Your 2007 Guide To Understanding

Oxygen Conserving Devices

VALLEY INSPIRED PRODUCTS

Introduction

The purpose of Valley Inspired Products' (VIP) 2007 Guide to Understanding Oxygen Conserving Devices is to provide valuable information regarding the operation of oxygen conserving devices (OCDs). Since the early 1990's, OCDs have become a popular method for efficient oxygen delivery. Because of the continuing advances in oxygen conserving technologies in the last 15 years, patients on oxygen today can now go on longer outings with their oxygen system, such as fishing retreats, weekend-long family reunions, and even take extended vacations across the country. There have been many advances in the area of home oxygen therapy in a short amount of time and, as a result, there is still much that is not understood about how these oxygen conserving devices function and operate. This Guide was created as a tool to help bridge that knowledge gap.

The target audience for this guide includes:

- Clinicians that use and prescribe oxygen therapy with conserving devices
- HME operations personnel that need to understand the proper functioning of conserving devices
- Marketing personnel that need to differentiate their product from other conserving devices
- Anyone with a vested interest in the use of conserving devices, including patients and their immediate friends and family

This guide is not intended to identify the "best" OCD. Rather, this guide is meant to educate and inform. Each product outlined in the following pages has features and capabilities that may benefit a specific patient, yet a different combination of these products may be found to best serve the patient mix of an individual HME provider.

The methods and materials used to test each conserving device are outlined later in this guide. Each device was bench tested using consistent methods throughout and selected results are reported in the Product Comparison section. There have been no practical standards developed for the testing of conserving devices, so VIP's noted experience in the area of oxygen therapy and conserving devices was employed for the rationale behind the specific testing protocols used for this guide. Using our methods as described should result in the same findings for whoever may be testing these devices on their own. If other methods are used, different results may occur. The key to comparison testing is consistency. If methods other than those outlined in this guide are used, they should be used for testing all devices for an accurate comparison.

As in all of health care, knowledge is critical to gaining maximum benefit from a product or program. OCDs operate in very different ways. There is an underlying assumption by many that at a given numerical setting on an OCD, the delivered therapy is equivalent to continuous flow oxygen (CFO). Studies have shown that this is not always the case, although OCDs do have the ability to adequately oxygenate the patient even if the therapy is not equivalent. Clinicians and providers must understand individual product operation to help provide the quality care their patients deserve. This 2007 Guide to Understanding Oxygen Conserving Devices is meant to aid in that endeavor.

This information is not meant to be a replacement for sound therapy. Oxygen patients should always be evaluated with oximetry or blood gas measurements and undergo proper clinical assessment, which includes evaluation and titration:

- at all relevant activity levels
- while sleeping, if required
- using the oxygen system they will employ at home
- during flights or at altitude for traveling patients

These assessments apply to the prescription of continuous flow therapy as well as systems that conserve oxygen.

2007 Guide to Understanding Oxygen Conserving Devices

Robert McCoy BS RRT FAARC
Managing Director
Valley Inspired Products, Inc.
bmccoy@inspiredrc.com

Ryan Diesem
Research Associate
Valley Inspired Products, Inc.
rdiesem@inspiredrc.com

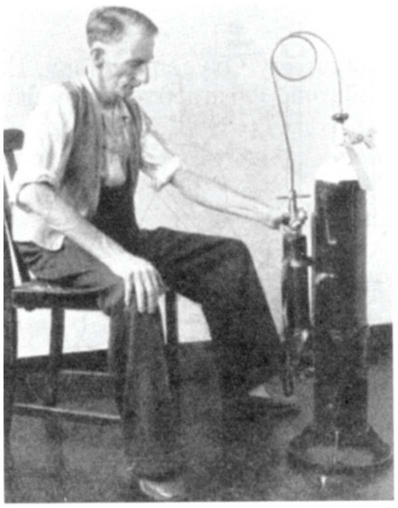
Design & Layout by Jonathan Johnston
jon@jonjohnston.com

Product Photography by Lynn Jonson
lynnjonson@comcast.net

Table of Contents

A Short History of Long Term Oxygen Therapy

Long Term Oxygen Therapy (LTOT) has been an option for treating patients in need of oxygen therapy for over 50 years. Cylinders were the first therapy option for LTOT since they were available in hospitals that did not have a piped oxygen system. After cylinders were delivered to the hospital by the gas delivery company, they would be transferred to the home with the patient. Liquid oxygen (LOX) soon became an option for efficient delivery of bulk oxygen to a hospital, and shortly thereafter, in 1965, a smaller system was introduced and made available for use inside the home.



