DOI:
10.3109/15412555.2012.707258

Document Version
Early version, also known as pre-print

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Journal:	*COPD: Journal Of Chronic Obstructive Pulmonary Disease*
Manuscript ID:	Draft
Manuscript Type:	Original Paper
Date Submitted by the Author:	n/a
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Keywords:	pulmonary , rehabilitation, utilisation, integrated care, community, referral

Effectiveness, attendance, and completion of an integrated, system-wide pulmonary rehabilitation service for COPD: prospective observational study.

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Keywords: Pulmonary; rehabilitation; utilisation; integrated care; community; referral

Abstract

Pulmonary rehabilitation (PR) is one of the most effective treatments for COPD but not widely available. Uptake is poor and completion rates are low. In this integrated PR service we report on effectiveness, attendance, and completion of twice weekly rolling recruitment and once weekly cohort recruitment programmes in two hospital and five community PR sites. The hospital and two of the community programmes were 'rolling' recruitment twice weekly for 8 weeks. Three community programmes ran in once weekly cohorts for 8 weeks. Predictors of attendance, completion and effectiveness were sought. 1114 eligible COPD patients were referred. 812(73%) attended assessment, 656(59%) started and 441(40%) completed. Significant improvements were seen in incremental shuttle walk test (ISWT) (mean 68.3m; 95%CI 59.3-77.4), Chronic Respiratory Questionnaire self-report dyspnoea scale (CRQ-SR) (0.94; 0.80-1.07), Hospital Anxiety and Depression Scale anxiety (0.9; 0.5-1.2) and depression (1.1; 0.8-1.4) components, exceeding the minimum clinically important difference for ISWT and CRQ-SR. Twice weekly compared with once weekly programmes showed similar improvement. Patients were less likely to complete if they were deprived (4^{th} quintile of deprivation 0.56; 0.33-0.94, 5^{th} quintile 0.57; 0.34-0.85), reported MRC dyspnoea scale 4 (0.61; 0.37-0.97) or 5 (0.39; 0.16-0.93), or had been referred by their general practitioner (0.42; 0.24-0.74) (pseudo R^2 0.103). PR is effective for COPD in real-world practice achieving results comparable to trials. Only a small proportion of the variance in attendance and completion of PR was explained by demographic characteristics, disease severity, psychological morbidity and source of referral despite the large number of participants.

Introduction

Evidence for the benefits of pulmonary rehabilitation (PR) in COPD is broadly based and widely accepted.[1,2] Its prescription is recommended in national and international guidelines for patients with symptomatic disease.[3,4] A number of randomised controlled trials and meta-analyses have reported on the beneficial effects of PR on exercise capacity, dyspnoea, quality of life and improvements in health care utility.[5-8] Low rates of referral, uptake and completion have been widely reported and have implications for service delivery. Although the availability of PR has improved in the United Kingdom, and many programmes are now available to patients referred from primary care as well as secondary care, few studies have examined the effectiveness and applicability of PR in conventional health care.[9,10] In a retrospective analysis of the trials included in a Cochrane Airways meta-analysis of rehabilitation, Bjoernshave et al highlighted selective inclusion criteria and significant drop-out rates or non-completion in several studies.[11] Seventy five percent of participants in 26 trials were non-completers due to ineligibility for study inclusion or drop-out. In the USA, Cote et al found that 53% of participants either declined to take part in a trial or dropped out.[12]

Trials investigating the predictors of drop-out from PR have highlighted a number of associated phenotypical features. In a recent systematic review Keating et al identified obstacles to initial PR uptake: disruption to valued routine, uncertainty of the referrer in its effectiveness, inconvenient timing, travel issues, and low perceived benefit.[13] Most of the studies included were small and several were qualitative. Obstacles to PR completion were illness and co-morbidities, travel, current smoking, lack of social support, COPD exacerbations, and low perceived benefit.[13] Severe disease including severe dyspnoea was associated with drop-out in a retrospective study of 239 patients by Sabit et al in the UK, and in the study by Cote et al in the USA, and Garrod and colleagues found that quadriceps weakness and depression were also predictors of drop out in the UK.[12,14,15] Whilst these studies suggest that severity of symptoms and co-morbidities may be associated with higher risk of drop-out, prior identification of participants at risk of non-attendance remains difficult and no robust predictive models are available.

