

## Product Performance Variability With Home Portable Oxygen Systems May Impact Patient Performance Outcomes: It May Be the Device, Not the Disease

Long-term oxygen therapy (LTOT) is typically delivered with continuous-flow oxygen, which is currently the accepted standard for stationary LTOT systems.<sup>1</sup> Lighter, portable LTOT systems with oxygen-conservation technologies have been developed to decrease the burden on the patient and provide longer operating time, which may improve patient adherence to LTOT and allow the patient to do more activities of daily living. These newer LTOT systems reduce the oxygen waste associated with continuous-flow LTOT devices, which should reduce the amount of oxygen the patient uses and the frequency of oxygen refills.

In this issue of *RESPIRATORY CARE*, Strickland et al<sup>2</sup> report a study of 4 LTOT systems: FreeStyle, Helios, Home-Fill, and the traditional cylinder system that Strickland et al customarily prescribe. They identify some of the key issues that impact oxygen use in the home and ambulatory settings: selection of the appropriate LTOT system, flow titration, and patient adherence to therapy. Given a choice, most patients will probably select the lightest-weight LTOT system that operates for the longest period. In addition, esthetics plays an important role in patient preference. An LTOT system that is wearable reflects the patient's self-image and helps restore the patient's self-confidence. An LTOT system that looks good will encourage adherence to therapy. The study by Strickland et al demonstrates patients' preference for an esthetically pleasing portable LTOT device.

Strickland et al tested the most popular LTOT systems. This popularity results from various marketing claims of being the lightest weight, longest lasting, and providing greater patient mobility. Patients are increasingly involved in LTOT system selection, to meet their particular needs. Patients often select home-care providers that can supply the LTOT system the patient thinks is best. Because different LTOT systems have different performance and capabilities, this must be considered in the selection of an LTOT system. Patients often learn about LTOT systems from other patients or the Internet. Physicians and respiratory therapists must be knowledgeable about the performance and characteristics of the available LTOT systems, to correctly match the device to the patient's needs.

The ultimate goal of LTOT is to provide adequate oxygenation during all activities.<sup>3</sup> Physicians and home-care providers are often not aware of the performance differences between the various LTOT systems and do not stay engaged in the titration and monitoring of the patient's ambulatory oxygenation while using LTOT. Some providers have assumed that the number on the dial of an oxygen-conserving LTOT device is equivalent to the oxygen flow of continuous-flow LTOT. For example, the dial setting of "2" on an oxygen-conserving device does not necessarily provide the equivalent of 2 L/min continuous flow.<sup>4</sup> Compounding that misunderstanding is the perception that if one oxygen-conserving device cannot provide adequate oxygenation at all activity levels, then none of the available oxygen-conserving devices will do so.

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The 3 oxygen-conserving LTOT systems evaluated by Strickland et al<sup>2</sup> (Helios, FreeStyle, and HomeFill) have similar dose and fraction-of-inspired oxygen ( $F_{IO_2}$ ) performance. That could create the impression that there are no important differences between the systems, but my bench evaluation of portable LTOT systems<sup>5</sup> revealed important performance difference between Helios, FreeStyle, and HomeFill. At the dial setting "2" on each device, the dose differed between Helios, FreeStyle, and HomeFill at 20 breaths/min (Table 1).

A variable not reported by Strickland et al<sup>2</sup> is respiratory rate, which has an important impact on  $F_{IO_2}$ . The HomeFill is affected by respiratory rate because of volume accumulation in the oxygen conserver, and the FreeStyle (which is a portable oxygen concentrator) has a fixed production of oxygen per minute. As the respiratory rate increases, the pulse volume or oxygen purity decreases with FreeStyle or HomeFill. It is important to report the respiratory rate in studies of LTOT systems to improve our understanding of the systems' capabilities. Other types of devices are also available, and at 20 breaths/min there are important performance differences between devices in the same class (see Table 1). It would be incorrect to conclude that all portable oxygen concentrators, including portable

Table 1. Oxygen Dose and  $F_{IO_2}$  at Dose Setting “2” and at Maximum Dose Setting With 6 Portable Oxygen Systems

