Long-Term Oxygen Therapy: In a Perfect World

This issue of RESPIRATORY CARE contains 2 papers of interest that deal with long-term oxygen therapy (LTOT). In the first, Martí et al investigated the efficacy of 2 oxygen-conserving devices in correcting exercise-induced hypoxemia in subjects with either COPD or interstitial lung disease (ILD). Of the 59 subjects who completed the study, 28 were diagnosed with COPD and 31 were diagnosed with ILD. A pulse-demand oxygen delivery system and a pendant reservoir cannula were compared to conventional continuous-flow oxygen therapy. All 3 systems were powered by small compressed oxygen cylinders. In a manner of speaking, the researchers "chased after" a satisfactory S_{pO_2} during exercise in these 2 groups of subjects with lung disease who had first demonstrated exercise-induced hypoxemia. The threshold to qualify for this was an average $S_{pO_2} < 88\%$ during a 6-min walk test (6MWT) without supplemental oxygen. The procedure monitored heart rate, breathing frequency, S_{pO_2}, dyspnea (using a modified Borg scale), and distance walked. The researchers found that, despite their best efforts in manipulating the settings of all 3 delivery systems, some 20% of the severe COPD subjects could not achieve a satisfactory S_{pO_2} during exercise (defined as an average $S_{pO_2} \geq 90\%$), regardless of the delivery system. In the subjects with ILD the pulse-demand system fell far short of being effective: almost 40% did not achieve a satisfactory S_{pO_2}. Interestingly, in both the COPD and the ILD groups the pendant reservoir cannula had the best results in correcting exercise-induced hypoxemia, but the pulse-demand system was the preferred system when given a choice. As the authors noted, the subjects apparently made their choice of device based more on esthetics and comfort than other factors.[1]

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The next paper, by LeBlanc et al,[2] compared the ability of 3 portable oxygen concentrators (POCs) to maintain a satisfactory S_{pO_2} during exercise in subjects with chronic lung disease (18 were diagnosed with COPD, and 3 with pulmonary fibrosis). Similar to the Martí et al study, the subjects in LeBlanc et al's study first demonstrated exercise-induced hypoxemia when performing the 6MWT without supplemental oxygen. However, these subjects met a lower threshold for proven exercise-induced hypoxemia (to qualify, the average S_{pO_2} during the 6MWT had to drop to $< 85\%$ while breathing room air). Then the 21 subjects performed a control 6MWT using their current oxygen system set at their prescribed exertional oxygen flow rate, and performed one 6MWT with each of the 3 POCs set at the maximum pulse-dose setting, with sensitivity set at "1" and the rise time set at "fast." They measured distance walked, dyspnea on the Borg 10-point scale, time with $S_{pO_2} \geq 90\%$, number of subjects who completed the 6MWT, and number who were asked to stop by the accompanying therapist (this occurred when S_{pO_2} dropped and stayed below 85% during the 6MWT while using supplemental oxygen).

Of the 3 POCs tested, one performed significantly better than the others in terms of pre-exercise baseline S_{pO_2}, time with $S_{pO_2} \geq 90\%$, and distance walked. Moreover, the same POC had higher percentages of those who completed the 6MWT and lower percentages for those who were asked to stop the 6MWT due to low S_{pO_2}. This device was described as having the largest bolus size of delivered oxygen. When the subjects were asked which of the 3 devices would be preferred, 2 of the POCs were rated about the same: the one that performed the best and the one that was smallest and lightest. Surprisingly, the POC that outperformed the other 2 was not preferred, and the authors noted that the size and weight of the devices were important factors for the subjects.[2]

While doing the literature review for writing this editorial, the phrase "*In a perfect world*" caught my attention. Patrick Dunne made mention of this when he was expressing the need for POCs to have settings that would link to the size of the bolus of delivered oxygen.[3] He used this phrase in his paper in the August 2009 issue of RESPIRATORY CARE, and noted that this standardization would allow for much easier comparison of these devices. As seen in the article by LeBlanc et al, the bolus size of delivered oxygen seemed to have the most influence on maintaining a satisfactory S_{pO_2}. Dunne made the point that a knowledgeable and experienced clinician should perform the initial assessment of the patient who is beginning to receive LTOT, and should perform a titration study to establish the appropriate settings. In many cases this patient will be coming home from a hospitalization related to an exacerbation. LTOT systems include several options

that have to be resolved as a new patient is started on LTOT:

- The traditional constant-flow, stationary system (nonportable electrically powered oxygen concentrator or liquid oxygen system) or a concentrator or liquid system using a pulse-dose device, which is built in to the regulator and provides a pre-set bolus of oxygen that responds to various breathing frequencies via a triggering mechanism and thus conserves oxygen
- A POC, using either a pulse-dose or a continuous-flow system or both functions, depending on the circumstances (ie, using the continuous mode while at home and powered by electrical power vs using the pulse-dose mode while away and using battery power)
- Patient interface: traditional nasal cannula using constant flow, or oxygen conserving technology
- Traditional nasal cannula with a pulse-dose device or a transtracheal oxygen catheter with constant flow or using a pulse-dose device
- Pendent reservoir