There is also a paucity of information concerning the effectiveness of different models of rehabilitation, optimal duration, frequency of supervision and method of recruiting.[16] In a randomised controlled trial evaluating the frequency of supervised sessions O'Neill et al have suggested that once weekly programmes may lead to similar outcomes as twice weekly programmes. However since this small study was not powered for equivalence, results should be

interpreted with caution. Within the current economic climate the frequency of supervised sessions remains an important clinical consideration. The impact of the method of recruitment, for example cohort recruitment (all patients start and finish together) or rolling recruitment (continuous programme, new patients start every week), has not been adequately tested. Community programmes are likely to be as effective as hospital programmes.[17] Increasingly, data show benefits of programmes integrated between primary and secondary care for COPD.[18,19]

We report outcomes from a prospective observational study on the effectiveness of an integrated system-wide service of pulmonary rehabilitation, where rehabilitation is provided in hospital and community settings, with rolling recruitment to twice weekly supervised programmes and cohort recruitment to once weekly supervised programmes. We have evaluated attendance at assessment and rates of completion, and have sought to define predictors of effectiveness, attendance at assessment and completion.

Methods

We have analysed data from an integrated PR service in two inner London boroughs across community and acute hospital settings between April 2008 and March 2010. Ethical approval was obtained from the Proportional Research Ethics Review Committee, St Thomas Hospital, London, (Research Ethics Committee reference number 09/H0701/90).

Participants

Patients with a diagnosis of COPD were eligible. Patients were excluded if they were not appropriate for rehabilitation due to cardiovascular instability or significant musculoskeletal limitations at referral or assessment. Referrals were received from primary and secondary care including general practitioners, practice nurses, community COPD teams, in-patient COPD teams, in-patient physiotherapists, and respiratory physicians in outpatient clinics. Within two weeks, patients were sent written confirmation of receipt of referral, together with a PR information leaflet produced by the British Lung Foundation. Patients were telephoned to offer an appointment for assessment at the most suitable location followed by written confirmation. Patients requiring transport used hospital transport services to attend hospital sites. All patients received a reminder telephone call prior to the appointment. Those who did not attend were offered one further assessment appointment.

Pulmonary rehabilitation programmes

Programmes took place in seven centres: two hospital physiotherapy gyms and five community settings (two local authority gyms, one health centre and two community halls). The two hospital and two of the community programmes were delivered on a rolling recruitment basis. Patients on rolling programmes attended twice weekly supervised sessions for eight weeks (16 sessions) and were encouraged to exercise at home for at least one additional session.[20] Three community programmes used cohort recruitment whereby patients attended once weekly supervision over 8 weeks (8 sessions) and were encouraged to exercise at home for at least two additional sessions, using a locally developed home exercise video.[21] Patients attended rehabilitation at a site of their choice. Once weekly cohort programmes were offered to enable attendance at a local venue where a rolling programme may not have been available.

Standardised exercise and education was delivered across all sites in accordance with guidelines.[20] Exercise consisted of cardiovascular and limb strengthening activities in line with individual baseline function. Walking was a component in all programmes and intensity was determined at 85% peak oxygen consumption from baseline walk testing.[22] Patients with a current prescription for ambulatory oxygen used it during exercise. Where evidence of desaturation to less than 85% was evident on exercise, supplementary oxygen was provided and those patients were offered further assessment of ambulatory oxygen need.[20]

Measures

Data collected included age, gender, ethnicity, postcode (to obtain the Index of Multiple Deprivation Score - IMD), MRC dyspnoea scale, referrer, forced expiratory volume in the first second (FEV_1).[23,24] The IMD score is based on national census and local authority data and reflects deprivation specific to a geographical area. IMD scores in 2007 ranged nationally from 0 (the least deprived) to 86 (the most deprived). For analysis the IMD scores were categorised into quintiles based on the scores of all patients at referral: 6.86-27.1: 27.2-34.4; 34.5-39.01; 39.02-43.4; 43.41–60.41. Age was categorised in four groups: 0-54; 55-64; 65- 74; 75 and over. The following measures were completed before and after a course of PR: Incremental Shuttle Walk Test (ISWT), Self-Reported Chronic Respiratory Disease Questionnaire (CRQ-SR) and the Hospital Anxiety and Depression Scale (HADS).[25-27]

