complete PR programs [**19**]. Sustaining long-term adherence to exercise training is difficult due to disease progression with intervening exacerbations, variation in day-to-day conditions, and transportation problems [**13**]. In the absence of any maintenance program, the gains from PR typically wane over 6 to 12 months [**14,20**]. Maintenance rehabilitation consists of ongoing supervised exercise at a lower frequency than PR programs [**21**]. However, the optimum maintenance intervention and supervision frequency are still unclear, and interventions have had varying impact [**20,22**].

Telerehabilitation, defined as the use of information and communication technologies to provide rehabilitation services remotely to people in their homes [**23**], has the potential to improve uptake and access to PR [**24**] and support long-term maintenance strategies [**13,25**]. A recent systematic review suggests that telerehabilitation achieves outcomes similar to those of traditional center-based PR [**26**]. Patients with COPD have a lower likelihood of acute exacerbations and hospitalizations when undertaking maintenance telerehabilitation compared to no rehabilitation [**27,28**]. The duration of intervention for studies of maintenance telerehabilitation ranged from four months [**28**] to 12 months [**27,29**]. Few studies followed people up after the intervention was finished, and no intervention lasted longer than 1 year, making it difficult to draw conclusions about the long-term effectiveness. Unsupervised home-based structured exercise represents another promising strategy to deliver maintenance rehabilitation with minimal resources [**24**]. While unsupervised exercise interventions have been proven to be effective at improving health-related quality of life and exercise capacity in the medium term [**24,30**], there is insufficient evidence for its provision to reduce hospital admissions and improve other outcomes, as well as long-term maintenance of benefits.

The aim of the present study was to compare long-term telerehabilitation of patients with COPD or unsupervised exercise training at home with standard care with respect to the

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combined number of hospitalizations and ED presentations occurring during 2 years as well as other secondary outcomes [**31**].

Methods

Study design

The iTrain study was an international multicenter randomized controlled trial (RCT) conducted in three countries (Norway, Australia, and Denmark), where 120 participants with COPD were randomly assigned to three groups (telerehabilitation, unsupervised training, control) in a 1:1:1 ratio. Each participant was followed up for 2 years since the day of inclusion in the study, and the interventions were delivered for the entire period of follow-up. Web-based computerized block randomization was performed, with randomization stratified by center and disease severity (FEV_1 < 50% vs FEV_1 ≥ 50%). The RCT received approval from the Regional Committee for Medical and Health Research Ethics in Norway (2014/676/REK nord), the Alfred Hospital Human Research Ethics Committee (289/14), and the North Denmark Region Committee on Health Research Ethics (N-20140038). The complete study protocol, including full details of the interventions, has been previously published [**31**] and was prospectively registered (ClinicalTrials.gov: NCT02258646).

Eligibility criteria

Eligible patients had: 1) a diagnosis of COPD, based on a FEV_1/FVC ratio < 0.70; 2) moderate, severe or very severe airflow limitation, with FEV_1% predicted < 80%; 3) at least one COPD-related hospitalization or COPD-related Emergency Department (ED) presentation in the 12 months prior to enrolment; 4) age between 40 and 80 years; 5) capacity to provide signed written informed consent.

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Participants were excluded if they had at least one of the following criteria: 1) attendance at a rehabilitation program in the 6 months prior to enrolment; 2) participation in another clinical study that might have had an impact on the primary outcome; 3) physically incapable of performing the study procedures; 4) presence of comorbidities which might prevent participants from safely exercising at home; 5) home environment not suitable for installation and use of rehabilitation and monitoring equipment (e.g. limited space for the treadmill, Internet connection not good enough).

Participants were recruited by hospital facilities with a pulmonary medicine department treating patients with COPD. Supervision in the telerehabilitation intervention was provided by physiotherapists specialized in PR.

Interventions

Participants in both intervention groups underwent a supervised in-person training session on the treadmill with an experienced physiotherapist, to ensure safety.

Participants in the telerehabilitation group were offered an integrated intervention consisting of exercise training at home, telemonitoring, and self-management. Each participant received an individualized training program of regular exercise on a treadmill and strength training exercises according to guidelines [**14**]. Depending on the participant's exercise tolerance and the clinician's preference, a program of continuous training (moderate intensity - Borg scale [**32**] ratings up to 4) or interval training (1-4 minute intervals, high intensity - Borg scale ratings up to 6) was assigned, with sessions lasting for at least 30 minutes [**Online Data Supplement**]. The frequency prescribed was 3-5 times/week for continuous training and 3 times/week for interval training [**31**]. Progression was made according to a standardized protocol [**Online Data Supplement**]. The equipment included a treadmill, a pulse oximeter, a tablet computer, and a holder for the tablet computer [**Online Data Supplement, Figure E1**]. The equipment was provided and delivered by the research team. A customized website was used by

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participants for self-management. They could access the individual training program [**Figure E2**], fill in a daily diary [**Figure E3**] and a training diary [**Figure E4**], review historical data, exchange electronic messages, schedule videoconferencing sessions, and facilitate individual goal setting and goal attainment. The information sent through the website was monitored and interpreted weekly by a physiotherapist. Participants had scheduled exercise sessions supervised by a physiotherapist via videoconferencing which followed a standardized protocol [**Online Data Supplement**]. After each supervised session, the physiotherapist could adjust the program if necessary and was also informed if a patient had been hospitalized. Telerehabilitation was delivered with two levels of supervision: 1) an intensive 8-week program (1 videoconferencing session per week in the first 8 weeks, plus once-weekly for one month after any readmission, supplemented by unsupervised sessions), 2) a lower intensity maintenance program (1 videoconferencing session per month commencing after the initial 8-week intensive program, supplemented by unsupervised sessions). Additional contacts with the physiotherapist could be arranged if necessary.

Participants in the unsupervised training group were provided with a treadmill only to perform unsupervised exercise at home. They also received an exercise booklet, a paper exercise diary to record their training sessions, and an individualized training program [**Online Data Supplement**] as prescribed to the participants in the telerehabilitation group, but without regular review or progression of the program. Participants were advised not to exercise if they felt unwell (more coughing, wheezing, breathless or having more sputum than usual), had less energy or loss of appetite. Participants in the control group were offered standard care.

Study procedures

Assessments were performed by appropriately trained study personnel who were blinded to group allocation. At baseline, participants were asked to perform spirometry, the 6-minute walk test [**33**] and complete the study questionnaires. Measures were repeated at 6-month, 1-year

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and 2-year follow-up. Data on hospitalizations and ED presentations were collected retrospectively from health records or registries after the end of the trial. Data on deaths, transplantations, dropouts and adverse events were collected systematically during the trial and at each follow-up. Participants also received information on self-management of exacerbations [**Online Data Supplement**]

Outcome measures

The primary outcome was the combined number of hospitalizations and ED presentations occurring in the three groups during the entire 2-year duration of the trial. These data were collected from health records (Australia) and registries (Denmark and Norway) at the end of the trial. Secondary outcomes included: hospitalizations and ED presentations (analyzed separately), time free from first event, functional exercise capacity measured with the 6-minute walk distance (6MWD) [**33**], dyspnea measured with the modified Medical Research Council (mMRC) Dyspnea scale, health status measured with the COPD Assessment Test (CAT) [**34**], health-related quality of life measured with the EQ-5D questionnaire [**35**], anxiety and depression measured with the Hospital Anxiety and Depression Scale (HADS) [**36**], self-efficacy measured with the Generalized Self-Efficacy Scale (GSES) [**37**], and subjective impression of overall change measured with the Patient Global Impression of Change scale (PGIC) [**38**]. Results on the remaining secondary outcomes, including levels of physical activity, cost-effectiveness and experiences in telerehabilitation, will be reported separately.

Statistical analysis

The sample size requirements were intended to provide adequate power for the analysis of the primary outcome. From studies with participants with similar characteristics, we estimated an Incidence Density used as a null hypothesis of 2 events per person-year, and a 40% relative reduction in the primary outcome [**31**]. Allowing for a 20% dropout, we calculated that a

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sample size of 40 participants per group would allow a power of 95% to detect an incidence rate ratio of 0.60, with a type-I error (α) of 0.05.

Descriptive statistics at baseline are reported as mean and standard deviation for continuous variables, and count and percentage for categorical variables. An intention-to-treat analysis was performed on all randomized subjects. The primary outcome and related secondary outcomes were measured with the Incidence Density, defined as the number of events in a group divided by the total person-time accumulated during the study in that group. Differences between study groups were tested by the Comparison of Incidence Rates. A two-sided test and a significance level of $\alpha = 0.05$ were used. All events from the day after randomization to participant exit/death were included. Linear mixed models were used to measure changes from baseline to all assessment time points in 6MWD, mMRC scale, CAT score, EQ-5D scores and GSES. The minimal important difference (MID) used for the 6MWD was 30 meters [**33**]. Baseline variables with differences among groups were also added as covariates to the Comparison of Incidence Rates and mixed models. Kaplan-Meier curves and the log-rank test were used to determine if there were differences in the survival distribution of the time free from first event for the telerehabilitation, unsupervised training and control groups. The Wald test computed utilizing binary logistic regression was used for the HADS (score < 8 = no case; score ≥ 8 = case). The Chi-Square Test was used for the PGIC. Differences in mortality rates between study groups were tested by the Comparison of Incidence Rates. A p-value <0.05 was considered significant for all tests. Statistical analyses were performed by using IBM SPSS Statistics (Version 25; IBM Corp).

Results

Study conduct and population

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Between October 2014 and December 2016, 502 individuals were assessed for eligibility, and 120 (24%) were recruited and randomized [**Figure 1**]. At the end of the study, data were available for the primary outcome and related secondary outcomes for 115 participants (96%), comprising 37 in the telerehabilitation group (93%), 40 in the unsupervised training group (100%) and 38 in the control group (95%). Details of the number of participants with complete data for each outcome at all assessment time points are reported in the online data supplement [**Table E1**].