Type of Portable Oxygen System	Dose Setting of “2”		Maximum Dose Setting	
	Oxygen Dose (mL/inhalation)	$F_{IO_2}$ (%)	Oxygen Dose (mL/inhalation)	$F_{IO_2}$ (%)
Low-dose				
Helios	29	26	34	29
HomeFill	21	26	43	30
FreeStyle	17	25	26	27
High-dose				
Spirit	30	28	73	38
iFill	30	28	70	38
Eclipse	32	28	88	42

$F_{IO_2}$  = fraction of inspired oxygen

liquid oxygen systems or oxygen generating systems, perform the same based on the evaluation of one product in that category.

The study by Strickland et al<sup>2</sup> was limited by the maximum dose setting of “3” on the FreeStyle. Had the patients been titrated for adequate oxygen saturation, the Helios could have been placed at setting “4”, and the HomeFill at setting “5”. The study shows the impact of a low-dosing LTOT system on the ability to exercise.

Titration is an important component of LTOT. Various methods have been used for titration studies. One method to determine the oxygen flow prescription, the 6-min walk test (used by Strickland et al<sup>2</sup>), evaluates the patient at a specific condition for a specific period of time. The 6-min walk test is usually done in a pulmonary function laboratory, and most often with continuous-flow oxygen. There is no standard titration method, however, that simulates the patient’s typical activities of daily living, and some providers don’t titrate the LTOT prescription with the same LTOT system the patient will be using. Using the continuous-flow prescription for selecting the setting for an oxygen-conserving LTOT system is not the ideal method to determine the LTOT prescription for that individual patient.

In the study by Strickland et al,<sup>2</sup> 44% of the subjects did not complete the 6-min walk test (mean walk time 4.6 min). If we translate that finding to activities of daily living in a patient using one of the tested LTOT systems, it is an ambulation time of 5 min. This effect is often observed with patients, who frequently need to rest to “catch their breath.” A patient using one of the 4 LTOT systems tested by Strickland et al would be unlikely to be able to maintain their activities of daily living because of the limitation of oxygen supply. This limitation would promote a more sedentary (rather than ambulatory) lifestyle, which may ultimately result in greater health-care utilization (eg, more

hospitalizations and physician office visits) than patients who ambulate more.

Strickland et al<sup>2</sup> report a mean oxygen saturation of 88% following the 4.6 min of walking. If a portable LTOT system can increase the dose and  $F_{IO_2}$  and produce an oxygen saturation > 88%, that may increase exercise tolerance. Emtner et al<sup>6</sup> found that administering oxygen to patients who were not hypoxemic increased exercise tolerance and may help with exercise training. The goal of improving exercise ability and increasing activities of daily living can then be afforded to an individual patient without limitations from the LTOT device itself.

Oxygen is a drug that should be prescribed correctly, monitored for effectiveness and benefits, and administered to allow adequate oxygenation at all activity levels. The newer lightweight, long-lasting portable LTOT systems will only provide benefit if they meet the patient’s needs at all activity levels. If LTOT is not monitored appropriately, patients might use LTOT systems or settings that do not maintain adequate oxygenation and compound the perception that the patient’s disease is the limiting factor, not the device. Patients who receive inadequate oxygen dose will limit their physical activity and become sedentary, which will increase health-care costs in the long term and vitiate the assumed economic benefit of more efficient LTOT equipment and limited services by the capped reimbursement and fixed payment schedules from government payers.

There is little published research on the available home LTOT systems. Most LTOT research has been conducted with intermittent-flow-oxygen equipment that is no longer used in today’s home-care environment.<sup>7</sup> Payers and regulatory agencies are arbitrarily changing payments and standards for LTOT, without adequate research on the needs of LTOT patients and the capabilities of the equipment and services available to provide LTOT. Further clinical research is necessary to develop an evidence-based foundation for LTOT in ambulatory patients, to ensure that patients are appropriately treated in the most efficient and cost-effective manner possible.

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The authors declare no conflicts of interest.

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