For the purpose of analysis the ISWT was categorised into quartiles based on the scores recorded at baseline in the patients attending assessment: 0-130 metres; 131-220 metres ; 221-340 metres ;

341-1020 metres. The anxiety and depression components of the HAD scale were also categorised into three categories based on previous study in a general population. The first category, 0-7 is normal, the second category 8-10 represents "risk" of anxiety or "risk" of depression, and the third category 11 or more represents "caseness" for anxiety or depression.[27] Patients were categorised as "completers" if they had attended at least 8 sessions (50%) on a rolling recruitment programme or had attended at least 6 sessions (75%) on a cohort recruitment programme, irrespective of attendance at final assessment.

Analysis

Analysis was carried out using SPSS (SPSS Inc, Chicago). Predictors of attendance at assessment were investigated using univariate and multivariate logistic regression with the independent variables age, gender, referrer and IMD score. Course completion was investigated using univariate and multivariate logistic regression with the independent variables age, gender, referrer, IMD score, MRC score, Global Initiative for Chronic Obstructive Lung Disease (GOLD) stage (based on FEV1), and ISWT, CRQ and HADS at baseline. Because of the number of comparisons in the univariate logistic regression of completion, we set the threshold for statistical significance at p=0.01 to allow for the increased possibility of finding a significant association by chance. Effectiveness of PR was assessed by comparing mean scores in ISWT, CRQ and HADS before and after PR using paired t-tests and 95% confidence intervals. We assessed the outcome not only in the significance of the difference but also in whether the lower end of the 95% confidence interval for the difference was greater than the minimal clinically important difference (MCID) for the ISWT (47 metres) and each domain of the CRQ-SR (0.5) and for the HADS (anxiety 1.32 and depression 1.4).[28-30] We composed a binary outcome variable based on the MCID for the outcome measure ISWT and for each domain of the CRQ-SR to seek, using multiple logistic regression, predictors of effectiveness of PR among demographic variables and baseline measures of severity.

Results

1266 people with COPD were referred to pulmonary rehabilitation between April 2008 and March 2010 (mean age (SD) 68.1 (11.0) yrs; male 52%; IMD 35.8 (9.2)). Figure 1 shows the recruitment pathway for all referrals. 812 (73%) eligible patients attended for assessment. The course was completed by 441 patients (40% of those referred, 54% of those who attended assessment and 67% of those who started the course). 635 (57%) patients were referred from primary care (13% general practitioner (GP), 21% practice nurse, 23% community COPD clinic), 41% from secondary care (19%

respiratory physician outpatient clinics, 13% in-patient multidisciplinary COPD team, 9% in-patient physiotherapist), and 2% from other referrers.

Attendance at assessment

The characteristics of the 812 patients who attended assessment are shown in Table 1 together with the adjusted odds ratios (multivariate analysis) for their attendance compared to referred patients who did not attend. Patients were less likely to attend assessment if they were under 55 years or over 74 yrs, or were referred by the in-patient COPD team, hospital physiotherapist or specialist COPD community clinic. Gender and deprivation score did influence attendance at assessment.

Completion of Pulmonary Rehabilitation

The characteristics of patients who attended PR are shown in Table 2. Unadjusted odds ratios (univariate analysis) show differences in characteristics between those who completed and those who dropped out. Factors associated with lower rates of completion were: GP referral, second to lowest quintile of deprivation (not the lowest), MRC score 4 or 5, baseline ISWT distance of less than 220m, lower baseline CRQ score in the domains of fatigue, emotion and disease mastery, and a HAD anxiety or depression score of 11 and above. Type of programme (once weekly cohort or twice weekly rolling recruitment) was not associated with completion.

In multivariate analysis GP referral, depression score of 11 and above, MRC score 4 or 5, and higher deprivation remained independently associated with lower rates of completion (Table 3).