Demographic and clinical characteristics of the study participants were similar between study groups at baseline [**Table 1**]. There were slightly more participants on long-term oxygen therapy (LTOT) in the telerehabilitation group (30%) than in the unsupervised training group (22.5%) and control group (15%), and more current smokers in the control group (37.5%) than in the telerehabilitation group (20%) and unsupervised training group (27.5%).

No treadmill-related injuries were reported during the study period [**Table E2**]. Adverse events included problems with the study equipment, most frequently the incline function on the treadmill, and medical problems which prevented participants from exercising (e.g. cancer, surgery, arthritis).

Hospitalizations and ED presentations

For the assessment of the incidence rate of hospitalizations and ED presentations, there were 71.05 person-years in the telerehabilitation group, 76.93 person-years in the unsupervised training group, and 74.59 person-years in the control group [**Table 2**]. By the end of the study, a total of 312 events (combined number of hospitalizations and ED presentations) occurred in the study population. Specifically, 84 events were reported in the telerehabilitation group, 88 in the unsupervised training group, and 140 in the control group. The incidence rate for the primary outcome was lower in both the telerehabilitation group (1.18 events per person-year; 95% confidence interval [CI], 0.94-1.46; $P = 0.0007$) and the unsupervised training group (1.14

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events per person-year; 95% CI, 0.92-1.41; $P = 0.0002$) compared to the control group (1.88 events per person-year; 95% CI, 1.58-2.21). Similarly, the difference in the incidence rate for hospitalizations and ED presentations analyzed separately was significantly lower in both telerehabilitation and unsupervised training groups compared to the control group [**Table 2**]. Adding smoking status and LTOT as covariates to the model did not change the results. There was a larger proportion of participants without hospital presentations (consisting of hospitalizations and ED presentations) occurring during the study period in the telerehabilitation (40.6%) and unsupervised training group (45.0%) compared to the control group (28.9%) [**Table 3**]. In addition, the control group has a higher proportion of participants with recurrent (≥2) hospital presentations (55.3%) compared to telerehabilitation (35.1%) and unsupervised training group (35.0%).

The survival distributions of the time-to-first hospitalization or ED presentation in the three groups were not significantly different ($\chi2(2) = 2.345$; $P = 0.310$) [**Figure 2a**]. Similar results were obtained for the time-to-first hospitalization ($\chi2(2) = 2.946$; $P = 0.229$) [**Figure 2b**] and time-to-first ED presentation ($\chi2(2) = 2.545$; $P = 0.280$) [**Figure 2c**].

Secondary outcomes

The telerehabilitation group experienced statistically significant changes at 6 months in CAT score ($P = 0.037$) and mMRC scale ($P = 0.037$) compared to the control group [**Table 4**]. The gains in health status and dyspnea were not maintained after 2 years. On average, participants had improvements in 6MWD that exceeded the MID at all time points. In contrast, participants in the control group experienced a decline in the 6MWD. A considerably higher proportion of participants in the telerehabilitation group (53.1%) experienced a significant, favorable change in the PGIC at 6 months compared to the unsupervised training group (24.2%) and the control group (13.3%, $P = 0.001$). No differences between groups were detected for self-efficacy,

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anxiety and depression. Adding smoking status and LTOT as covariates to the model did not change the results.

The unsupervised training group also experienced improved CAT score (P = 0.002) and mMRC scale (P = 0.027) at 6 months compared to the control group [**Table 4**]. Dyspnea levels were maintained for 2 years, while the gains in health status were maintained for 1 year. Participants had improvements in 6MWD that exceeded the MID for the entire 2-year period. However, there was only a statistically significant difference between the unsupervised training group and the control group at 2 years. Participants in the control group experienced an earlier decrease in their health-related quality of life at 6 months (EQ-5D utility index) compared to the unsupervised training group (P = 0.036), with similar findings for EQ-VAS at 2 years (P = 0.040). No differences between groups were detected for self-efficacy, anxiety and depression.

The mortality rate at the end of the trial was 7.5% (3/40 participants), 10% (4/40 participants) and 5% (2/40 participants) in the telerehabilitation, unsupervised training and control groups, respectively, with no difference between groups.

Discussion

To our knowledge, this was the first trial delivering a 2-year telerehabilitation intervention to patients with COPD. The iTrain study demonstrated that both long-term telerehabilitation and unsupervised training at home were successful in reducing the number of hospital readmissions for patients with COPD. Telerehabilitation and unsupervised training groups experienced better health status for 1 year. Intervention participants reached and maintained clinically significant improvements in exercise capacity.

A systematic review suggested a lower likelihood of acute exacerbations and hospitalizations for maintenance telerehabilitation compared to no rehabilitation [**26**]. The evidence, however,

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was limited to two studies [**27,28**], neither of which had an intervention lasting longer than 12 months. The iTrain study was designed assuming an incidence rate of 2 events per person-year and expecting a 40% relative reduction in the primary outcome. Results showed a 37.3% reduction (–0.70 events per person-year) in the telerehabilitation group and a 39.4% reduction (–0.74 events per person-year) in the unsupervised training group compared to the control group (1.88 events per person year). While there was a larger proportion of participants without hospital presentations in the intervention groups, the control group has a higher proportion of participants with recurrent (≥2) hospital presentations. Despite no significant difference in the time-to-first event, both interventions appear to be better than the control. Moreover, while incidence rates were very similar among intervention groups, participants in the telerehabilitation group presented to the ED sooner than the those in the unsupervised training group [**Figure 2c**]. One possible reason is that they were supervised regularly by a health professional, suggesting that telerehabilitation might allow earlier detection of problems.

It was expected that participants in the telerehabilitation group would gain additional benefits due to the remote supervision by a physiotherapist [**40**]. The findings from this trial indicate that both interventions seem to work well and produced beneficial results compared to standard care. These results might be explained by the characteristics and preferences of the participants. Positive attitudes towards both supervised and unsupervised maintenance programs have been reported [**41**]. However, while some patients need ongoing support for exercise participation, others can maintain the gains of PR regardless of intervention [**39**]. As such, unsupervised training at home is a simple intervention using minimal resources which could be offered to patients with COPD who do not access PR or maintenance programs. Telerehabilitation is likely to be more expensive, but it may be useful for patients who are unsuitable for unsupervised training due to factors such as disease severity, anxiety or depression, poor social support or low motivation [**13**]. The remote supervision by a physiotherapist can provide those

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individuals additional benefits, as confirmed by the higher proportion of participants in the telerehabilitation group who experienced a favorable change in the PGIC. These benefits can, in turn, result in better adherence to exercise. Identifying these patient groups is an important challenge for both clinicians and researchers [**39**]. Future research should focus on adapting PR and maintenance programs to the individual needs of the participants in order to maximize the benefits while making good use of healthcare resources [**42**].

A variety of strategies have been used to sustain the clinical gains achieved in traditional center-based PR [**14,20**], but outcomes have been inconsistent [**39**]. Maintenance models in COPD are heterogeneous in terms of supervision (supervised or unsupervised), frequency (once weekly to monthly or less frequent supervision) [**21**], modality (in person or remote supervision) [**22**] and self-management education [**42**]. Supervised maintenance exercise can be effective in improving CAT score at 6-12 months following PR [**22**]. The evidence for maintaining exercise capacity and quality of life is weak [**22,42**]. Supervised maintenance programs of monthly or less frequent supervision seem to be insufficient to maintain the gains of PR [**21**]. In a multicenter RCT, a weekly maintenance program was proven to be modestly effective in improving 6MWD and health status for 2 years after completing PR [**43**]. Unsupervised home-based structured exercise can also help maintaining 6MWD and quality of life [**24**]. Giving brief advice to continue exercising may therefore have similar benefits to "light touch" strategies or more intensive supervised programs, at least in some patients [**39**]. Maintenance telerehabilitation may achieve improvements in CAT score, mMRC scale as well as exercise capacity compared to no rehabilitation [**26**]. In an earlier study, the 6MWD was better maintained in subjects attending a 12-month maintenance program, but it returned to pre-rehabilitation levels by 24 months [**44**]. The iTrain study demonstrated that both long-term telerehabilitation and unsupervised training at home lead to gains in CAT score and mMRC scale at 6 months, but these were not maintained after 2 years. Moreover, participants in both

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intervention groups achieved and maintained clinically significant improvements in 6MWD over 2 years. In contrast, participants in the control group experienced a decline, which is normally attributable to low adherence to exercise, disease progression and exacerbations [**45**]. There were no changes in the other outcomes. CAT score and 6MWD are more responsive to PR than other patient-centered outcomes [**13**], and this can explain the results in the two intervention groups. The study, however, was not powered for the secondary outcomes. The lack of changes in HADS might be also explained by the low number of participants with anxiety or depression at baseline. The Pulmonary Rehabilitation Adapted Index of Self-Efficacy (PRAISE) might have been more suitable to measure changes in self-efficacy, due to five additional pulmonary rehabilitation-specific questions [**46**]. However, validated translations in Norwegian and Danish were not available.

The results from traditional maintenance programs in COPD are applicable only to individuals who attend and complete PR [**39**]. However, due to very low rates of referral, attendance and completion, the majority of patients with COPD do not access PR or maintenance programs [**15,17,19**]. The iTrain study addressed the unmet needs of those patients by offering easily accessible home-based models. Earlier RCTs showed that home-based primary PR models (8 weeks) delivered with minimal resources and little supervision (weekly telephone calls) can produce short-term clinical improvements similar to those of center-based PR [**24,47**]. The interventions tested in the iTrain study, which combined components of primary and maintenance rehabilitation, not only can reduce the number of hospital readmissions and lead to improvements in health status and exercise capacity, but also result in a better maintenance of the benefits over the long term.

Study strengths and limitations

We successfully conducted a complex RCT with participants recruited from three countries. The interventions were innovative models combining elements of primary and maintenance

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rehabilitation and the findings are novel. While previous studies lasted up to 1 year, making it difficult to draw conclusions about the long-term effectiveness, our study had a unique long-term follow-up of 2 years. The RCT used robust methods, including intention-to-treat analysis, blinding of assessors, sample size requirements and adherence to CONSORT guidelines. The primary outcome was relevant to both patients and healthcare systems.