Cylinder Transfilling

Portable oxygen was first made available via the use of smaller cylinders. These systems usually weighed 20 lbs and required the use of a cart. Subsequently, the LOX portable offered a lighter option with more operating range. LOX portables weighed approximately 8 – 10 pounds and could be carried by the patient. Carts were again available for patients that could not carry that amount of weight. While these were great strides, weight and range-of-use are big issues for most patients. Pulmonary diseases are debilitating and any additional work related to moving an oxygen system often countered the benefit of having portable oxygen to begin with.

In these early years, and up until the late 1970's and early 80's, patients were prescribed LTOT as a last resort to combat their disease. However, this would change after the results of two significant studies were published. The most significant research related to LTOT occurred in the late 1970's with the British Medical Research Council (MRC) and the North American Nocturnal Oxygen Therapy Trials (NOTT). Both of these studies were conducted on a significantly large number of patients over several years. The findings of the MRC were that patients with 12 hours of oxygen therapy a day had better survival rates than patients who did not use oxygen at all. The NOTT study followed that with the discovery that patients on close to 24 hours of LTOT had a better survival rates than patients on 12 hours. In addition to this conclusion, looking at the NOTT study data from another perspective revealed that patients who were ambulatory during the study had an even higher survival rate than the more stationary patients. These ambulatory patients also had reduced hospitalizations and shorter lengths of stay when they were hospitalized. This data suggested that patients should be encouraged to be as active as possible while still maintaining proper oxygen saturation levels. As a result of these landmark and groundbreaking studies, early prescription of LTOT became the standard of care as opposed to the "last resort".

First Home LOX System

Now that LTOT in the home setting was becoming more and more prevalent, the next logical step was to maximize the use of available oxygen to a patient.

In 1984 the first intermittent flow oxygen delivery device, CRYO/2's Demand Oxygen Controller, was introduced to the home care market. Chad Therapeutics followed shortly thereafter with the Oxymatic conserver. Appreciating the fact that oxygen delivered when the patient was exhaling is wasteful, these oxygen conserving devices (OCDs) sensed the patient's inspiratory effort and delivered a dose of oxygen only during inhalation. Yet neither the Demand Oxygen Controller or Oxymatic devices found mainstream acceptance until the mid-1990s.

CRY0/2 Demand Oxygen Controller, circa 1984

Since then, a combination of improved designs and ease of use, as well as extreme cost pressure from reimbursement sources, has moved these systems from a curiosity to an essential part of ambulatory oxygen therapy. OCDs are found not only as stand alone components to be used with stationary oxygen systems, but also integrated with:

- Regulators for use with high-pressure cylinders
- Small, lightweight liquid oxygen systems
- Portable oxygen concentrators

Originally conceived as simply a means to extend the life of a source of oxygen, OCD technology has changed the face of oxygen therapy. OCDs have enabled many patients to be shifted from older, heavier liquid oxygen systems to gaseous systems of similar weight and range. The development of OCD technology has allowed the creation of four-pound liquid oxygen systems that have up to 8 hours of use time. In addition, OCD technology has enabled the long-standing dream of a portable oxygen concentrator (POC) to become a reality. In the last three years alone, four new POCs have been introduced to the LTOT market.