Effectiveness

Statistically significant improvements were evident overall and in both the twice weekly rolling and the once weekly cohort recruitment groups for ISWT, all domains of the CRQ, and HADS anxiety and depression scores (Table 4). The mean change and the lower limit of its 95% confidence interval in ISWT and all domains of the CRQ exceeded the minimal clinically important differences (MCID) in patients completing PR overall and in those in twice weekly rolling recruitment groups. The MCID of the HADS anxiety element was not reached but participants in the twice weekly rolling recruitment group reached the MCID for depression. In the once weekly cohort recruitment programme, the mean change in ISWT and CRQ also exceeded the MCIDs but the lower limit of the 95% confidence interval was less than the MCID with respect to the ISWT and the CRQ emotion, fatigue and mastery domains and higher than the MCID for CRQ dyspnoea.

No consistent predictors of effectiveness were found across the outcome measures of the ISWT and the four domains of the CRQ-SR. For example, patients with MRC dyspnoea score of 5 at baseline were less likely to improve in ISWT more than 47 metres (OR 0.054, 95% CI 0.004-0.669) or in CRQ-SR Dyspnoea domain by more than 0.5 (OR 0.054, 95% CI 0.004-0.669) when adjusting for age, sex, referrer, IMD score, and GOLD stage. Yet these patients were no less likely to improve in CRQ-SR emotion, fatigue and mastery domains. Similar sporadic associations were observed with other demographic variables and baseline severity scores. Overall pulmonary rehabilitation was equally effective in patients with mild disease, in patients over seventy five years, and in patients from more deprived backgrounds.

Discussion

In this large observational evaluation of an integrated PR service for COPD across primary and secondary care, PR was effective in improving exercise capacity, reducing dyspnoea, improving quality of life, and reducing anxiety and depression. Seventy three percent of referred patients attended for assessment and 40% completed the course of treatment. This research confirms the findings of clinical trials in a real world setting with no prior selection of participants. It answers the criticism that has been made of some trials in which many patients suitable for PR programmes were excluded.[11] It demonstrates the effectiveness of PR in everyday clinical practice, but it also shows that the key obstacles to its delivery are to be found in the take-up and completion of the treatment by those referred.

Its strength comes from its large sample size, the absence of restrictive patient selection criteria, and its application over two years. The capacity of this PR programme has been in excess of 600 annual places for at least five years for a population of about 5000 COPD patients. Access is open to clinicians from primary and secondary care and the programme has been promoted widely. PR is shown here to be effective in all patients with COPD irrespective of age and socio-economic deprivation, in patients with moderate, severe, and very severe disease.[28,29] The conclusions that can be drawn are limited by the absence of a control group. Nonetheless the size of the improvement achieved does match that observed in trials.[1] The baseline ISWT was not preceded by a training walk but the improvement seen in the ISWT matched the improvement in dyspnoea and quality of life.

As with twice weekly rehabilitation, changes in outcomes in the once weekly cohort were statistically significant. However, the lower limits of the outcomes' 95% confidence intervals in the once weekly cohort only exceeded the MCID with respect to the dyspnoea element of the CRQ-SR. The analysis was not powered to look at differences between once and twice weekly provision of rehabilitation, and patients were not randomised to once only or twice only, but this finding gives more confidence in the advantage of twice weekly over once weekly attendance.

Attendance at assessment

Eligible referrals to PR came from primary and secondary care, with slightly more from the former. This reflects an important shift in primary care awareness of PR. We were limited in comparing attenders and non-attenders before assessment by the information provided by the referrer, a problem highlighted by Keating et al in their review.[13] We cannot explain why people below 55 or above 75 years were less likely to attend assessment. This may have reflected a greater likelihood of employment in the younger group, and poor mobility and co-morbidities in the older group. Poor attendance at assessment by patients referred from a specialist COPD community clinic or while they were in hospital may reflect more complex needs and more severe disease. Recent data shows an important benefit of rehabilitation after exacerbation leading to hospital admission, but recruitment during this acute phase is more difficult.[8,31] Rehabilitation providers may have to consider whether the needs of these patients are different.