Recruitment lasted for 2 years. The technical setup of the interventions was challenging. However, we offered successfully a common website in three languages and the same or very similar equipment. The applicability of our rehabilitation approaches in different health systems and funding models, or in groups with lower digital literacy, remains to be established. While the presence of at least one hospitalization or ED admission in the previous 12 months was an inclusion criterion, we did not record the time point at which these occurred. Rehabilitation interventions may have larger effects in recently hospitalized patients, so this could have affected the study outcomes. The study was not powered for the secondary outcomes. It was not possible to compare the benefits of the interventions with traditional center-based PR or maintenance programs based on the study design, and it was not possible to compare intervention fidelity across groups, as few participants in the unsupervised training group returned their paper-based training diaries. Despite randomization, the number of current smokers in the control group was higher than the intervention groups, and the number on LTOT in the control group was lower. Controlling for these factors in the analysis of secondary outcomes did not change the pattern of findings, but we cannot exclude an effect of this imbalance in demographic characteristics. While traditional PR programs have been conducted in groups of 8-12 participants [**48**], our telerehabilitation intervention consisted of individual sessions. Peer support in the form of group-based online exercise sessions [**49,50**], both supervised and unsupervised, has the potential to increase motivation, self-efficacy [**40**] and the ability to exercise in the long term [**42**].

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Conclusions

Long-term telerehabilitation and unsupervised exercise training at home were both successful in reducing the number of hospitalizations and ED presentations for patients with COPD. Telerehabilitation and unsupervised training groups experienced better health status for 1 year. Intervention participants reached and maintained clinically significant improvements in exercise capacity. The delivery of long-term telerehabilitation or unsupervised exercise training at home has the potential to broaden the availability of PR programs and maintenance strategies, especially to those living in remote areas and with no access to center-based exercise programs.

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Tables

Table 1. Baseline participant characteristics.

	Telerehabilitation	Unsupervised training	Control
Participants, *n*	40	40	40
Age, yr	64.9 ± 7.1	64.0 ± 7.7	63.5 ± 8.0
Male	23 (57.5%)	20 (50%)	23 (57.5%)
Stratification			
FEV_1 (% predicted) < 50%	28 (70%)	28 (70%)	28 (70%)
FEV_1 (% predicted) ≥ 50%	12 (30%)	12 (30%)	12 (30%)
COPD diagnosis, yr	8 ± 7	10 ± 8	7 ± 7
LTOT	12 (30%)	9 (22.5%)	6 (15%)
mMRC scale			
0	0 (0%)	2 (5%)	4 (10%)
1	14 (35%)	12 (30%)	12 (30%)
2	13 (32.5%)	13 (32.5%)	10 (25%)
3	10 (25%)	12 (30%)	12 (30%)
4	3 (7.5%)	1 (2.5%)	2 (5%)
BODE index			
0-2 points	11 (27.5%)	11 (27.5%)	11 (27.5%)
3-4 points	13 (32.5%)	17 (42.5%)	16 (40%)
5-6 points	12 (30%)	9 (22.5%)	7 (17.5%)
7-10 points	4 (10%)	3 (7.5%)	6 (15%)
Smoking history			
Current smoker	8 (20%)	11 (27.5%)	15 (37.5%)
Ex-smoker	31 (77.5%)	28 (70%)	24 (60%)
Never smoked	1 (2.5%)	1 (2.5%)	1 (2.5%)
Pack years	31 ± 17	38 ± 21	35 ± 16
FEV_1, liters	1.18 ± 0.61	1.21 ± 0.52	1.14 ± 0.52
FEV_1, % predicted	40.4 ± 16.5	44.6 ± 17.1	40.3 ± 16.1
FVC, liters	2.48 ± 0.89	2.60 ± 0.75	2.63 ± 0.91
FVC, % predicted	68.9 ± 19.1	75.4 ± 18.2	74.4 ± 23.7
FEV_1/FVC, %	50.1 ± 14.8	49.5 ± 12.8	46.7 ± 14.9
Number of comorbidities	2.9 ± 1.6	2.7 ± 1.7	2.6 ± 2.1
BMI, kg/m^2	27 ± 6	28 ± 7	26 ± 6
Living arrangements			
Alone	19 (47.5%)	20 (50%)	17 (42.5%)
With spouse	15 (37.5%)	16 (40%)	15 (37.5%)
With family	5 (12.5%)	4 (10%)	7 (17.5%)
With friends	1 (2.5%)	0 (0%)	1 (2.5%)
Supported accommodation	0 (0%)	0 (0%)	0 (0%)
Social status			
Working	5 (12.5%)	8 (20%)	11 (27.5%)
Retired	35 (87.5%)	32 (80%)	29 (72.5%)
Distance to outpatient clinic, km	37 ± 67	37 ± 59	21 ± 35
Digital competence			
Daily user or nearly every day	25 (62.5%)	26 (65%)	28 (70%)
At least once a week, but not every day	8 (20%)	9 (22.5%)	5 (12.5%)
No experience	7 (17.5%)	5 (12.5%)	7 (17.5%)

Definition of abbreviations: FEV_1, forced expiratory volume in 1 s; LTOT, long-term oxygen therapy; mMRC, modified Medical Research Council; BODE, Body-mass index, airflow Obstruction, Dyspnea, and Exercise; FVC, FVC, forced vital capacity; BMI, body mass index.

Data are shown as mean ± standard deviation or *n* (%) unless otherwise indicated.

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Table 2. Hospitalizations and emergency department presentations.

Outcome measure	Telerehabilitation	Unsupervised training	Control
Hospitalizations and ED presentations† (combined), n	84	88	140
Person-years, n	71.05	76.93	74.59
Incidence rate (per person year) (95% CI)	1.18 (0.94, 1.46)	1.14 (0.92, 1.41)	1.88 (1.58, 2.21)
Incidence rate ratio (95% CI)	0.63 (0.48, 0.83)	0.61 (0.46, 0.79)	1 [reference]
P value*	0.0008	0.0002	
Hospitalizations, n	68	74	126
Person-years, n	71.05	76.93	74.59
Incidence rate (per person year) (95% CI)	0.96 (0.74, 1.21)	0.96 (0.76, 1.21)	1.69 (1.41, 2.01)
Incidence rate ratio (95% CI)	0.57 (0.42, 0.76)	0.57 (0.43, 0.76)	1 [reference]
P value*	0.0002	0.0001	
ED presentations†, n	71	75	118
Person-years, n	71.05	76.93	74.59
Incidence rate (per person year) (95% CI)	1.00 (0.78, 1.26)	0.97 (0.77, 1.22)	1.58 (1.31, 1.89)
Incidence rate ratio (95% CI)	0.63 (0.47, 0.85)	0.61 (0.46, 0.82)	1 [reference]
P value*	0.0022	0.0009	

Definition of abbreviations: CI, confidence interval; ED, Emergency Department.
* *P*-value for test of equality vs. control group.
† Data include only ED presentations not followed by a hospitalization.
‡ Data include all ED presentations, including those followed by a hospitalization.

Table 3. Distribution of patients by number of hospitalizations and emergency department (ED) presentations occurred in the study period.

Hospitalizations and ED presentations	Telerehabilitation	Unsupervised training	Control
0	40.6%	45.0%	28.9%
1	24.3%	20.0%	15.8%
≥ 2 (recurrent hospital presentations)	35.1%	35.0%	55.3%
2-5	21.6%	22.5%	36.9%
6-10	10.8%	10%	7.9%
≥ 10	2.7%	2.5%	10.5%

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Table 4. Secondary outcomes.

Outcome measure	Telerehabilitation		Unsupervised training		Control
	Mean ± SD	*P* value	Mean ± SD	*P* value	Mean ± SD
6MWD, meters		0.380†		0.065†	
Baseline	367 ± 125		367 ± 111		384 ± 111
6-month	420 ± 126	0.126	406 ± 114	0.332	389 ± 101
1-year	415 ± 146	0.209	431 ± 117	0.057	374 ± 116
2-year	400 ± 142	0.235	460 ± 126	**0.009**	357 ± 102
CAT, total score		0.189†		0.023†	
Baseline	19.6 ± 6.2		20.1 ± 6.3		19.7 ± 8.1
6-month	18.2 ± 6.9	**0.037**	15.2 ± 7.6	**0.002**	20.8 ± 7.2
1-year	18.7 ± 6.9	0.086	17.5 ± 7.6	**0.047**	20.8 ± 7.0
2-year	19.0 ± 7.1	0.373	18.4 ± 8.6	0.272	19.8 ± 6.8
mMRC, score		0.131†		0.033†	
Baseline	2.1 ± 1.0		1.9 ± 1.0		1.9 ± 1.1
6-month	1.7 ± 1.2	**0.037**	1.5 ± 1.0	**0.027**	2.2 ± 0.8
1-year	1.8 ± 1.2	0.089	1.5 ± 1.0	**0.012**	2.2 ± 1.1
2-year	1.9 ± 1.2	0.105	1.5 ± 1.1	**0.008**	2.3 ± 1.1
EQ-5D, utility index		0.280†		0.119†	
Baseline	0.739 ± 0.110		0.744 ± 0.155		0.759 ± 0.180
6-month	0.728 ± 0.154	0.089	0.768 ± 0.184	**0.036**	0.685 ± 0.190
1-year	0.671 ± 0.215	0.903	0.747 ± 0.171	0.373	0.674 ± 0.236
2-year	0.725 ± 0.153	0.259	0.686 ± 0.280	0.740	0.673 ± 0.228
EQ-5D, EQ-VAS		0.654†		0.208†	
Baseline	51.9 ± 21.0		52.0 ± 17.7		52.4 ± 19.6
6-month	58.7 ± 16.4	0.299	55.4 ± 21.6	0.735	55.1 ± 16.8
1-year	56.3 ± 18.9	0.653	58.0 ± 19.1	0.381	53.7 ± 19.5
2-year	54.9 ± 21.4	0.295	58.4 ± 21.2	**0.040**	50.0 ± 20.8
GSES, total score		0.70†		0.160†	
Baseline	30.7 ± 5.4		31.4 ± 5.3		32.0 ± 5.8
6-month	30.9 ± 5.4	0.165	31.1 ± 4.6	0.263	30.3 ± 4.7
1-year	30.5 ± 5.5	0.462	31.5 ± 4.7	0.215	30.3 ± 7.8
2-year	30.4 ± 5.6	0.311	30.6 ± 5.4	0.576	32.7 ± 5.6
HADS, participants free from anxiety					
Baseline	30/40 (75.0%)		31/40 (77.5%)		28/40 (70.0%)
6-month	26/35 (74.3%)	0.599	29/35 (82.9%)	0.970	25/32 (78.1%)
1-year	22/32 (68.8%)	0.829	24/30 (80.0%)	0.351	18/30 (60.0%)
2-year	20/27 (74.1%)	0.318	23/31 (74.2%)	0.290	25/30 (83.3%)
HADS, participants free from depression					
Baseline	35/40 (87.5%)		33/40 (82.5%)		33/40 (82.5%)
6-month	31/35 (88.6%)	0.110	27/35 (77.1%)	0.362	22/32 (68.8%)
1-year	23/32 (71.9%)	0.208	24/30 (80.0%)	0.945	25/30 (83.3%)
2-year	22/27 (81.5%)	0.521	22/31 (71.0%)	0.201	26/30 (86.7%)
PGIC, participants with score at 6 months					
PGIC < 5	15 (46.9%)		25 (75.8%)		26 (86.7%)
PGIC ≥ 5	17 (53.1%)	**0.001**	8 (24.2%)	0.271	4 (13.3%)

