Thorax Online First, published on February 20, 2007 as 10.1136/thx.2006.063636

Short burst oxygen therapy after activities of daily living in the home in chronic obstructive pulmonary disease

S J Quantrill, R White, A Crawford, J S Barry, S Batra, P Whyte, C M Roberts

Corresponding author:

Simon Quantrill
Chest Clinic
Whipps Cross University Hospital
Leytonstone
London E11 1NR

Tel: 0208 535 6642
Fax: 0208 535 6709
Email: simon.quantrill@whippsx.nhs.uk

Authors' affiliations:

SJ Quantrill	Whipps Cross University Hospital, London, UK
R White	Whipps Cross University Hospital, London, UK
A Crawford	Whipps Cross University Hospital, London, UK
JS Barry	Whipps Cross University Hospital, London, UK
P Whyte	Whipps Cross University Hospital, London, UK
S Batra	Whipps Cross University Hospital, London, UK
CM Roberts	Whipps Cross University Hospital, London, UK

Keywords: chronic obstructive pulmonary disease, oxygen, activities of daily living, randomised controlled trial, guidelines

Word count: 2512

Background: Short burst oxygen therapy (SBOT) is widely prescribed in the UK with little evidence of benefit. We aimed to examine whether SBOT benefits patients when undertaking normal activities at home, among those who already use it.
Methods: 22 patients with chronic obstructive pulmonary disease (COPD) were included in the study. All regularly use SBOT at home and claim that it helps them. Each patient chose two daily living activities for which they used SBOT for relief of breathlessness. Patients were then randomised to use either an air or oxygen gas cylinder. At least 15 minutes later, the same activity was performed but using the other gas cylinder. The same process was then repeated for the second chosen activity. The main endpoints were subjective
and objective times to recovery, analysed for each activity separately or taking the average over the two activities. A paired statistical analysis was performed.
Results: All patients used SBOT with nasal prongs post-exercise. Using the average recovery time over two activities for each patient, the mean objective recovery time was 38 seconds lower using oxygen (95% CI -81 to +5) and 34 seconds lower when considering subjective recovery times (95% CI -69 to +2). 5 patients were correctly able to distinguish oxygen from air after both activities and there was a suggestion that their recovery times were shorter than those who did not correctly identify the gases (91 vs 20 seconds using objective recovery times, and 80 vs 22 seconds using subjective recovery times), though this was a subgroup analysis based on only 5 patients with non-significant results.
Conclusions: There is some evidence that SBOT shortens recovery time after activities of daily living in a selected group of patients with COPD, but the effect is small. There appears to be a subgroup of patients who may benefit to a much greater degree.

INTRODUCTION

Short burst oxygen therapy (SBOT) refers to the intermittent use of oxygen, usually from a static cylinder. It is widely prescribed for the alleviation of breathlessness in patients with chronic obstructive pulmonary disease (COPD), despite little convincing evidence of benefit.[1] In the UK nearly £18 million was spent on oxygen cylinders in the year 2004-2005 and the cost has risen annually since 1997.[2] International COPD guidelines do not offer any concrete recommendations on who should receive SBOT and when to prescribe,[3-7] in contrast to long term oxygen therapy (LTOT) via a concentrator and ambulatory oxygen with a portable cylinder, both proven to be effective.[8-10] The continued use of SBOT may be a reflection of the lack of conclusive studies and anecdotal reports of benefit from patients. Studies published to date have all been conducted in the hospital or laboratory setting, often requiring the patient to undertake activities with which they may be unfamiliar, such as cycling and treadmill tests.[11, 12]

We aimed to determine whether patients who claimed that they were helped by SBOT and were using it regularly at home could demonstrate consistent subjective and objective benefit likely to be of clinical value. Our aims were confined to determining benefit from using SBOT for exercise, and not from other uses such as breathlessness at rest, during or recovering from exacerbations, for example.

METHODS

Subjects

39 patients with COPD defined by NICE criteria,[3] who regularly used SBOT at home were identified from the Waltham Forest general practice prescribing database and screened using a telephone questionnaire to ascertain suitability for the study. It was a specific requirement that all patients reported that oxygen use was of value in reducing the symptom of breathlessness and had replaced their oxygen cylinder at least once in the past 6 months, as an indication of current usage. Patients with significant comorbidity causing limitation of exercise were excluded, as were patients who stated that they did not benefit from oxygen or who had not replaced their cylinder within the past 6 months. Patients were required to be in a stable clinical state and at least 6 weeks free from an acute exacerbation when visited at home. Informed written consent was obtained and the study approved by the Waltham Forest ethics committee.