Today's OCDs Enable Freedom

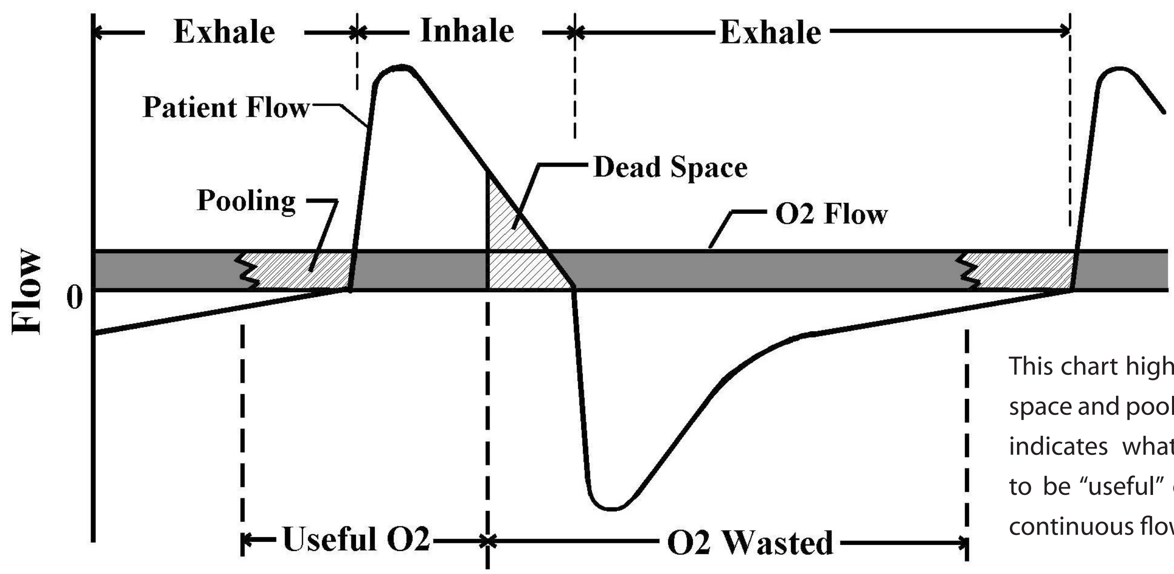
There is no doubt that devices that efficiently use available oxygen are here to stay. While early systems were quite crude and bulky, the technology has evolved to be reliable, compact and easy for a patient to use. Patients are no longer limited to staying in and around their homes; the development of OCDs and the resulting technological advances have enabled them to live their lives as normally as possible.

Oxygen Delivery Fundamentals

To adequately understand OCDs, it is first beneficial to think about continuous flow oxygen (CFO) delivery, which for decades was considered the 'gold standard' of LTOT. As CFO is applied via nasal cannula, some of the oxygen delivered during inhalation is mixed with inspired air for a net Fraction of Inspired Oxygen (FIO2) in the lungs. Unfortunately, determining FIO2 isn't quite as simple as calculating the flow of oxygen and the flow of air. Several factors conspire to complicate the process.

Dilution

During CFO the flow rate is fixed, so as a patient breathes faster, creating a shorter inhalation time, the amount of oxygen inhaled per breath decreases. As a result, the net FIO2 drops.



This chart highlights the dead space and pooling factors, and indicates what is considered to be "useful" oxygen, during continuous flow therapy.

Dead Space

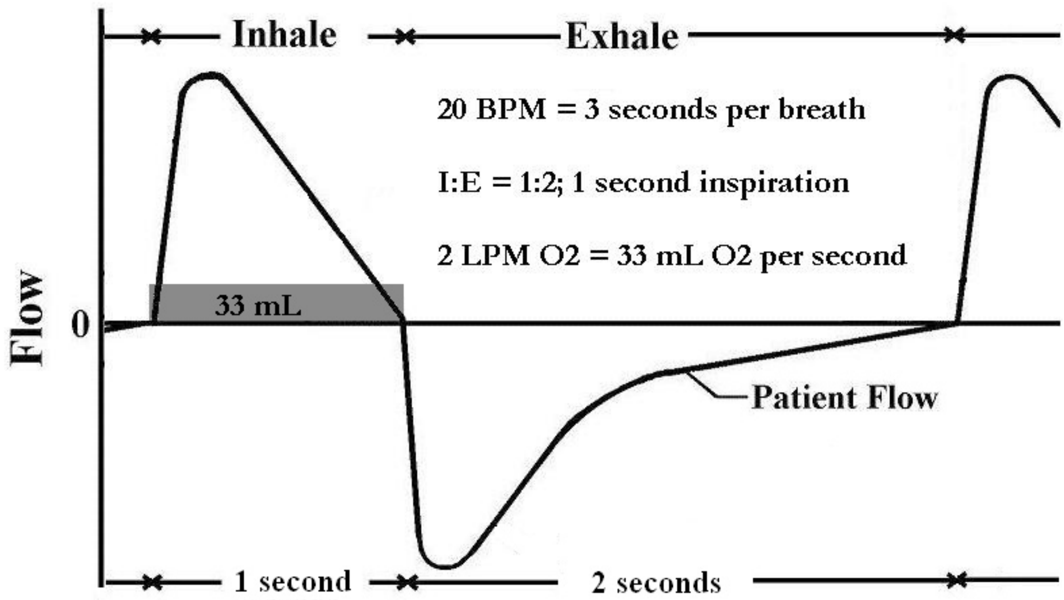
During the latter portion of inhalation, gas entering the airway never reaches the lungs. Instead, it remains in the air passages that lead to the alveoli, only to be exhaled before they reach these gas exchange units. This includes some of the oxygen volume delivered from CFO therapy, meaning that that oxygen was wasted. The amount of oxygen wasted varies with the patient's anatomy and breathing pattern.