Definition of abbreviations: 6MWD, 6-minute walking distance; mMRC, modified Medical Research Council; CAT, COPD Assessment Test; EQ-5D, EuroQol 5 dimensions; EQ-VAS, EuroQol visual analogue scale; GSES, General Self-Efficacy Scale; HADS, Hospital Anxiety and Depression Scale; PGIC, Patient Global Impression of Change; SD, standard deviation.

Differences between groups for change over time were analyzed with linear mixed models for 6MWD, mMRC, CAT, EQ-5D utility score, EQ-VAS and GSES. † *P* value for overall group by time interaction. *P* values at follow-ups represent comparison of intervention and control group at each time point. Baseline time point and control group were used as reference.

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The Wald test computed by means of binary logistic regression was used for the HADS. The Chi-Square Test was used for the PGIC.
Data are mean ± standard deviation except for the HADS and PGIC. Data for the HADS and PGIC are number and proportion of participants (%). Participants free from anxiety/depression: participants classified as a 'normal' (score<8). Bold values are statistically significant.

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Figures

Figure 1. Consolidated Standards of Reporting Trials CONSORT diagram for study flow.

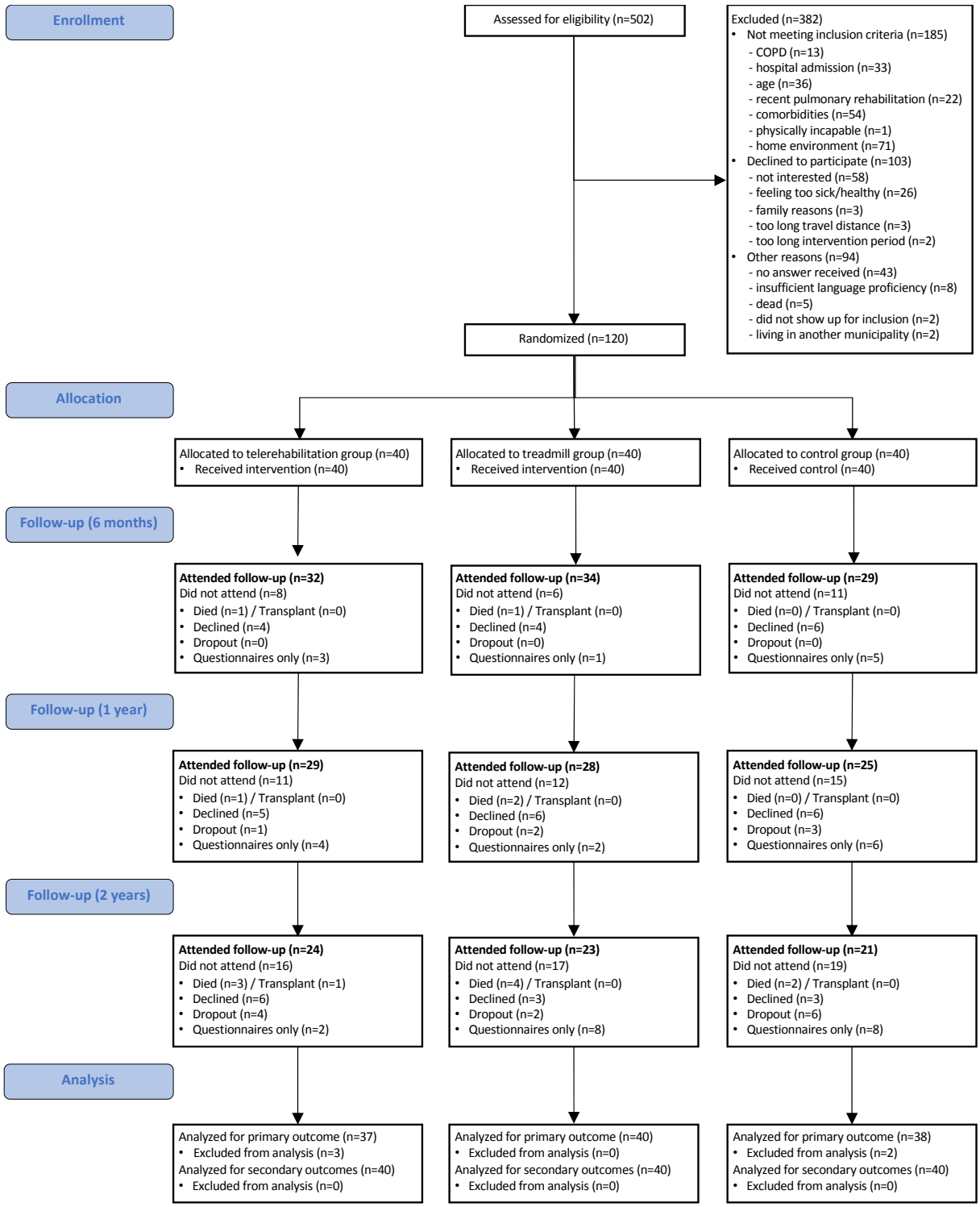

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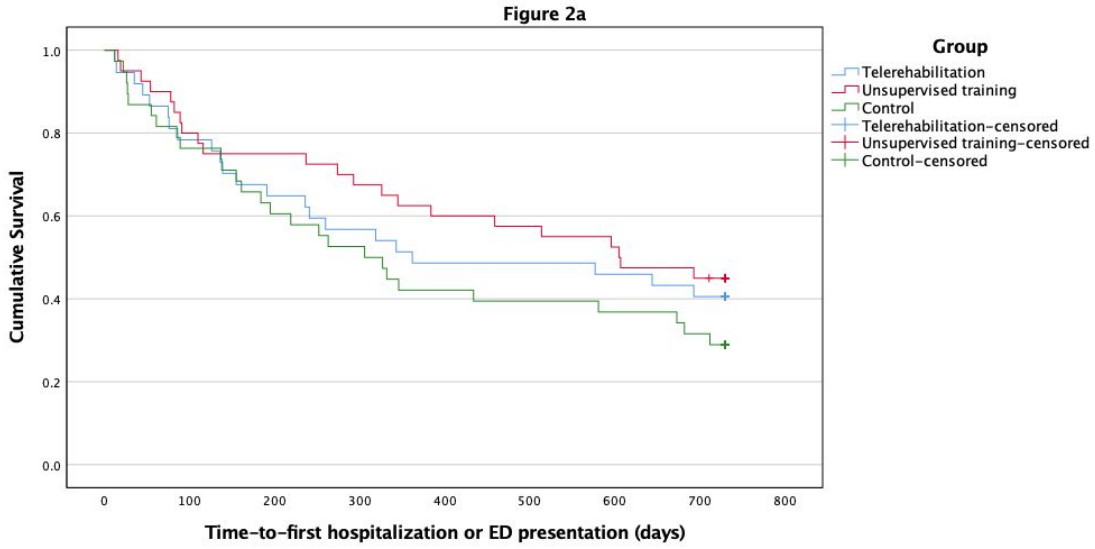
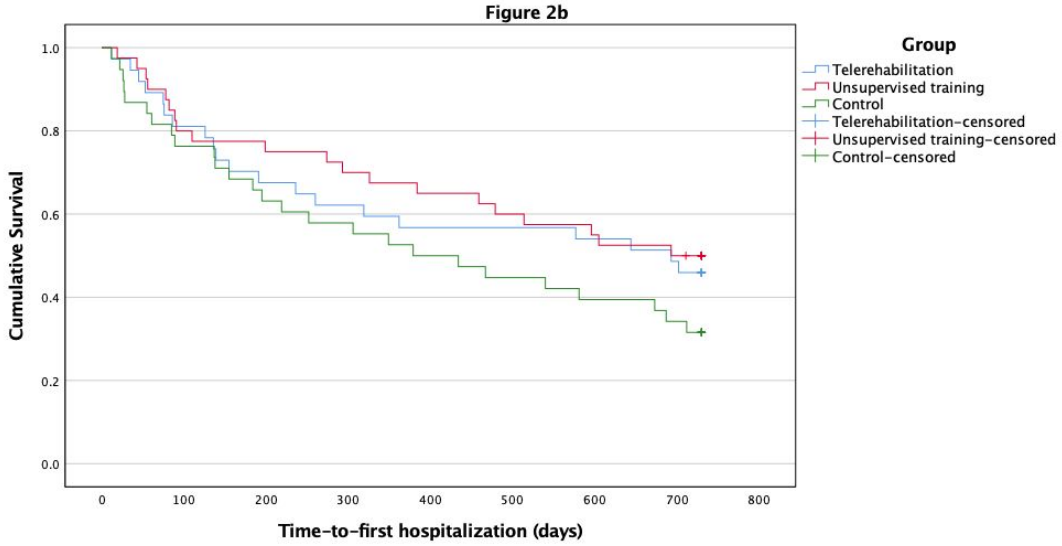
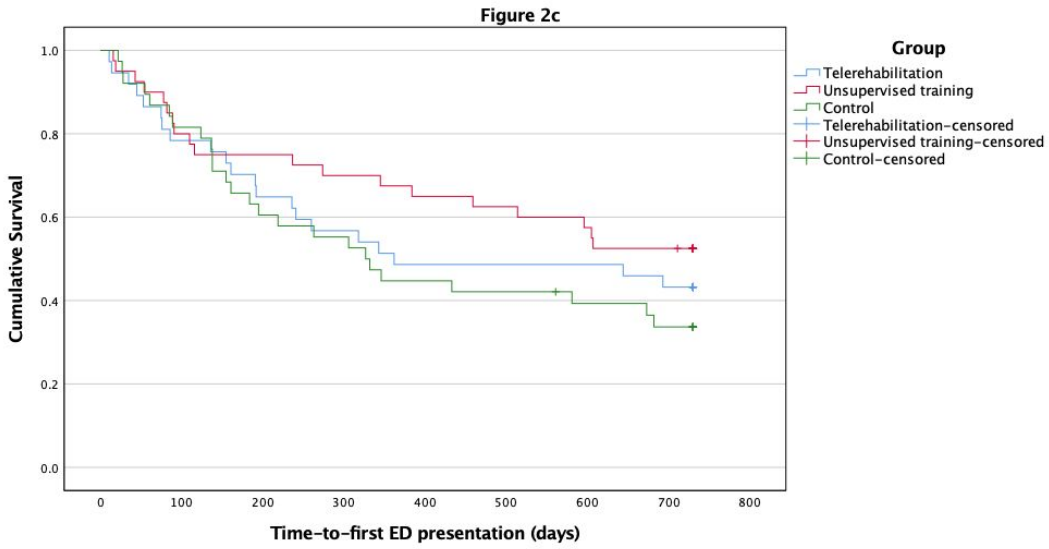
Figure 2. Time-to-first event: hospitalization or emergency department presentation (2a), hospitalization (2b), emergency department presentation (2c). ED, emergency department.