Completion of rehabilitation

The rates of completion are similar to those observed in trial settings from the time of contact or screening. Completion rates after randomisation in trials of PR are usually about 75%, compared to 54% after assessment in participants in this study.[11] This is not surprising because participants in trials are generally less affected by co-morbidities and have usually signalled their commitment to participation by completing consent forms. Patients referred by general practitioners were as likely to attend assessment as patients referred by respiratory physicians in outpatient clinics, but they were less likely to complete rehabilitation. Further exploration of the methods of preparation of patients for PR may be justified. As with Fan et al and Garrod et al, we found that depression was a predictor of drop out. [15,32,33] While these factors together with deprivation and more severe disease were significantly associated with reduced completion, they only explained 10% of the variance (pseudo r^2 = 0.103) in completion rate after assessment.[34] This was despite the large

numbers in our multivariate analysis (n=657) and the extensive data on deprivation, source of referral, severity, quality of life, exercise capacity and mental health.

A new understanding is required of the reasons why nearly half of patients assessed for PR and 60% of those referred fail to complete the treatment. We know that the determinants of behaviour with respect to exercise are complex.[35] A new approach is required which seeks to understand from the patients' perspective why they fail to complete PR. Qualitative research may lead to the development of new hypotheses which could be tested in less reductionist fashion, perhaps adopting Bayesian statistical methods to allow for more complex relationships.

Conclusions

Despite our concerns about high levels of failure to attend assessment and to complete pulmonary rehabilitation, it is clear from this study that pulmonary rehabilitation is effective in the routine clinical care of COPD in those who complete the course. Clinicians from all sectors of health services should be able to refer their patients. They should be aware that rates of attendance at assessment may be 75% or less and the course of treatment may be completed by only 40% of all those referred. Providers should plan services that make allowance for these low rates of attendance and completion. There is no reason to suspect that age or socio-economic deprivation are factors that will prevent patients from taking advantage of what is one of the most useful treatments in the management of COPD.

Acknowledgements

Funder: Guy's and St Thomas' Charity, Reference no: G060703.

We are grateful to Paul Seed of King's College London for statistical advice, and to Dr Jack Barker of King's College Hospital NHS Foundation Trust who developed and manages the database on which all clinical data relating to pulmonary rehabilitation in King's College Hospital and in community services in Lambeth Southwark is collected

Declaration of Interest

The authors report no conflict of interest

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Table 1. Characteristics of attenders at assessment for pulmonary rehabilitation.

(Adjusted odds ratios for association with attendance)

Characteristic	Attended assessment n (% of all referred)	Adjusted odds ratios† (95% CI) n = 1084
Age (years)		
0-54	83 (60)	1
55-64	225 (77)	2.17 (1.38-3.44) [a]
65-74	276 (78)	2.24 (1.43-3.5) [a]
75+	228 (69)	1.49 (0.96-2.3)
Gender		
Female	382 (71)	1
Male	430 (74)	0.92 (0.7-1.22)
Referrer		
Consultant respiratory physician	168 (80)	1
In-patient COPD multidisciplinary team	96 (63)	0.45 (0.28-0.73) [a]
In-patient physiotherapist	60 (61)	0.43 (0.25-0.75) [a]
GP	110 (78)	0.94 (0.55-1.61)
Practice nurse	180 (76)	0.78 (0.49-1.24)
Community COPD clinic	181 (72)	0.63 (0.4-0.98) [a]
Other	17 (71)	0.67 (0.26-1.75)
Deprivation quintiles (IMD)		
6.86-27.1	137 (72)	1
27.2-34.4	174 (80)	1.3 (0.81-2.06)
34.5-39.01	153 (69)	0.8 (0.52-1.23)
39.02-43.4	164 (77)	1.18 (0.75-1.84)
43.41–60.41	162 (67)	0.76 (0.49-1.16)

[a] = significant effect. † Adjusted for other variables in the table.
Pseudo R^2 (McFadden 1974) for multiple logistic regression = 0.064. Describes how well (6.4%) the model performs when compared to a perfect prediction model.[34]

Table 2. Characteristics of patients who completed a pulmonary rehabilitation course and of those who dropped out.