Pooling

Oxygen delivered from CFO therapy late in the exhalation phase, when the patient's expiratory flow rate is relatively low (or during the pause after total exhalation), may not be wasted. The oxygen exiting the small diameter cannula is traveling at a relatively high velocity and some amount of oxygen is 'pooled' in and around the nose, nasopharynx and upper airway. This oxygen volume is able to be inspired at the beginning of inhalation. Patient disease, anatomy and breathing pattern, as well as environmental conditions (like wind) can vary this effect.

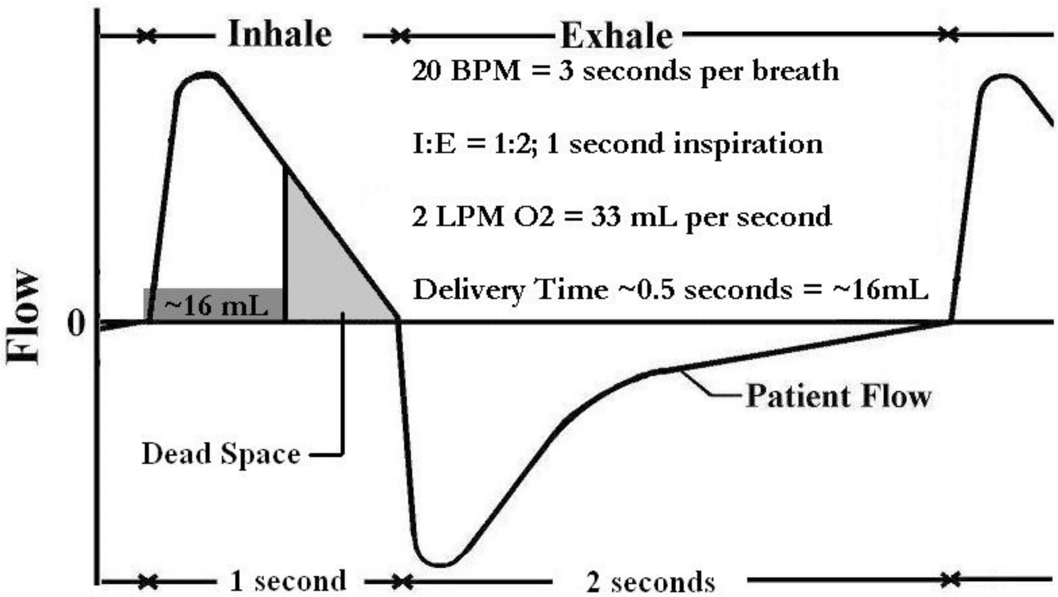
Early Conserving Concepts

Intermittent Oxygen Delivery with 2 LPM Flow Therapy



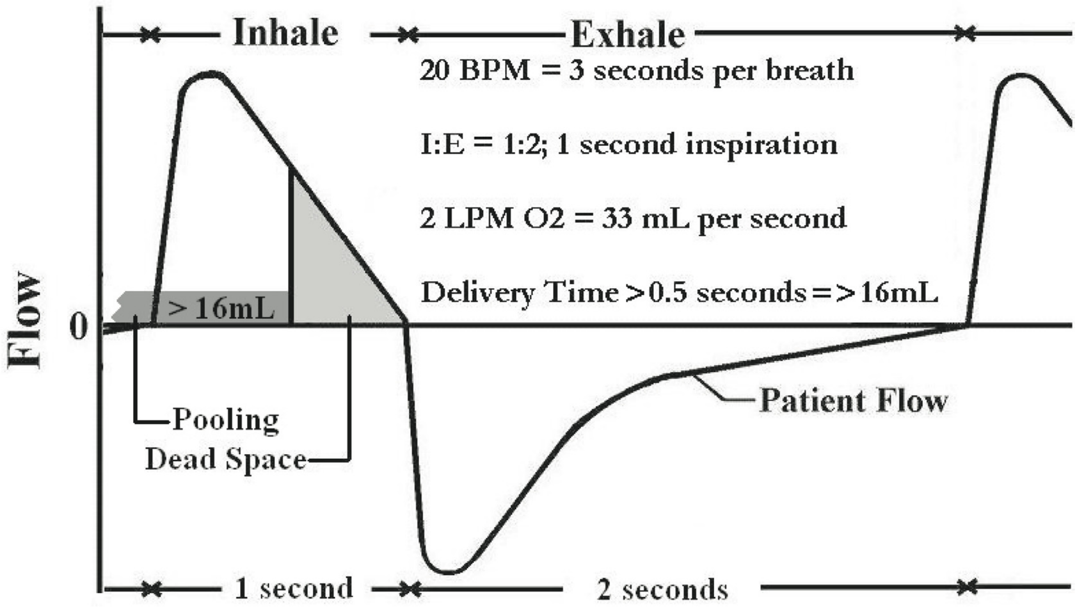
Early conserving pioneers estimated that only the oxygen delivered during inhalation was considered useful. Assuming a typical breath rate of 20 breaths per minute, and an Inspiratory:Expiratory (I:E) ratio of 1:2, that would mean that 1 second delivery was required. If a 2 LPM setting was used, this meant that on each breath, 33 mL of oxygen was "useful".