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American Journal of Respiratory and Critical Care Medicine

Long-Term Telerehabilitation or Unsupervised Training at Home for Patients with Chronic Obstructive Pulmonary Disease: A Randomized Controlled Trial

Paolo Zanaboni, Birthe Dinesen, Hanne Hoaas, Richard Wootton, Angela T. Burge, Rochelle Philp, Cristino Carneiro Oliveira, Janet Bondarenko, Audhild Hjalmarsen, Torben Tranborg Jensen, Belinda R. Miller, Anne E. Holland

Online Data Supplement

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Figure E1. Equipment provided to the participants in the telerehabilitation group.

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Figure E2. Example of individual training program on the website.

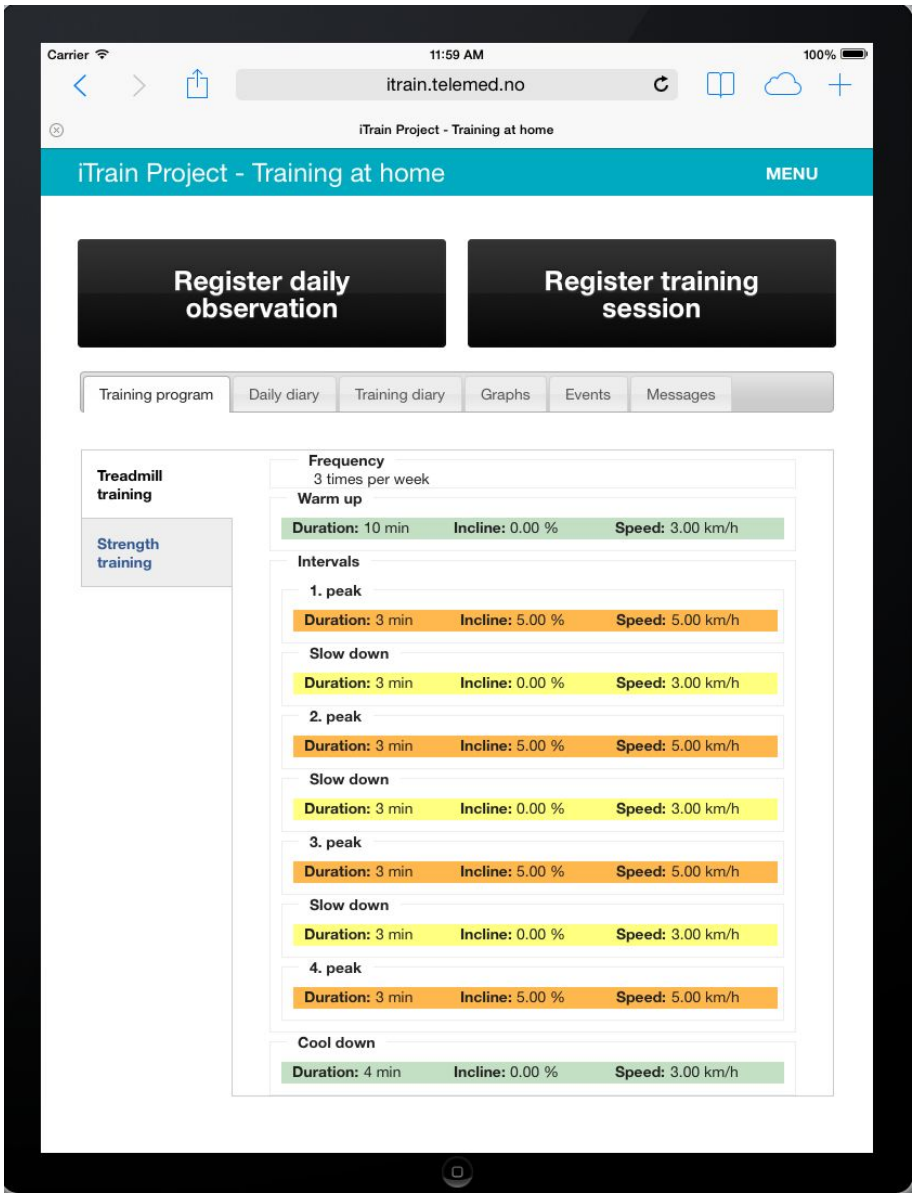

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Figure E3. Registration of daily diary on the website.

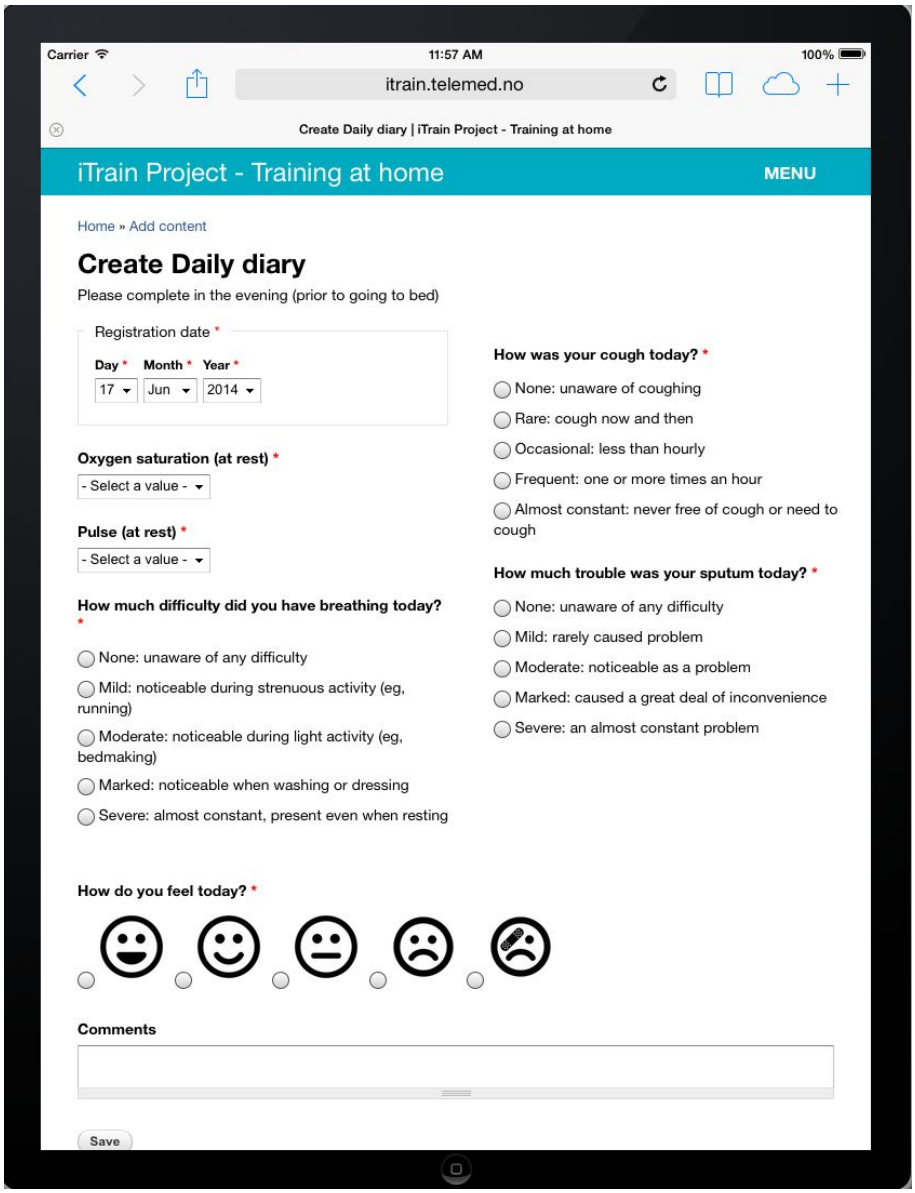

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Figure E4. Registration of training diary on the website.