The complexity of these options calls for having a "knowledgeable and experienced clinician" to assess and decide on which of these options should be used in setting up a new patient on LTOT. The American Association for Respiratory Care's *2013 AARC Buyer's Guide for Respiratory Care* lists companies that manufacture devices related to oxygen delivery and conservation. Under each of the headings "Valves—Demand," "Concentrators—Portable," and "Concentrators—Stationary," the guide lists 12 companies. Many of these cross over into all 3 categories: some do not, but this points out the fact that there is competition among these products, and the assortment of features and specifications of these devices and systems require knowledge, insight, and understanding to make the right choices for establishing LTOT.[4] Dunne also recommends a reassessment of the patient and long-term oxygen delivery system some days after starting therapy, as the patient's condition may be continuing to change post-discharge, and their oxygen therapy needs may have changed.[3]

The best-qualified and most logical choice of this knowledgeable and experienced clinician would be a respiratory therapist. In a perfect world the order written for establishing LTOT would read "Respiratory therapist to titrate LTOT" to keep $S_{pO_2} \geq$ (insert desired level here: say 90%). Protocols and patient-centered care should be utilized to titrate oxygen under differing circumstances. Having the most appropriate settings during times like sleep, exercise, and awake/active may be important in avoiding a readmission to the hospital. Desaturations at home can cause dyspnea, increase stress for the patient and family, and feed the underlying fear of dying. When these feelings and emotions occur, patients very often go to the emergency department and may end up being readmitted.

Like Dunne, Martí et al mention the need for a personalized adjustment of the LTOT system to strive for a satisfactory S_{pO_2} during exercise.[1] LeBlanc et al also discuss the idea of meeting the patient's need during exercise: an idea that calls for a knowledgeable and experienced clinician. LeBlanc et al added that education should be provided to the patient concerning the goal of LTOT to meet the body's oxygen requirements.[2] This education should reinforce the importance of selecting the proper device and interface that can meet the requirements of this goal. In a perfect world, personalized adjustment of LTOT and provision of education would be done by a qualified respiratory therapist. In a bench test of 4 POCs, Chatburn and Williams noted that there were large differences in performance characteristics among the POCs, and that this places great emphasis on the respiratory therapist's understanding of these differences and the importance of titrating the POC to meet the patient's need. These authors also mentioned that one POC manufacturer had advertised that their device could be used in all circumstances: while traveling, resting, or sleeping.[5] This "one-size-fits-all" approach implies that a single setting (eg, 2 L/min) would suffice for all settings, and the proof is growing that refutes this approach to LTOT. In a perfect world, titration of oxygen therapy should incorporate these 3 conditions: during sleep, while awake and active, and during exercise. The AARC clinical practice guideline, "Oxygen Therapy in the Home or Alternate Site Health Care Facility: 2007 Revision and Update," recognizes the need for titrating the oxygen therapy so that it can be set appropriately for ambulation, exercise, or sleep.[6]

The AARC has published a valuable tool for making decisions regarding LTOT: *A Guide to Portable Oxygen Concentrators*,[7] which provides the performance characteristics of 14 POCs manufactured by 10 companies. These characteristics include the product name, oxygen delivery method (constant flow, intermittent flow, or both), the weight with and without batteries, and the details on the available settings.[7] Who is qualified and motivated to understand the differences in these devices and teach patients about what they should choose? Who else but a respiratory therapist?

As technology continues to race forward, we are experiencing a new level of patient involvement in their own

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healthcare. The Internet has brought the patient immediate access to high quality, peer-reviewed information about diseases, medications, devices, research, and guidelines. Patients with chronic diseases such as diabetes mellitus, COPD, and asthma are being taught about self-monitoring and self-management. As technology advances and self-management is encouraged, we will move into new paradigms. Regarding LTOT, a paper in RESPIRATORY CARE in 2011 brought this idea into the spotlight. This paper describes an automated oxygen regulator that uses a pulse oximeter signal to titrate flow in order to maintain a targeted S_{pO_2}.[8] We have seen this model in home care where auto-titrating CPAP systems are being used in sleep apnea patients.[9] Much more complex systems are appearing in critical care, as some of the new-generation mechanical ventilators use a closed-loop system to titrate parameters such as rate, PEEP, and pressure-support based on monitored patient information such as end-tidal CO_2, rapid-shallow breathing index, and peak and static airway pressure.[10]

Pulse oximeter auto-titration of LTOT could conceivably resolve the issue of needing a respiratory therapist to monitor and adjust oxygen delivery systems to meet patients' needs during various situations. However, as we have seen, LTOT is a complex issue, with many devices and many systems on the market, and the initial set-up involves critical thinking to decide which device, which system, and which interface to use. With the advancements being made for applications in smart phones we may see the auto-titration link to many medical interventions, including CPAP, LTOT, pacemakers, insulin pumps, and pain management. In a perfect world all goes smoothly, nothing breaks, and nothing quits working; but we have to deal with this imperfect world and push toward perfection. We can hope for and expect that the best qualified, best trained, most knowledgeable professionals will be called into action to make this push in home care and acute care.

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