Intermittent Oxygen Delivery with Timed 2 LPM Flow Therapy



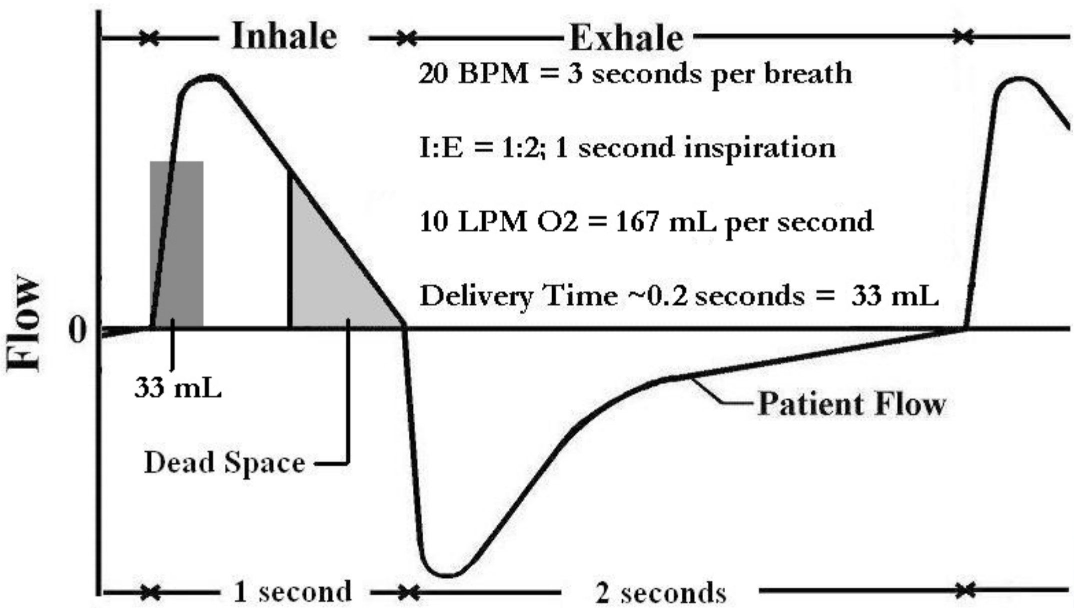
Others recognized that, while 1 second of inhalation time was spent breathing in air, the last portion of the delivered oxygen never reached the lungs; it remained in dead space, only to be exhaled. Product developers theorized that it was possible to cut the delivery time roughly in half while keeping the delivery flow rate the same. Since continuous flow oxygen could not be providing "useful" oxygen for the full inhalation time, reducing the delivery time from 1.0 seconds to approximately 0.5 seconds would reduce the delivered oxygen volume from 33 mL to ~16 mL, and, in theory, the patient should still get the same therapeutic benefit of CFO therapy. This theory led to the development of oxygen conserving devices that could claim a much higher savings ratio though they delivered oxygen in a very similar manner to other products.