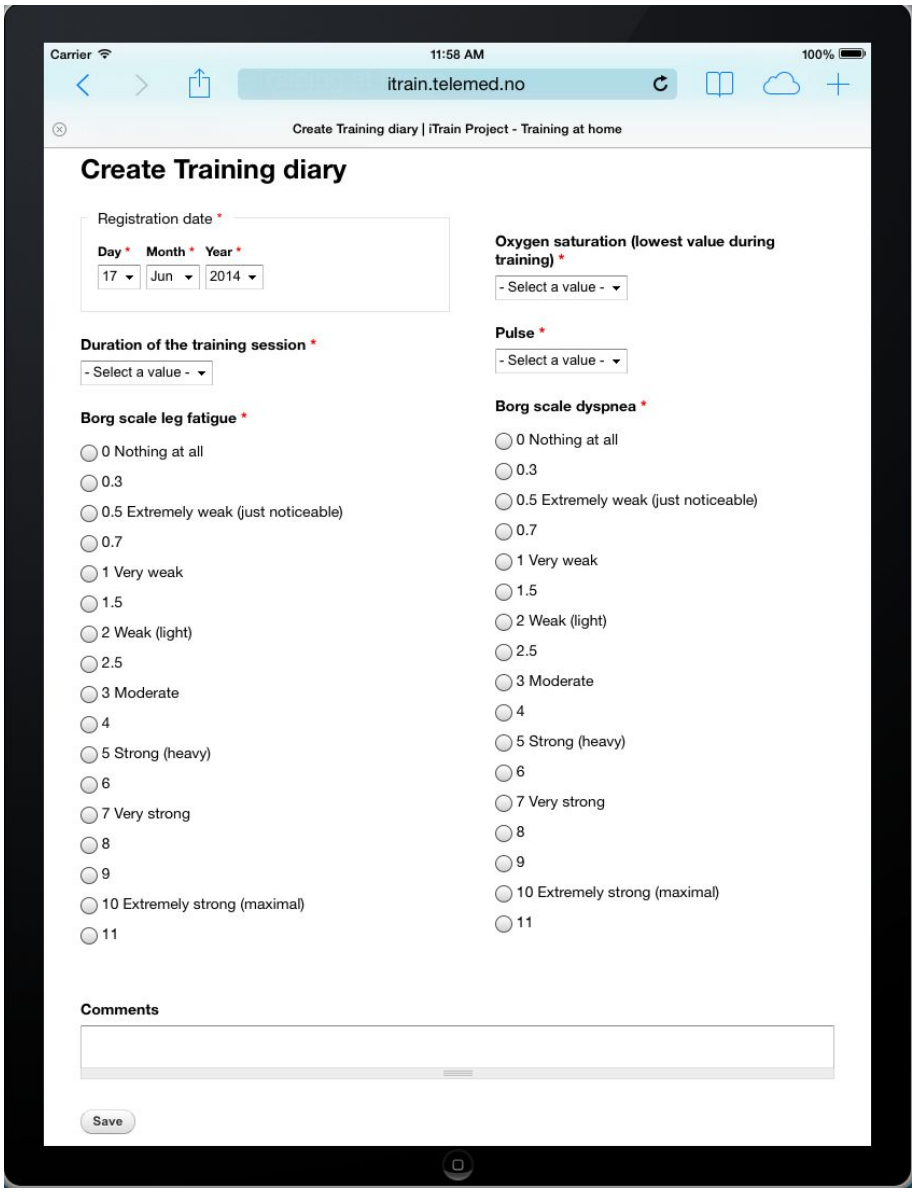

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Table E1. Participants with complete data for each outcome.

Clinical outcomes	Participants with complete data, n		
	Telerehabilitation	Unsupervised training	Control
6MWD			
Baseline	40	40	40
6 months	32	33	26
1 year	28	25	23
2 years	23	20	17
CAT			
Baseline	40	40	40
6 months	35	35	33
1 year	32	30	30
2 years	27	32	30
mMRC			
Baseline	40	40	40
6 months	34	35	30
1 year	32	30	31
2 years	26	31	29
EQ-5D, utility index			
Baseline	40	40	40
6 months	35	35	32
1 year	31	30	30
2 years	27	32	30
EQ-5D, EQ-VAS			
Baseline	40	40	40
6 months	35	35	31
1 year	31	30	30
2 years	27	32	29
GSES			
Baseline	40	40	40
6 months	35	35	32
1 year	32	30	30
2 years	27	31	30
HADS			
Baseline	40	40	40
6 months	35	35	32
1 year	32	30	30
2 years	27	31	30
PGIC, score			
6 months	32	33	30

Definition of abbreviations: 6MWD, 6-minute walking distance; mMRC, modified Medical Research Council; CAT, COPD Assessment Test; EQ-5D, EuroQol 5 dimensions, EQ-VAS, EuroQol visual analogue scale; GSES, General Self-Efficacy Scale; HADS, Hospital Anxiety and Depression Scale; PGIC, Patient Global Impression of Change.

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Table E2. Adverse events occurred during the study period.

Adverse events	Telerehabilitation	Unsupervised training	Control
Treadmill-related injuries	0	0	0
Problems with equipment	8	10	0
Medical problems	3	10	1

Table E3. Number of patients stratified by the number of hospitalizations and ED presentations.

Hospitalizations and ED presentations	Telerehabilitation (n=37)	Unsupervised training (n=40)	Control (n=38)
0	15	18	11
1	9	8	6
2	1	1	5
3	2	2	3
4	3	4	5
5	2	2	1
6		2	
7	1		1
8	2	1	2
9	1	1	
11			1
13	1		
15			1
17		1	
18			1
23			1

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Treadmill exercise prescription: continuous training

Treadmill walking speed

Initial walking speed: 80% of average 6MWT walking speed (based on the best of the two 6MWTs)

Example:
If the patient walked 300 m in the 6MWT, then:
300 x 10 ÷ 1000 = 3.0 km/h.
80% of 3.0 km / hr = 2.4 km/h.
Therefore, the initial treadmill speed would be set at 2.4 km/h. The treadmill may start at approximately 2 km/h to account for the patient being unfamiliar with treadmill walking.

Beside this, a Borg dyspnea or leg fatigue score of 4 (moderate to severe) is considered a target training intensity.

Duration

A total minimum duration of 30 minutes should be achieved. This can be in 2 sets of 15 minutes if required. Some patients may need to start with an exercise duration of 2 x 10 minutess, but this should be built up to a total duration of 30 minutes by the second week of the program.

Participants are permitted to take short rests in the event of intolerable symptoms, or if oxygen saturation decreases ≤ 88 %, but rest time does not count towards training duration.

Frequency

A frequency of 3-5 times per week is prescribed.

Treadmill training progression

Treadmill walking speed:

- Increase walking speed as tolerated each week by 0.25 km/h if initial walking speed is <3 km/h; increase 0.5 km/h if initial speed is >3 km/h (this can be increased more quickly if the Dyspnoea or RPE scores are below 3)
- Once walk speed reaches 5 km/h, reduce speed to 4.5 km/h and add gradient of 1-2%. Then increase gradient 1-2% weekly
- If unable to reach 5 km/h due to leg length, gradient can be introduced a little earlier

Duration:

- Training duration up to 60 minutes can be tolerated after some weeks of training, depending on the patient's condition. Longer duration could affect the frequency, but a minimum frequency of 3 times per week should always be targeted.

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Treadmill exercise prescription: interval training

Treadmill walking speed

- **Warm up:**

Choose one of 4 levels of initial speeds based of the patients' condition.

Level	Initial speed	Increase gradually to (if tolerated)	Borg ratings Dyspnea/leg fatigue	Time
# 1.	1,6 km/hr	2,4 km/hr	3-4	10 min or more, include breaks if needed *
# 2.	2,4 km/hr	3,6 km/hr	3-4	10 min or more, include breaks if needed *
# 3	3,6 km/hr	4,8 km/hr	3-4	10 min or more
# 4.	4,8 km/hr	5,4 km/hr	3-4	10 min or more

*Rest time does not count towards duration of warm up

- **Intervals:**

Choose length of high intensity interval peaks based on the patients' level of function and GOLD stadium. You might choose a longer interval for the patient than prescribed for his/her GOLD stadium and rather base your decision of his/her actual level of function. Account for experience of training, lung function, desaturation, ventilator limitations/dynamic hyperinflation, weight etc.

GOLD stadium	Length of interval	Number of interval	Progression
I-II	2-4 min	3-4	Increased incline/speed
III- IV	1 min	4	Longer duration of interval

Intervals of 1 min x 4 times:

From warm up speed, increase speed as tolerated until Borg ratings of 5-6 for dyspnea or leg fatigue.

Intervals of 2 min x 4 times:

From warm up speed, increase incline or speed as tolerated until Borg ratings of 5-6 for dyspnea or leg fatigue.

Intervals of 3 min x 3-4 times:
From warm up speed, increase incline and speed until Borg ratings of 5-6 for dyspnea or leg fatigue.

Intervals of 4 min x 3-4 times:

From warm up speed, increase incline and speed until Borg ratings of 5-6 for dyspnea or leg fatigue.

Beware that the SpO2 should be always above 88%. If desaturation, decrease length of interval peak or incline/speed. Full stops might be needed instead of active breaks.

- **Active rests:**

Between the interval peaks there should be active rests or full stops depending on the patients' condition. The active rests/stops could last 2-4 minutes. Dyspnea or leg fatigue ratings of 3-4 are desired. Reduce gradient, and then speed if needed.