(Unadjusted odds ratios for association with completion)

	Attended Assessment n=812		Unadjusted odds ratio (95% CI)	p value [a]
Characteristic	**Drop Out** [b] n=371(%)	**Completer** n=441 (%)		
Age:				
up to 54 years	44 (11.9)	39 (8.8)	1	
55 to 64 years	113 (30.5)	112 (25.4)	1.12 (0.08-1.85)	0.66
65 to 74 years	108 (29.1)	168 (38.1)	1.76 (1.07-2.88)	0.026
75 years +	106 (28.6)	122 (27.7)	1.3 (0.79-2.15)	0.309
Sex:				
Male (%)	182 (49.1)	248 (56.2)	1.33 (1.01-1.76)	0.04
Source of referral:				
Consultant respiratory physician	71 (19.1)	97 (22.0)	1	
In-patient COPD team	44 (11.9)	52 (11.8)	0.87 (0.52-1.43)	0.574
In-patient physiotherapist	32 (8.6)	28 (6.3)	0.64 (0.35-1.16)	0.14
GP	65 (17.5)	45 (10.2)	0.51 (0.31-0.83)	0.006 [c]
Practice nurse	69 (18.6)	111 (25.2)	1.17 (0.77-1.81)	0.46
Community COPD clinic	80 (21.6)	101 (22.9)	0.92 (0.61-1.41)	0.72
Other	10 (2.7)	7 (1.6)	0.51 (0.77-1.81)	0.2
IMD score of deprivation:				
Quintiles:				
6.86-28.1	63(17.2)	97 (22.5)	1	
28.11-35.02	75 (20.4)	92 (21.3)	0.8 (0.51-1.24)	0.31
35.03-39.57	60 (16.3)	92 (21.3)	0.99 (0.63-1.57)	0.99
39.58-43.85	90 (24.5)	78 (18.1)	0.56 (0.36-0.87)	0.01 [c]
43.86–60.41	79 (21.5)	72 (16.7)	0.59 (0.38-0.93)	0.02
Ethnicity:	n=282	n=409		
White British & Irish	255 (90.4)	347 (84.8)	1	
White Other	3 (1.1)	21 (5.1)	5.14 (1.52-17.43)	0.009 [c,e]
Black	16 (5.7)	31 (7.6)	1.42 (0.76-2.66)	0.27
Asian sub-continent [d]	7 (2.5)	6 (1.5)	0.63 (0.21-1.9)	0.41
Other	1 (0.4)	4 (1.0)	2.94 (0.33-26.46)	0.34
MRC Dyspnoea:	n=308	n=426		
1 and 2	46 (14.9)	93 (21.8)	1	
3	102 (33.1)	168 (39.4)	0.78 (0.51-1.18)	0.24
4	128 (41.6)	140 (32.9)	0.52 (0.34-0.78)	0.002 [c]
5	30 (9.7)	16 (3.8)	0.25 (0.13-0.5)	<0.001 [c]
Gold Stage n (%)	n=222	n=285		
I	16 (7.2)	27 (9.5)	1	
II	85 (38.3)	113 (39.6)	1.02 (0.6-1.75)	0.95
III	88 (39.6)	106 (37.2)	1.13 (0.65-1.94)	0.67
IV	33 (14.9)	39 (13.7)	1.43 (0.66-3.09)	0.37
Baseline ISWT:	n=252	n=390		
Quartiles:				
0-130m	83 (32.9)	82 (21.0)	1	
131-220m	75 (29.8)	92 (23.6)	1.24 (0.8-1.91)	0.33
221-340m	44 (17.5)	108 (27.7)	2.48 (1.56-3.95)	<0.001 [c]
341-1020m	50 (19.8)	108 (27.7)	2.19 (1.39-3.44)	0.001 [c]
CRQ Dyspnoea:	n=278	n=406		
Mean (SD)	2.54 (1.14)	2.74 (1.20)	1.16 (1.02-1.33)	0.029
CRQ Emotion:	n=281	n=407		
Mean (SD)	3.69 (1.39)	4.21 (1.40)	1.31 (1.17-1.47)	<0.001 [c]
CRQ Fatigue:	n=282	n=406		
Mean (SD)	3.01 (1.29)	3.44 (1.37)	1.27 (1.13-1.43)	<0.001 [c]
CRQ Mastery:	n=283	n=407		