Oxygen Delivery via Timed 2 LPM Flow Therapy with Pooling



To further complicate matters, with continuous flow therapy, there is oxygen flowing throughout exhalation also. While most of that is blown out into the atmosphere, the oxygen delivered at the very end of exhalation may pool in and around the nose, and then is inhaled when the patient starts their next breath. The amount of pooled oxygen will vary greatly (patients' breathing pattern, their anatomy, the oxygen flow rate, the wind, etc., all are factors), so it is very difficult to estimate how much oxygen is required to achieve an equivalent dose amount to a 2 LPM continuous flow rate of oxygen. But it was suspected that the oxygen dose would need to be more than 16 mL to maintain equivalent therapy to CFO delivery. This theory led to the idea of demand/hybrid delivery OCDs delivering a bolus volume early in inhalation to account for the lost volume from the lack of pooled oxygen around the nose at the start on the inspiratory phase.

Intermittent Oxygen Delivery via Pulse Delivery Device



Gerald Durkan, whose product development work led to the products and patents now marketed by Sunrise Medical, thought that it would be advantageous to deliver the same 33 mL dose resulting from 2 LPM continuous flow oxygen therapy early in inhalation, but at a higher flow rate and for a much shorter duration. With this method of delivery, the delivered pulse volume could easily be changed by varying the duration of the delivery. Most, but not all, pulse devices today operate in this manner, increasing the delivery time with an increase in the setting number.

To Conclude

Initially, OCDs were not well received. Many patients and clinicians experienced limited success with the new devices. Many problems were related to technical issues that occur with any new product on the market. Recent research related to the testing of how OCD products operate provides another possible cause for poor results using different OCDs.

Each manufacturer determines what volume of gas to provide at each setting and often reports that to be equivalent to continuous flow. Testing each unit on the bench found that one device set on 4 was giving 66 ml per breath and another unit set on 4 was giving 34 ml per breath. These types of differences in volume, on the same setting, created confusion and the perception that the units did not work properly.

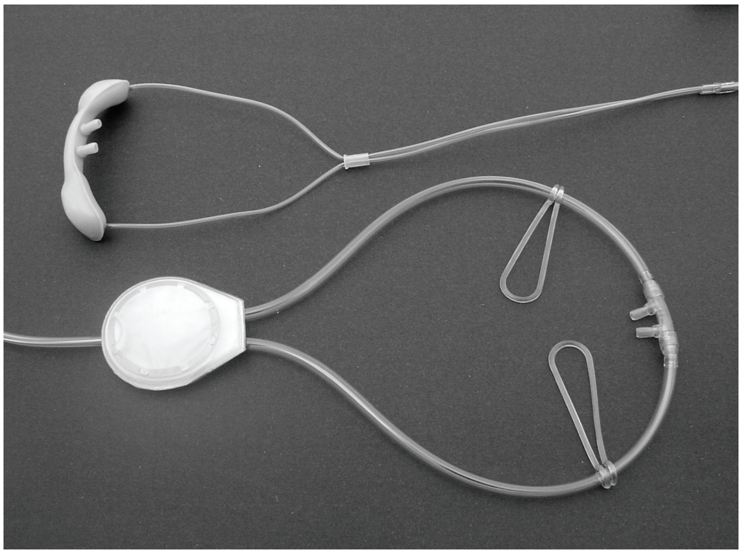
With some manufacturers promoting savings ratio rather than patient oxygenation, OCDs initially had an acceptance problem. There is a lesson to be learned from this experience. Clinicians need to be informed on the performance capabilities of each piece of equipment that a patient utilizes. The respiratory products industry is growing rapidly. Without direction from knowledgeable clinicians, manufacturers are sometimes left in the dark in regards to how their devices should operate to maximize therapeutic benefits.

This section outlines the various ways oxygen delivery can be conserved during the application of oxygen therapy.

Methods of Delivery

Titrate Correct Flow for Patients on Continuous Flow Oxygen
In the past, patients were simply prescribed 2 LPM continuous flow for oxygen delivery. This "rubber stamp" was a default setting to start patients on oxygen therapy. If the patient's oxygen levels were appropriate, rarely did the clinician test to see if a lower setting would have accomplished the same objective. Doing so would have conserved some oxygen for patients who were able to stay oxygenated at lower flow rate settings. With the advent of conserving devices, CFO therapy is used much less than in the past, but these same issues still exist today.

Reservoir Cannulas
Reservoir cannulas, often referred to as moustache or pendant cannulas depending on the design and use characteristics, have approximately 20 mL of reservoir space that stores oxygen during exhalation. On inhalation, the patient receives that stored oxygen, adding a bolus volume to the ongoing continuous flow delivery. These devices are simple, effective, and, when used properly, can allow a patient to receive the same therapy at a lower CFO flow rate, thus conserving oxygen. Numerous studies have proven their effectiveness, yet the appearance of the devices has been a limiting factor for most patients.