- **Cool down:**

Choose the same level as initial speed and reverse the speed prescription (e.g. 3,6 km/hr → 2,4 km/hr.) Minimum 5-10 minutes of low to moderate intensity. Borg ratings of 3-4.

Duration

A total minimum duration of 30 minutes should be achieved. Participants are permitted to take full stops in the event of intolerable symptoms, or if oxygen saturation decreases ≤ 88 %, but rest time does not count towards training duration.

Frequency

For interval training a frequency of 3 times per week is prescribed.

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Interval training progression

If the patient reports lower dyspnea or leg fatigue ratings than prescribed, progression should be made. Try to make progression 3, 6 and 9 weeks into the program as followed:

If starting interval peaks of 1 min x 4 times:

Make progression by increasing duration of peaks to 2 min, and later on increase duration to 3 min. When 3 min duration is reached, you could make further progression by increasing incline and/or speed or duration up to 4 min if tolerated.

Intervals of 2 min x 4 times:

Make progression by increasing duration of peaks to 3 min. When 3 min duration is reached, you could make further progression by increasing incline and/or speed or duration up to 4 min if tolerated.

Intervals of 3 min x 3-4 times:

Make progression by increasing duration of peaks to 4 min. You could also make progression by increasing incline and/or speed.

Intervals of 4 min x 3-4 times:

Make progression by increasing incline and/or speed.

Progression can also be made by adding active breaks if full stops between interval peaks has been prescribed earlier in the program.

If patient reports higher dyspnea or leg fatigue ratings than prescribed, reduction to the program must be made. Continuous training could be an option, or gradient/speed should be reduced.

Duration:
Total training duration up to 60 minutes can be tolerated after some weeks of training, depending on the patient's condition.

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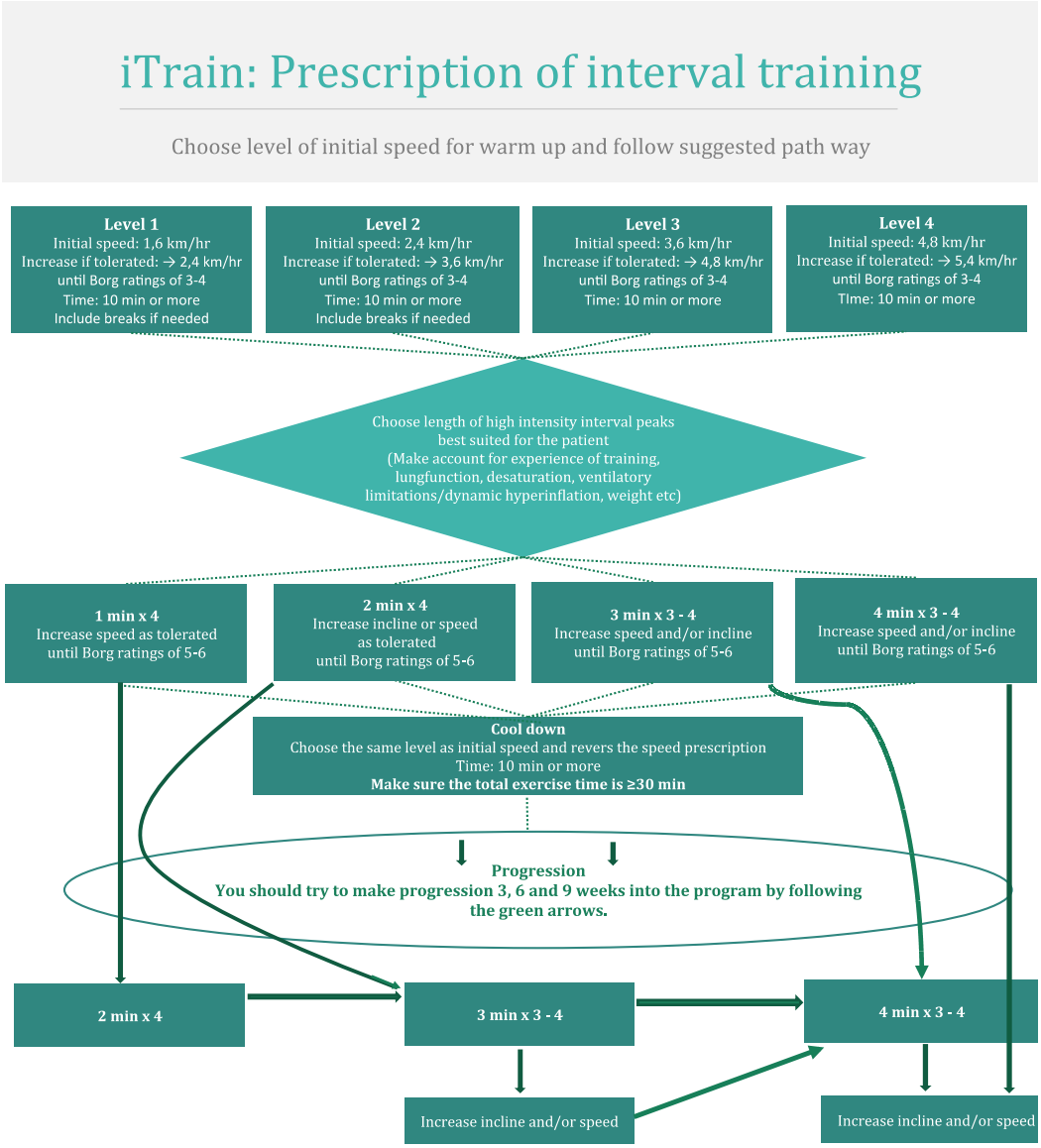

Strength training prescription

Choosing type of exercises

Each training session should include at least 4 strength exercises from the list below. Choose two lower limb exercises and two for the upper limbs.

Lower limb exercises:

Exercise	Repetitions	Sets
Sit to stand	6-12	3
Squats	6-12	3
Step ups (e.g in stair case)	6-12	3
Lunge	6-12	3
Calf raise	6-12	3

Upper limb exercises:

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Exercise	**Suggestion of equipment, depending on availability**	**Repetitions**	**Sets**
Biceps curl	- Free weights - Bottle filled with sand or water - Elastic bands - Sit by a table and press your palms up underneath the table	6-12	1-3
Shoulder press	- No weight or free weights - Bottle filled with sand or water - Elastic bands - Broomstick	6-12	1-3
Wall push up	- Move feet away from the wall to make progress	6-12	1-3
Bench press (supine position)	- No weight or free weights - Bottle filled with sand or water - Broomstick	6-12	1-3
Standing row (lean forward onto a chair or bench)	- No weight or free weights - Bottle filled with sand or water	6-12	1-3
Seated row	- No weight or free weights - Bottle filled with sand or water - Elastic bands	6-12	1-3
Lateral pull down	- Elastic bands	6-12	1-3
Triceps	Try to lift your body weight by pressing your arms against the arm rests	6-12	1-3

Frequency

A frequency of 2-3 days per week is prescribed.

Progression

Aim to achieve muscle fatigue between 6 to 12 repetitions. If muscle fatigue is not present after 12 repetitions, add hand weights or use a back pack with books etc to increase resistance. The exercise dosage must increase over time (the so-called overload) to facilitate improvements in muscular strength and endurance. If the current work-load (resistance(weight)/reps/sets) can be performed without compensatory movements on two consecutive sessions, the work-load must be increased.

Disease exacerbations

Strength training might be an option for training during disease exacerbations.

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Conduction of video conferences

Theoretical background

During the videoconferences the physiotherapists should support and educate the patients in health-enhancing behavior. A special focus is set on increasing the patient's motivation for exercise training and other physical activities. Support to gain insight in their own health and treatment strategies must also be emphasized. One of the aims is to enhance self-efficacy (e.g. the confidence in successfully managing one's health). The physiotherapists should be able to interact with the patients in a way that promotes the dialogue around patients' needs for knowledge and skills to optimally manage their illness and everyday life. Goal setting is important and patients should be encouraged to set their own goals. The goals should be of significance for the patient, realistic, measurable, time limited, but not limited to this specific intervention. The webpage will have a feature for goal setting and goal attainment. Goal setting can be a topic for the first videoconferences and should be evaluated and discussed regularly. As goals are reached, new goals should be set.

There are many ways to promote health-enhancing behavior and self-efficacy, and physiotherapists across the sites should not be limited to specific theories, but rather be able "to use every tool in their tool box". However, we suggest using concepts from salutogenic theory during the videoconferences. A salutogenic approach focuses on the patient's resources and capacity to improve health rather than the classic patogenetic approach which focuses more on risks, illness and diseases (1).

Understanding the patient's own resources and point of view is crucial for the effect of the videoconferences. As Kierkegaard states:

"If One Is Truly to Succeed in Leading a Person to a Specific Place, One Must First and Foremost Take Care to Find Him Where He is and Begin There. This is the secret in the entire art of helping. Anyone who cannot do this is himself under a delusion if he thinks he is able to help someone else. In order truly to help someone else, I must understand more than he–but certainly first and foremost understand what he understands. If I do not do that, then my greater understanding does not help him at all." (2)

In addition, the most powerful arguments for change in behavior is the one we voice ourselves. The physiotherapist should assist the patients to reflect over what good health is for them, set goals accordingly, and inspire them to voice their own positive arguments for change in this direction. Encouraging the patient to describe what will be different when the goals are reached, what the first signs of change are and what changes can be expected, is one way to find the patient's own arguments for change. Try to make the goals describe what the patient wants to happen or to achieve, not what he/she wants to avoid. The things you focus on and give attention will grow. Other useful questions to get the patient's own argument might be: "What do you think would be the most important benefits for you if you were fitter and stronger?"; "What are you already doing that will help you achieve this?"; "How important is it for you to do this right now?". Check the goals with "The dead man test": if the goals could be achieved by death, they will not encourage an active attitude and change in the patient. Goals like "I want to have less pain" and "I don't want to be breathless anymore" could be rewritten to "I want to be able to play with my grandchildren for 15 minutes and enjoy this time with them" and "I want to have breath enough to sing one song".