Mean (SD)	3.83 (1.49)	4.33 (1.41)	1.27 (1.14-1.42)	<0.001 [c]
HAD Anxiety: n (%)	n=285	n=403		
<=7	113 (36.9)	204 (50.6)	1	
8-10	66 (23.2)	93 (23.1)	0.78 (0.52-1.15)	0.21
>11	106 (37.2)	106 (26.3)	0.55 (0.39-0.79)	0.001 [c]
HAD Depression: n (%)	n=283	n=403		
<7=	131 (46.3)	246 (61.0)	1	
8-10	67 (23.7)	85 (21.1)	0.68 (0.46-0.99)	0.045
>11	85 (30.0)	72 (17.9)	0.45 (0.31-0.66)	<0.001 [c]
Programme type: n (%)	n=371	n=441		
Cohort recruitment	113 (30.5)	133 (30.2)	1	
Rolling recruitment	258 (69.5)	308 (69.8)	1.01 (0.75-1.37)	0.93

[a] The large number of tests of association increases the risk of finding a significant association by chance. We have therefore increased the threshold for significance by only accepting p values of 0.01 or less.
[b] Drop out = patient declined at assessment, did not start PR course or started but did not complete course.
[c] = significant result
[d] Asian sub-continent = Bangladesh, Bhutan, India, Nepal, Pakistani, Sri Lanka
[e] The importance of the significant finding with respect to White Other subjects is doubtful because the group consisted of only 3 participants

Table 3. Characteristics of patients who completed pulmonary rehabilitation compared with those who dropped out (adjusted).

Characteristic	Adjusted odds ratio for completion of the course [a] (95% CI) n=657
Referrer	
Consultant respiratory physician	1
In-patient COPD multidisciplinary team	0.87 (0.48-1.57)
Hospital physiotherapist	0.55 (0.27-1.15)
GP	0.42 (0.24-0.74) [b]
Practice nurse	0.89 (0.54-1.48)
Community COPD clinic	0.82 (0.49-1.35)
Other	0.55 (0.15-2.07)
MRC dyspnoea score	
1 or 2	1
3	0.88 (0.55-1.41)
4	0.61 (0.37-0.97) [b]
5	0.39 (0.16-0.93) [b]
Depression score (HADS)	
(Not depressed) 0-7	1
(Risk of depression) 8-11	0.77 (0.51-1.18)
(Depressed) >11	0.56 (0.37-0.85) [b]
Deprivation quintiles (IMD)	
IMD score 6.86-28.1	1
28.11-35.02	0.72 (0.43-1.2)
35.03-39.57	1.0 (0.59-1.7)
39.58-43.85	0.56 (0.33-0.94) [b]
43.86–60.41	0.57 (0.34-0.85) [b]

[a] adjusted for other variables in table and age and sex
[b] significant effect .
Pseudo R^2 (McFadden 1974) for multiple logistic regression = 0.103. Describes how well (10.3%) the model performs when compared to a perfect prediction model.[34]

Table 4. Changes over time in exercise tolerance, health-related quality-of-life, and anxiety and depression scores.

(Rolling and cohort programmes shown separately)

	All completers		Rolling		Cohort	
	n	Mean change (CI)	n	Mean change (CI)	n	Mean change (CI)
ISWT (m)	311	68.3 (59.3-77.4)	205	74.2 (63.5-85.0)	106	56.9 (40.3-73.2)
CRQ Dyspnoea	329	0.94 (0.80-1.07)	214	0.99 (0.82-1.15)	115	0.84 (0.60-1.09)
CRQ Emotion	334	0.64 (0.52-0.76)	218	0.66 (0.50-0.82)	116	0.61 (0.41-0.81)
CRQ Fatigue	333	0.7 (0.58-0.83)	217	0.74 (0.57-0.90)	116	0.64 (0.44-0.84)
CRQ Mastery	333	0.71 (0.58-0.84)	217	0.71 (0.54-0.87)	116	0.71 (0.49-0.92)
HAD Anxiety	327	0.9 (0.5-1.2)	212	0.9 (0.5-1.3)	115	0.8 (0.2-1.3)
HAD Depression	328	1.1 (0.8-1.4)	212	1.4 (0.9-1.8)	116	0.6 (0.1-1.0)

Minimally clinically important differences: ISWT 0.47m; CRQ-SR all domains 0.5; HADS anxiety 1.32, depression 1.4.
All p values < 0.001 with the exception of change in the Anxiety (p=0.009) and Depression (p = 0.02) scores for cohort programmes.