Reservoir Style Cannulas

Intermittent Flow Devices
Intermittent flow devices operate by turning oxygen delivery "on" during some portion of inhalation and "off" for the balance of the breathing cycle. In this way, oxygen that would otherwise be wasted as the patient exhales is conserved. This method often allows a given supply of oxygen to last 2-4 times as long as it would if it were delivered continuously. One benefit of the use of intermittent flow conserving devices is that a smaller oxygen supply may be carried, "lightening the load" for the patient.

With intermittent flow devices, the way in which oxygen is delivered to the patient differs greatly from one device to another, and NO device delivers oxygen in the same way as continuous flow (let it be said that this is not necessarily a bad thing).

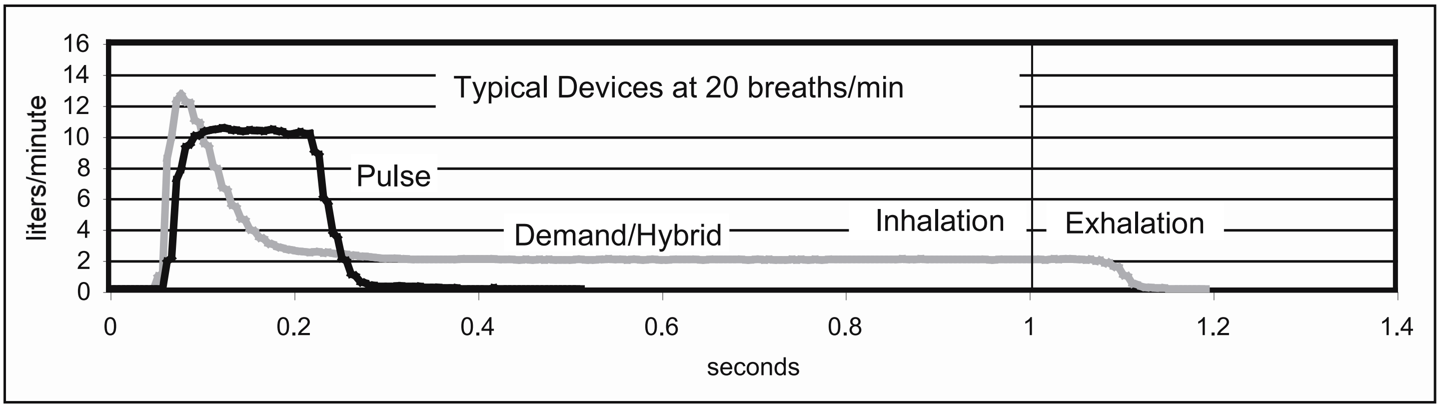
Intermittent flow devices can be separated into two broad categories, pulse and demand, and within these categories there are many variants.

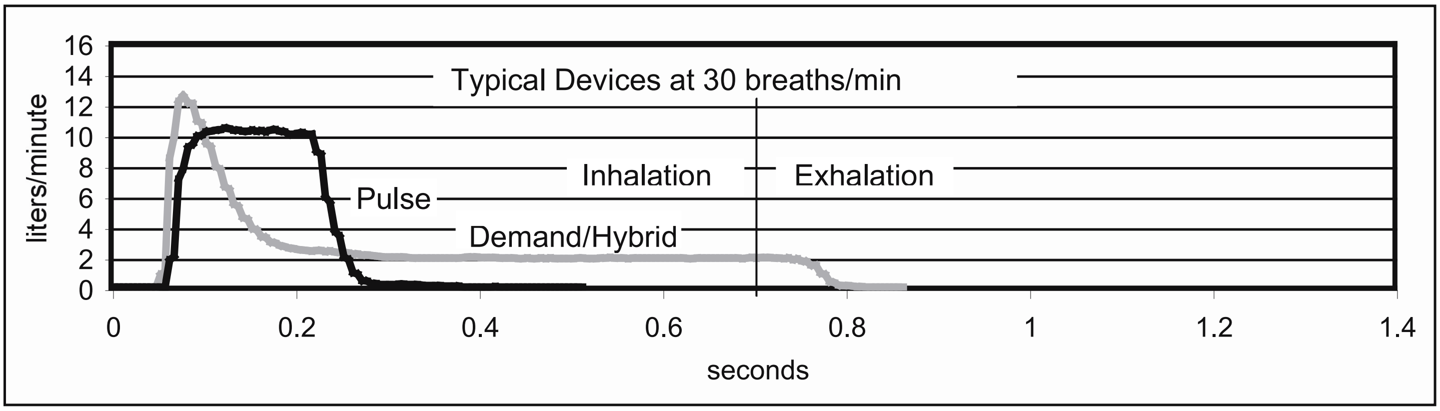
Pulse Delivery Devices
Pulse delivery devices deliver oxygen in the form of a relatively high flow rate bolus beginning early in inhalation. For example, the original CRYO/2 device, when set at the "2" setting, delivered oxygen at a rate of 10 LPM for only 0.2 seconds. Some pulse delivery devices vary the dose of oxygen by changing the duration of the bolus. Others increase the peak flow rate at which the dose is delivered as the user increases the setting number. Some devices do a combination of both.