To facilitate user participation, discussion between the therapist and the patient about "What is working?", "What should be different?", "Are we on the right track here?", "Are we working with your goals?", etc. might be useful. Some focus on user participation might prevent dropouts.

Linda Aarøen Lien, the physiotherapist who followed the patients in the Norwegian pilot project, tried to keep a curious and supportive attitude towards the patients during videoconferences by asking questions like: "What do you want?", "What can you manage?", "What is stopping you?", "What effect did you perceive from what you have done or not during the last week?". She also explained that the physiotherapist has to be aware of the ethical aspects one might come over. By participating in this project, each patient agreed to exercise according to a program, register data and monitor daily health conditions so that the physiotherapist can give relevant guidance. If a patient does not exercise for a long period, the physiotherapist might show a challenging attitude in an attempt to encourage the patient to start exercising again. The patient might start feeling guilty, but guilt almost never motivates people. The physiotherapist should try to give the patient knowledge on how to use the equipment and eventually to find the reasons why the patient didn't exercise. At the same time, the physiotherapist should keep in mind that each patient might react differently to knowledge and guidance. We would like to quote one of Linda's videoconferences with a patient to make an example on how she tries to support the patient's own resources, support him and make him responsible for his own health:

Patient: Hi. As you can see, I haven't exercised at all last week...
Linda: Yes, I see that. What has been stopping you?
P: My breath has been so heavy. I think I'm coming down with something. I haven't managed to get myself up

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on the treadmill.
L: Yes, you have to listen to your own body. Do you have a lot of sputum?
P: Yes, it has been more than normal lately.
L: Some weeks ago you told me that you had some good experiences with techniques for airway clearance before exercising. And actually exercising makes you breathe deeper and this will mobilize some of the sputum. If you get the sputum up and away, your breath should feel a bit lighter.
P: Yes, that is true. I had almost forgotten about that.
L: You could try that. But the most important thing is that you listen to what your body is telling you and then decide if it's smart to exercise on the treadmill or not today.

Health personnel will often have an understanding that patients should be responsible to implement measures which could improve their health. Patients might not always have the same understanding of their situation. A dualistic set of mind is still present in the population.

The dividing of the human as two separate substances: Body as pure nature and material substance on one side – Soul and consciousness, the immanent substance, on the other side, is still seen in both patients and health personnel (3). The body, or parts of it, becomes an object which is presented as a problem area. The expectation from the patient might then be that the physiotherapist should give an exact recipe on how to improve his/her health. If the physiotherapist says that you know best yourself, and you have to learn from your experiences, the meeting between you is set for a collision course. The patient could come to a conclusion that the physiotherapist is ignorant and doesn't bother to do the job properly, and the physiotherapist might think that the patient is "lazy". In order to have a good communication, the parties must have somewhat similar perceptions of the situation this is (4). The physiotherapist should be responsible to ensure that this happens.

Another aspect to consider before contacting patients via videoconferencing is that this implies visiting them in their homes. When visiting a rehabilitation facility, they are seen as patients with COPD. When they are at home, they are just themselves: fathers, chefs, outdoor enthusiasts, hippies, bureaucrats and poets. They are "kings of their own castles" and the physiotherapist is invited in to contribute with tools which can help them be better self manage their own lives. They integrate your contributions in the way that suits them best. The physiotherapist's goal should be to make herself redundant over time. A sign of success is when the physiotherapist's and the participant's horizons merge in a joint effort, leaving each other richer than when they first met.

Practical conduction of the video conferences

Frequency:

- At least 1 individual videoconference per week in the first 8 weeks after enrollment.
- At least 1 individual videoconference per month in the following period.
- In case of hospital admission (or if needed after a serious exacerbation without hospital admission), at least 1 video conference per week should be arranged in the month after discharge/exacerbation, as a reinforcement strategy.
- Additional peer-group exercise sessions (sessions with more than one patient participating via video conference) supervised by the physiotherapist can be organized.
- The physiotherapist could also set up voluntary, unsupervised videoconferences between groups of patients to promote motivation and peer-support.
- Video conferences should be agreed with the patient and set up as upcoming events in the patient's web page.
- If the patient does not reply your attempt to contact him/her via video conference at the scheduled time, try to contact him/her by phone (to understand whether there are problems and try to establish video conference). If videoconference is not performed as scheduled, agree with the patient to conduct a new meeting within a week. If he/she does not reply, postpone the videoconference to the next month as planned. Make an effort to get in touch at least once a month. Remember to register all problems occurred in the troubleshooting form.

Before the first meeting with the patient:

- Make sure you have all the information about the patient that you need. You should be given a copy of the spirometry, 6MWT and the exercise program if someone else has done the first prescription of the program.

First meeting via videoconferencing (60 minutes):

- Getting to know each other (clinical history, experience with exercising and computers and other information you would like to know about the patient).

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- Goal setting and expectations regarding participation in the project. Post the goals you agree up on in the patient webpage.
- Explain the project and functions of the webpage if needed.
- Try out the exercise program, and post it at the patient webpage if this have not been done.
- Schedule the next meeting and post it as an upcoming event.

Weekly interpretation of data and before the videoconference:

- Go through the patient' webpage, daily measurements, training diary, comments and messages if there are any.
- Assess the whole picture. Has the patient exercised according to the plan? Are adjustments to the exercise program needed? Do health conditions seem stable?
- You should go through the patient' web page on a weekly basis, even though you haven't scheduled a videoconference. Answer questions or write comments if needed.

Videoconference (20-30 minutes, more time might be needed for the first couple of meetings):

- Clarify whether the patient wants to use this session to exercise or just discuss exercise, goals, daily measurements etc. You could do a bit of both if there is time available, but do not expect the patient to have a whole conversation with you while walking. The patient needs his/her breath for exercising.
- Discuss last week's/last month's exercising:
  - Accomplishments? New experiences? Changes?
  - Try to make progress in the exercise program often, especially in the beginning.
  - Deviation from the plan? Why? Need to make adjustments?
  - Coping with dyspnea during exercise?
  - Exercising during illness and convalescence.
  - A major goal with this discussion is to make the patients understand how exercise influences their body, to provide knowledge and experience in how they can adjust their training according to their daily conditions and make progressions.
  - Motivation.
- Dialogue regarding daily measurements:
  - Educate the patient in early recognition and treatment of COPD exacerbations. The warning signals are:
    - More wheezy or breathless than normal
    - More coughing than normal
    - Less energy for usual activities
    - Loss of appetite or sleep
    - Change in amount or color of sputum (yellow-green or brown)
    - Need for an inhaler or nebulizer more often than usual.
    - Signs of fever or the first signs of a cold.
    - Increased heart rate, resting saturation and BCSS score might also predict upcoming exacerbation (5).
  - Treatment:
    - Encourage the patient to get a plan for increasing medication/ dosage for rescue medication for early treatment of exacerbations from his physician if he does not have one yet, and guide him to use this additional medication when needed.
    - Reduce activity level and rest frequently.
    - Clear sputum with techniques for airway clearance (active cycle and huffing).
    - Use of breathing- and relaxation techniques.
    - Eat small amounts of nourishing food, often.
    - Drink extra fluids.
    - Advice patient to get in touch with a physician if they seem to have a more severe chest infection and are unable to perform normal activities (e.g. dressing, bathing, eating), have fever or chills, increased swelling of ankles or extremely shortness of breath. Note that the project-patients should use all the health services as other COPD patients (e.g. standard care) during the two-year period.
- Goal and goal attainment, regularly:

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  - To keep focus on the goals and the progress these questions among others could be asked:
    - What have been different in regard of your goal this week?
    - Have you discovered any small signs of change in regard to your goal this week?
    - What do you need to change to get closer to your goal?
    - Why do these things seem different?
    - What have you done that seems to work?
- Other discussion topics:
  - Need of more knowledge about COPD and living with COPD?
  - What to do to stay well and healthy (Plan activities and pace yourself, listen to your body, nutrition, social activities, smoking cessation if needed, avoid allergens and things that make symptoms worse, take medication and use oxygen as prescribed etc.).

After the videoconference:

- Make notes for future references in the electronic journal.
- Adjust the exercise program on the patient's webpage if not previously done while talking. The different versions of the exercise program will be saved.

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Training program (group B)

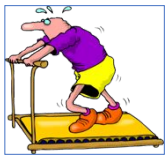
iTrain-study

Treadmill training for	Frequency: 3 times per week

Training session	Duration (minutes)	Speed (km/h)	Incline (%)	Borg scale (intensity)

BORGS CR 10 SCALE

0 Nothing at all
0,3
0,5 Extremely weak Just noticeable)
0,7
1 Very weak
1,5
2 Weak Light
2,5
3 Moderate
4
5 Strong Heavy
6
7 Very strong
8
9
10 Extremely strong "Maximal")
11
• Absolute maximum Highest possible



Training diary
Tick each day you exercise. Do you get 3 or more marks each week?
N.B. Do not exercise if you feel sick (for ex. more coughing, wheezing, breathless or sputum than usual. Need of inhaler/nebulizer more than usual. Less energy, appetite or sleep than usual).

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January 2016

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

February 2016

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29					

March 2016

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

April 2016

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

May 2016

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

June 2016

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

July 2016

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August 2016

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September 2016

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October 2016

Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

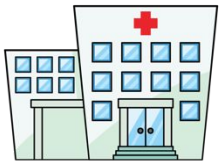
November 2016

Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

December 2016

Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Self-management during exacerbations



iTrain study

Get to know signs and symptoms of a chest infection or flare up.
Early treatment might minimise the severity of an infection.

Beware of the following warning signs:

- coughing more than normal
- change in amount or color of sputum (yellow-green or brown)
- more wheezy or breathless than normal
- less energy during your daily activities
- loss of appetite or sleep
- need for an inhaler or nebulizer more often than normal
- signs of fever or first signs of a cold
- swelling of ankles

Actions:

- Look for medical assistance with your GP or respiratory specialist
- Let us know calling on **xxxx xxxx** and mention the **iTrain study**
- Please leave a message on the answering machine if unattended

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