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Ask the expert - New developments in long-term oxygen therapy and ambulatory oxygen

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Q **1. One of the areas that remains uncertain is the maximum inspiratory oxygen fraction (F_{I,O_2}) that should be made available to patients on long-term oxygen therapy (LTOT) at home who require high levels of oxygen, *e.g.* end-stage interstitial lung disease (ILD) patients. In the situation of increasing breathlessness, but with a limited evidence base, what is your recommendation? Although ambulatory oxygen (AO) has a good evidence base to support its effect on a test of exercise performance, as yet there is little evidence on whether patients should have AO assessment pre- or post-pulmonary rehabilitation (PR), *i.e.* whether AO should be used during PR, or not. Therefore, practice varies widely, and I would be keen to know your recommendation. Moreover, if the answer is post-PR, what degree of desaturation would you allow before reducing the exercise intensity or duration for that individual, and do you feel that would limit the patient's potential? If your answer is pre-PR, would you recommend reassessing the need for AO post-PR as well in case of change from increased fitness?**
J. Bott (Chertsey, UK)

A The number of end-stage patients with restrictive pulmonary disease has grown in recent years. In answer to your first question, this would depend on different epidemiology and hence on the better survival and prognosis reached by the medical progress in this field. Overall, despite the fact that no international guidelines are conclusive, LTOT is prescribed worldwide in those patients reaching end-stage with associated chronic respiratory insufficiency. Recently, the Italian QuESS study [1] found no benefits of LTOT in terms of survival in a mixed population of patients with chronic respiratory failure, including restrictive individuals (data reported by authors but not yet published). In addition, LTOT has not shown superiority compared with noninvasive ventilation in several restrictive conditions that also develop hypercapnic respiratory failure [2, 3]. Notwithstanding these findings, LTOT is commonly prescribed even at high flows in these end-stage patients and no clear contraindications about the risk of absorption atelectasis or toxicity are specifically reported. The optimal F_{I,O_2} should be individually tailored based in both conditions at rest and during walking as reported in other individuals [4].
With regard to your second point, all healthcare professionals dealing with rehabilitation are aware of the lack of evidence. In addition, no specific indications on this assessment have been reported in restrictive individuals. Overall, AO assessment in a patient during the pre-PR phase would allow us to recognise the physiological response to walking in the patient's baseline condition and thus to provide oxygen at a flow that fits individual needs to achieve an arterial oxygen saturation >90% [5]. A step-by-step protocol has been proposed [6] but it is clearly less useful in real life. The post-PR reassessment of AO could also be recommended, as the exercise intervention and the multidisciplinary approach are likely to improve the patient's physiological response, at least in chronic obstructive pulmonary disease (COPD) patients.

Q 2. Is the utilisation of oxygen justified (hard evidence?) for COPD patients who only show marked desaturation on exercise, with normoxia at rest and absence of hypoxia during sleep? If yes, how must the oxygen therapy be managed to achieve maximal benefit?
S. Györik (Bellinzona, Switzerland)

A Assessment of oxygen desaturation during standard exercise will enable professionals to recognise the individual's physiological response in COPD. It is interesting to note that this response may vary according to the type of exercise used for testing [7], walking being an activity that increases the proportion of desaturators among COPD patients, compared with cycling. In particular, in COPD patients without resting hypoxaemia, oxygen supplementation is likely to reduce dynamic hyperinflation, thus reducing dyspnoea [8]. Practice guidelines on oxygen supplementation during PR, regardless of whether or not oxygen desaturation during exercise occurs, often allows for higher training intensity and/or reduced symptoms in the research setting [9]. However, at present, it is still unclear whether this translates into improved long-term clinical benefits.

Q 3. How long can I deliver continuous oxygen therapy in patients with COPD without the supervision of gases in the blood, if we do not have apparatus for analysis of blood gases in hospital apart from pulse oximetry? These patients have oxygen saturation in the blood measured by pulse oximetry (S_{p,O_2}) ≤50%.
M. Obradovic (Mladenovac, Serbia)

A LTOT in COPD patients who are hypoxaemic at rest is so far recommended according to the results of long-term studies in the 1970s [10, 11]. National societies of respiratory medicine usually promote guideline implementation and local recommendations. Blood gas analysis reassessment even at 3- to 6-month follow-up should be performed in order to check treatment effectiveness, physiological response (*i.e.* carbon dioxide retention), and indication to reset therapy [12]. The rate of diffuse ILD after pulmonary tuberculosis is unknown to me. Upper-zone post-tuberculous fibrosis is seen frequently, but there is no development of diffuse ILD outside areas of the infected parenchyma as sequelae of tuberculosis.

Q 4. I would like to know the long-term survival rate in ILD patients receiving oxygen therapy. How do you titrate LTOT in this group?
V. Arya (Meerut, India)

A Survival rates in ILD patients, specifically those receiving oxygen, have not been reported. In contrast to COPD, ILD patients using oxygen are not nationally registered and survival data is limited. Moreover, survival may vary *per se* according to the primary diagnosis (whether it is idiopathic pulmonary fibrosis (IPF), nonspecific interstitial pneumonia or others); in IPF in particular the prognosis is poor [13] and the median survival (<2 yrs) does not allow evaluation of the efficacy of any adjunctive treatment. Nonetheless, use of supplemental oxygen is commonly prescribed in those hypoxaemic patients as palliative care (see also reply to Question 1).