Tests of activities of daily living

Patients were asked to name two activities of daily living such as walking upstairs or vacuum cleaning, for example, for which they might normally use their SBOT, and how they would normally use their oxygen to relieve breathlessness (e.g. nasal prongs or mask, before or after exercise). Each subject was studied at home performing each of their self-selected daily living activities and received either compressed air from a cylinder or oxygen from a cylinder in a randomised blinded fashion. Patients received either oxygen or air first and then crossed over to use the other cylinder after a minimum 15 minute rest period. Each patient did the 2 different activities twice (once recovering with air and once with oxygen) making a total of 88 separate activities. Cylinders were labelled "Gas A" and "Gas B" and blinded to both patients and researchers. Patients performed each activity until they felt the need to stop and use oxygen. Subsequent tests were only performed when the patient had completely recovered from the previous activity both subjectively and objectively. Pulse oximetry (Minolta Pulsox 3iA, Sunrise Medical, UK) was monitored throughout.

Endpoint measures were subjective and objective recovery times. Subjective recovery was defined as the point at which each patient stated their breathing had returned to normal. Objective recovery was defined as occurring when the oxygen saturation had returned to within 2% and heart rate to within 5 beats/min of pre-activity values. Breathlessness was measured using a 10cms visual analogue score (VAS) with the end points of "not breathless at all" and "the most breathless I have ever been" at the start and end of each activity and at the point of subjective recovery. After each activity had been repeated, patients were asked if one cylinder enabled them to recover quicker than the other. If they did notice a difference, they were asked if the less effective cylinder was "better than nothing at all".

Statistical analysis

The recovery time for each patient was taken as the average time for the two activities undertaken. Recovery times tended to have a skewed distribution (long tail to the right), so both the mean and median values are presented. However, the differences in recovery times (oxygen minus air) tended to be Normally distributed (as determined by a probability plot) so paired t-tests were used. Data were analysed using SPSS. The sample size was originally estimated to be 20 patients, based on differences in VAS scores for breathlessness, to detect a difference of 8mm, with 90% power. However, VAS measurements would only have been useful for patients using SBOT *before* exercise, and during the course of the study we discovered that all patients used it *after* exercise. We therefore considered recovery times to be more appropriate, but it was difficult to perform a power calculation at the outset when the range of recovery times and expected differences between the groups was not known and could not be anticipated from existing data.

RESULTS

Patient characteristics

22 patients (14 male, mean age 72 years, range 56-86 years) were deemed suitable and agreed to take part. Reasons for exclusion amongst the other 17 patients included: comorbidity (6), SBOT not used in relation to exertion (6), current exacerbation (2), too unwell (1), away from home (1), SBOT not yet prescribed (1). The characteristics of patients included in the study are shown in table 1.

Table 1 Characteristics of subjects (n=22)

	Mean (SD)	**Range**
Age (years)	72 (7.3)	56-86
FEV1 (litres)	0.87 (0.38)	0.40-1.69
FEV1 (% predicted)	38 (16.1)	17-74
SaO_2 (%) resting, on air	93.1 (3.8)	82-98
Desaturation with activity (%)	-7.5	-25 to -0.5

FEV1=forced expiratory volume in 1 second; SaO_2=oxygen saturation

17 patients had moderate or severe COPD as measured by spirometry, but although FEV1 in the remaining 5 patients was >50% predicted, TLCO in 4 of these 5 was <42% predicted indicating significant emphysema (unmeasured in the other). Most desaturated on exercise. 11 (50%) patients used LTOT via a concentrator. All patients stated that they breathed oxygen via nasal prongs and none used masks. Flow rates were 2l/min in 18 and 4l/min in 4 patients. In addition, all used their oxygen post-activity and none pre-activity. Activities selected by patients for use of oxygen included walking upstairs (20), walking around the house or garden (13), vacuum cleaning (8), walking uphill (1), kitchen work (1) and sweeping up (1). Activity time and change in VAS after activity was not significantly different for oxygen compared to air.