Figure Legends

Figure 1. Recruitment pathway of all PR referrals received April 2008 – March 2010. Percentages based on eligible referrals (n=1114).

Figure 1

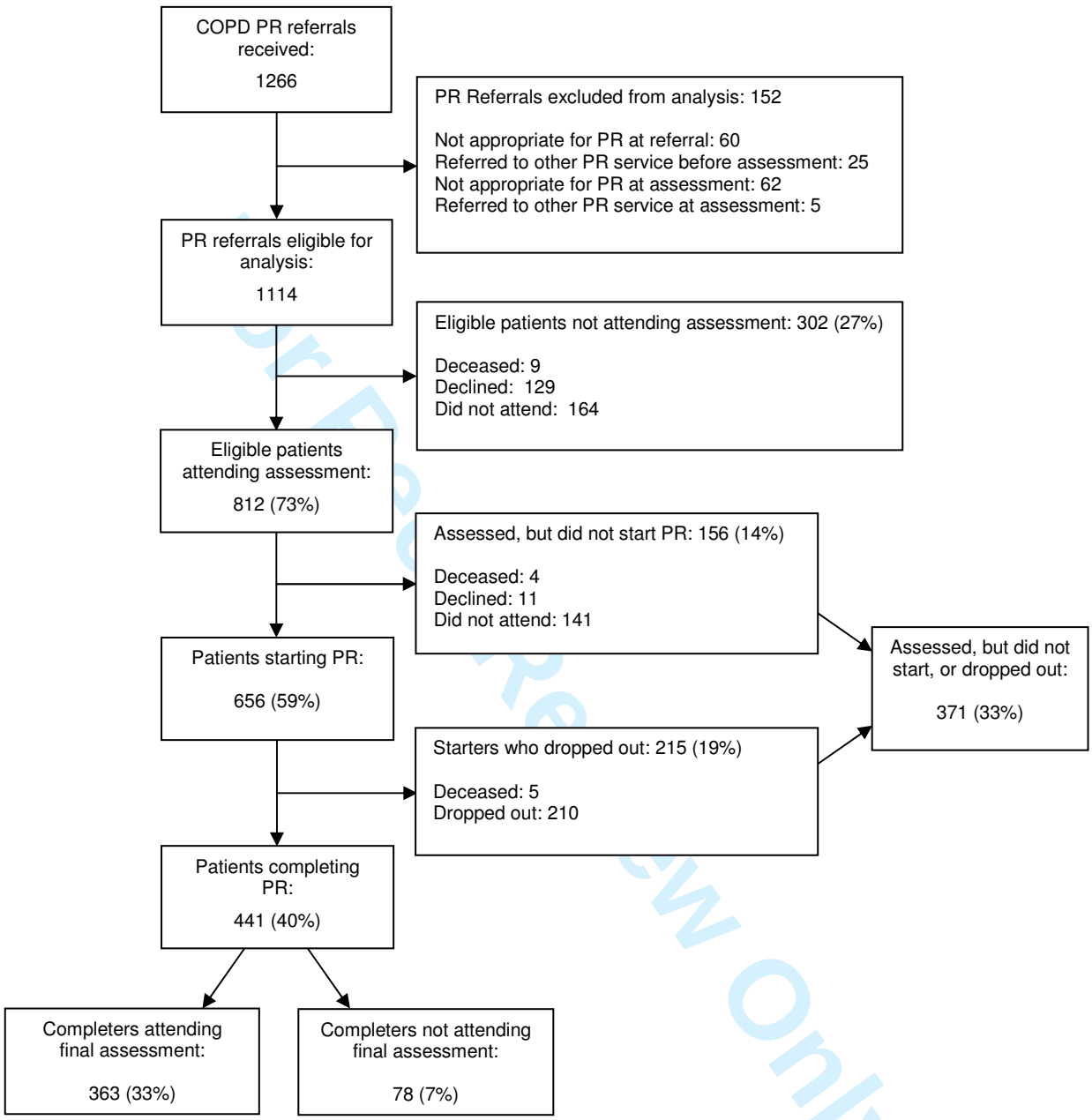

Figure Legends

Figure 1. Recruitment pathway of all PR referrals received April 2008 – March 2010. Percentages based on eligible referrals (n=1114).