Q **5. I would be interested to know your thoughts on portable oxygen systems. What types of patients benefit from these and what are the reasons for preferring portable concentrators or liquid oxygen systems (clinical considerations or patient acceptance)?**
N. Higson (UK)

A The aim of portable oxygen systems is to enable a higher level of patient independence. Recent technologies allow patients to be provided with both portable refillable liquid oxygen cylinders or concentrators. The concentrator has limits of flow delivery, since the higher the flow is set, the lower the F_{I,O_2} available for the patient [14]. Overall, liquid oxygen cylinders are widely accepted and used (though not in all countries); the limited capacity and time-limit at the higher oxygen flow rates can be partly resolved by using conserving devices such as economisers. Large and cumbersome systems are a strong limitation to use during physical activities. However, it has also been reported that portable devices may be also carried and pulled on wheeled cart with reduced symptoms and a better performance in COPD patients [15].

Q **6. I would like to know your opinion about the role of demand oxygen delivery systems (DODS) for portable oxygen concentrators in LTOT. Which patient populations are indicated and contraindicated (age, diseases, *etc.*)? For its prescription, is there an accurate equivalence between continuous flow and DODS settings? From the physiological point of view, are DODS that deliver a high flow in a short time at the very beginning of the inspiration, followed by a lower flow in the rest of the inspiration phase, more efficient than those that deliver a constant flow in the same period of time?**
V. Hoischen (Madrid, Spain)

A DODS for portable oxygen concentrators (both as reservoirs or pulsed-flow systems) are widely found commercially. Notwithstanding the additional cost that might be incurred [16], it has been reported anedoctically that about a 30% oxygen saving during several daily activities in COPD [17]. However, experience is limited and no firm benefits in the long term are reported using these devices. It appears meaningful and practical to propose the use of DODS in those patients needing higher oxygen flows. In particular, it has been proposed that if exercise endurance is increased by hyperoxic therapy, the endurance walk should be repeated using a DODS set at the flow rate that gives the greater increase in endurance. The particular DODS tested should be prescribed only if the exercise endurance while using the DODS is comparable to that during continuous-flow oxygen therapy [6].

Q 7. Is there any new evidence or recommendations regarding the oxygen indication in nocturnal hypoxaemia alone (mean arterial oxygen saturation (S_{a,O_2}) <90% in >30% of the sleep time?) or exercise hypoxaemia alone (S_{a,O_2} <85% along with less dyspnoea under oxygen supplementation)?
V. Popov (Barmelweid, Switzerland)

A Supplemental oxygen prevents transient arterial hypoxaemia in a majority of subjects with COPD and nocturnal desaturation unrelated to coexisting sleep apnoea syndrome [18], and some observations suggest that there may be a benefit in terms of survival [19]. Therefore, preventing desaturation during sleep with nocturnal oxygen supplementation is likely to reduce all-cause mortality by decreasing the physiological stresses of repeated hypoxaemia [20]. Additional benefits may include improved quantity and quality of sleep. However, no clear recommendation exists and studies are required to test this indication. A recent international survey has shown that <50% of COPD patients with nighttime oxygen desaturation are individually tested in order to adjust flows and correct hypoxaemia [21]. For exercise hypoxaemia oxygen indications, see also the reply to Question 2. The actual aim is to prescribe oxygen during exercise even in COPD desaturators during effort in order to increase training intensity [4], particularly within a rehabilitation programme.

Q 8.You may realise that there is an increasing geriatric and 'chronic lung disease' population that we are treating these days. Home care as a field is not well established in India, leading respiratory physicians to take most such decisions for our patients. I would be keen to know how to choose the ideal portable concentrator for the patient with chronic lung disease (*e.g.* COPD and ILD), who wishes to be ambulatory and lead as active a life as possible. I am undecided between pulsed and continuous flow portable oxygen concentrators. As both are equally expensive, how should one guide the patient correctly?
S. Rajan (Mumbai, India)

A First of all, I want to underline your point about the different patient groups we are used to caring for at present. The main indication for LTOT is COPD and this population is actually growing in age and complexity, thus having a prognostic impact which may be seriously dependent on several coexisting diseases [22]. For example, in some COPD patients, coexisting but underestimated chronic heart failure may lead to mild-to-moderate hypoxia from an extrapulmonary cause. The often incomplete diagnostic process is due not only to a real clinical difficulty, but also to the separation among sub-specialities (pulmonology and cardiology in this instance) that frequently occurs in the medical practice. This may have important implications for both medical therapy and/or LTOT prescription. In fact, due to a deficient diagnosis, medical therapy may not be optimised. As a consequence, chronic moderate hypoxaemia, which might be successfully treated with appropriate medications, becomes the objective of a questionable LTOT prescription. In Italy, the ongoing multicentre study sponsored by Italian Agency of Drugs (Protocol Code: FARM6YHYW4 -2007) will hopefully help to address this issue.
For the last part of the question I would refer you to the replies to Questions 2, 5 and 6. The choice between pulsed or continuous flow portable oxygen concentrators should be made according to the proven effectiveness, and to the patient's preference and adherence.

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