Duration of activity

Because the same activity was performed twice (once with oxygen and once with air) we checked that the length of activity was similar when using oxygen or air, in case this could explain the differences in recovery times. There was no evidence that activity length differed. During the first activity the mean difference in the length of activity (oxygen minus air) was –8 seconds (p-value from a paired t-test= 0.64), and during the second chosen activity the mean difference was 11 seconds (p-value= 0.60).

Recovery time

Subjective and objective times to recovery with oxygen and air are shown in table 2. The table shows the effect of oxygen therapy for each activity separately and using the average. There was no difference in recovery times with oxygen compared to air. There was, however, a tendency for the effect on objective recovery times to be greater during the first activity (table 2). This may not be surprising given that by the time the patient performs the second activity he/she would already have performed the first activity twice.

Ability to distinguish oxygen from air

5 (22.7%) patients were correctly able to distinguish the oxygen from air on both occasions, 5 were able to identify the oxygen after one activity only, and 10 could not identify the oxygen on either occasion. 7 patients thought that even though they had identified one gas as not being oxygen, that it was better than nothing at all. Data was not available for 2 patients. A subgroup analysis was performed on those 5 patients who correctly distinguished oxygen from air on both occasions and results compared against those who could not. This subgroup of 5 correct identifiers had shorter subjective and objective recovery times using oxygen compared to air (80s and 91s respectively vs 22s and 20s for incorrect identifiers), although these results did not reach statistical significance (see figure 1).

There were no significant differences in age, %predicted FEV1, baseline O2 saturation or mean lowest desaturation between the two subgroups. There was no significant difference in either objective recovery time (p=0.77) or subjective recovery time (p=0.13) for those patients on LTOT compared to those who were not.

DISCUSSION

The data in this study suggests that SBOT shortens recovery time after activities of daily living in a highly selected group of patients with COPD. However, the beneficial effect is small overall. The shortening of recovery times did not reach statistical significance but this is likely to be due to the relatively small number of subjects. One of the limitations to the study was that sample size was powered on a different outcome measure (VAS score), which was subsequently found to be inappropriate for this particular study. To show a difference in recovery times of about 35 seconds would require at least 50 patients (paired analysis), more than twice as large as the current study.

Previous studies have shown similar small improvements with SBOT or no benefit overall, for the alleviation of breathlessness on exertion in COPD.[11, 12, 14-18] There may however be concerns that these trials have missed a subgroup of patients for whom SBOT is beneficial. In our study, only 5 of 20 patients questioned were correctly able to distinguish oxygen from air after both sets of activities, a finding which is even more striking considering that all our patients had claimed that SBOT helps them in undertaking these activities. However, there was a much greater difference in recovery time for the 5 patients who correctly distinguished oxygen from air both times (80s for subjective recovery and 91s for objective recovery), and although not statistically significant, this could represent a subgroup for which oxygen is beneficial.

Previous studies have all been conducted in the artificial setting of the lung function laboratory or hospital environment and have studied a mixture of patients who may or may not be regular oxygen users.[11, 12, 14-18] Our study is unique as we aimed to overcome these problems by specifically targeting the subgroup that regularly use SBOT, testing patients at home undertaking activities of daily living with which they are familiar. Furthermore, it was a specific requirement that patients claimed SBOT alleviates their breathlessness. Interestingly all our patients used oxygen after activity and none before, suggesting that they do not perceive benefit from pre-oxygenating. This concurs with the results of studies in which patients were administered oxygen prior to exercise.[14, 16, 17]

The difficult question of when does a change become clinically significant in terms of relief of breathlessness, shortening of recovery time and improvement of exercise capacity can be illustrated by the wide variation in cut-off points used in studies of SBOT and ambulatory oxygen.[12, 16, 18-23] Although subjective recovery time was 34s or 15% shorter using oxygen compared to compressed air, the clinical importance of this must be debatable. McDonald et al[24] in a study of ambulatory oxygen in COPD also make the point that the increase in 6MWD of <20m in their laboratory tests, whilst of "statistical significance" did not translate to any useful improvement in day-to-day functioning and the prescription of oxygen on the basis of these tests could not therefore be justified. Perhaps we should move away from a statistical model of what is significant to a more patient-centred view, reflecting the change in philosophy of the UK healthcare system as a whole over recent years.

The limitations of our study are the relatively small numbers included which means that a statistically significant reduction in overall objective recovery time could have been missed, but then there is still the question of whether this would be of any clinical value. Our study also included a mixture of patients with half on LTOT. However, this simply reflects actual clinical practice where SBOT is prescribed. Some patients with a concentrator used this at times instead of a cylinder (although not in the study): however, they were all known to use their oxygen cylinder regularly, as this is how they were originally identified from prescribing records. All patients used nasal prongs, which is a possible confounder as some who are predominantly mouth breathers might benefit more from oxygen via a mask. We did not study the effect of SBOT during exacerbations which is another important area for research, particularly as oxygen cylinder usage may increase at these times and also be prescribed for patients on discharge from hospital.

In conclusion, we have shown that SBOT does appear to shorten recovery time overall after activities of daily living in this highly selected patient group, but that it is debatable as to whether this is of clinical significance. However, there appears to be a small subgroup of patients who are able to perceive this benefit, and a larger study is needed to verify this and determine how they may be identified.

Competing interests: none declared.

Funding: chest clinic amenity fund.

REFERENCES

1 Roberts CM. Short burst oxygen therapy for relief of breathlessness in COPD. *Thorax* 2004;**59**:638-40.

2 Prescription Pricing Authority. www.ppa.org.uk/pdfs/PPA_stakeholder_review_2004-2005.pdf (accessed 6th April 2006).

3 National Collaborating Centre for Chronic Conditions. National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. *Thorax* 2004;**59**(Suppl 1).

4 American Thoracic Society. Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1995;**152**:S77-121.

5 Siafakas NM, Vermeire P, Pride NB *et al*. Optimal assessment and management of chronic obstructive pulmonary disease (COPD). The European Respiratory Society Task Force. *Eur Respir J* 1995;**8**:1398-420.

6 National Heart Lung and Blood Institute and WHO. Global initiative for chronic obstructive lung disease: global strategy for diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2005 update. www.goldcopd.com/Guidelineitem.asp?l1=2&l2=1&intId=989 (accessed 6th April 2006).

7 Pauwels RA, Buist SA, Calverley PM, *et al*. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease . NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Workshop Summary. *Am J Respir Crit Care Med* 2001;**163**:1256-76.

8 Nocturnal Oxygen Therapy Trial Group. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. *Ann Intern Med* 1980;**93**:391-8.

9 Medical Research Council Working Party. Long term domiciliary oxygen therapy in chronic hypoxic cor pulmonale complicating chronic bronchitis and emphysema. *Lancet* 1981;**1**:681-6.

10 Davidson AC, Leach R, George RJ, *et al*. Supplemental oxygen and exercise ability in chronic obstructive airways disease. *Thorax* 1988;**43**:965-71.

11 Stevenson NJ, Calverley PM. Effect of oxygen on recovery from maximal exercise in patients with chronic obstructive pulmonary disease. *Thorax* 2004;**59**:668-72.

12 Woodcock AA, Gross ER, Geddes DM. Oxygen relieves breathlessness in "pink puffers". *Lancet* 1981;**1**:907-9.

13 Bland JM, Altman. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986:1(8476);307-10

14 Nandi K, Smith AA, Crawford A, *et al*. Oxygen supplementation before or after submaximal exercise in patients with chronic obstructive pulmonary disease. *Thorax* 2003;**58**:670-3.

15 Killen JW, Corris PA. A pragmatic assessment of the placement of oxygen when given for exercise induced dyspnoea. *Thorax* 2000;**55**:544-6.

16 Lewis CA, Eaton TE, Young P, *et al*. Short-burst oxygen immediately before and after exercise is ineffective in nonhypoxic COPD patients. *Eur Respir J* 2003;**22**:584-8.

17 McKeon JL, Murree-Allen K, Saunders NA. Effects of breathing supplemental oxygen before progressive exercise in patients with chronic obstructive lung disease. *Thorax* 1988;**43**:53-6.

18 Evans TW, Waterhouse JC, Carter A, *et al*. Short burst oxygen treatment for breathlessness in chronic obstructive airways disease. *Thorax* 1986;**41**:611-5.

19 Royal College of Physicians. Domiciliary oxygen therapy services. London: Royal College of Physicians 1999.

20 Wilson RC, Jones PW. Long-term reproducibility of Borg scale estimates of breathlessness during exercise. *Clin Sci* 1991;**80**:309-12.

21 Jolly EC, Di B, V, Aguirre L *et al*. Effects of supplemental oxygen during activity in patients with advanced COPD without severe resting hypoxemia. *Chest* 2001;**120**:437-43.

22 Leach RM, Davidson AC, Chinn S *et al*. Portable liquid oxygen and exercise ability in severe respiratory disability. *Thorax* 1992;**47**:781-9.

23 Redelmeier DA, Bayoumi AM, Goldstein RS, *et al*. Interpreting small differences in functional status: the Six Minute Walk test in chronic lung disease patients. *Am J Respir Crit Care Med* 1997;**155**:1278-82.

24 McDonald CF, Blyth CM, Lazarus MD, *et al*. Exertional oxygen of limited benefit in patients with chronic obstructive pulmonary disease and mild hypoxemia. *Am J Respir Crit Care Med* 1995;**152**:1616-9.

Table 2. Comparison of the effect of oxygen therapy and air on recovery times

	Recovery time with oxygen (seconds)			Recovery time with air (seconds)				
	Median	IQR	Mean	Median	IQR	Mean	Mean difference (oxygen minus air) (95% CI)	p-value
Activity 1								
Objective	65	55	90	120	95	145	-55 (-115, +5)	0.07
Subjective	170	98	169	165	160	201	-32 (-85, +20)	0.21
Activity 2								
Objective	58	78	104	110	120	129	-25 (-96, +47)	0.48
Subjective	180	120	207	230	150	241	-35 (-76, +6)	0.09
Mean of activity 1 & 2								
Objective	75	82	97	110	62	135	-38 (-81, +5)	0.08
Subjective	186	110	186	240	140	219	-34 (-69, +2)	0.06

IQR: interquartile range

Figure 1a Subjective time to recovery in subgroup who correctly identified O2 after both activities vs others who did not

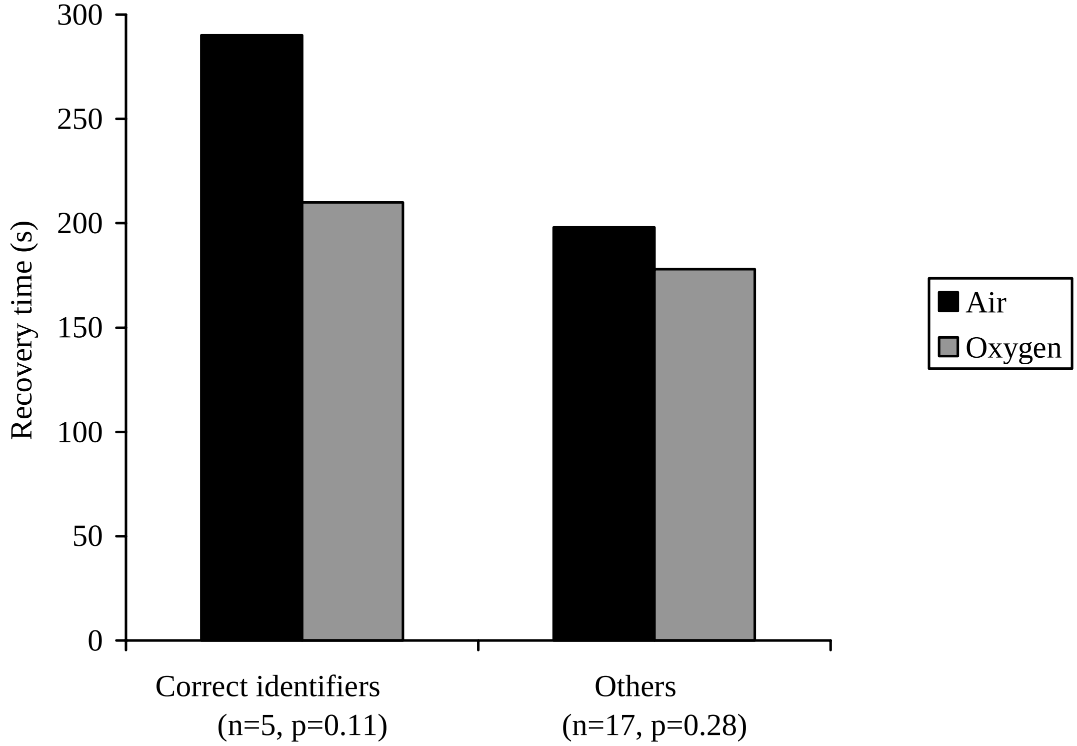

Figure 1b Objective time to recovery in subgroup who correctly identified O2 after both activities vs others who did not