Certain pulse delivery devices, in addition to allowing for oxygen conservation, may have an added benefit over continuous flow therapy. On a continuous flow system the flow rate stays constant, and as a patient's respiratory rate increases, the inspiratory time decreases, so the volume of oxygen inhaled per breath actually decreases. However, on most pulse delivery devices, the delivered volume at a given setting stays the same regardless of the patient's breathing rate, so the oxygen dose that is delivered stays the same, regardless if the patient is breathing at 15BPM or 30BPM. As a patient moves from rest to activity and their breath rate increases, a pulse device operating in this manner may maintain oxygenation better than continuous flow or a demand device. This, however, has not been proven clinically. Therefore, it is impossible to say that pulse type delivery is equivalent or otherwise to continuous flow delivery across a wide variety of breathing patterns. Device manufacturers however, label their products with the same setting numbers used for continuous flow ("1, 2, 3…"), and so there is often confusion about why a conserving device set at "2" is not oxygenating a patient like continuous flow at 2 LPM does.

Also important to note here is that a few pulse delivery OCDs are manufactured such that they decrease the delivered dose per breath as the patient's breath rate increases. These devices are sometimes known as minute-volume delivery devices, as they generally deliver the same total oxygen volume over one minute regardless of the patient's breath rate.

Pulse vs. Demand/Hybrid devices at 20 and 30 bpm





Demand Delivery Devices

Demand delivery devices have evolved from the initial, intuitive idea of creating an oxygen conserving device that simply used the patient's breathing signals to turn the device's oxygen delivery on during inhalation and off during exhalation. Because of the lack of pooling, however, this has not proved to be an adequate approach. For this reason, most current demand conservers deliver some amount of bolus volume at the onset of delivery, to make up for lost pooled oxygen. These demand devices are sometimes called hybrids, because they act like both a pulse and demand device, delivering a fixed pulse volume at the onset of inhalation and then continuing to deliver oxygen at a "tail" flow rate until the device senses the beginning of exhalation.

Transtracheal Oxygen

This is a surgical procedure that bypasses the upper airway's dead space by inserting a catheter through a small hole made in the front of the neck and into the trachea. Oxygen conservation is achieved as the patient is usually able to be given the equivalent of CFO therapy with nasal breathing at a lower continuous flow setting. Studies have also shown that a single lumen intermittent flow conserving device will work with transtracheal delivery, however the oxygen savings is about the same as using nasal breathing with that same intermittent flow device. Because patients on oxygen often can be self-conscious about how they appear when using their oxygen equipment, a notable benefit of transtracheal oxygen therapy is an increase in patient compliance to therapy due to the lack of cannula interface with the patient's cheeks and ears and the fact that the public usually is not able to see the catheter.

Trach Insertion Site

Key Issues In Oxygen Therapy With Conserving Devices

Proper Oxygen Saturation

One objective of an OCD is to ensure that the oxygen delivered to the patient reaches gas exchange units in the lung. Oxygen delivered anytime during the breathing cycle that does not reach a gas exchange unit is considered wasted.

The goal for efficient oxygen delivery using a conserving device is proper oxygen saturation or oxygen pressure in the blood for the patient requiring supplemental oxygen at all activity levels. It is important to note that oxygen savings is considered accomplished only after the patient is adequately oxygenated and is a secondary objective for device performance.

Ventilation and Perfusion Issues

A patient's respiratory physiology is a very dynamic process. Even if a conserving device is providing consistent oxygen delivery, results can vary for an individual patient from moment to moment, and also between groups of patients using similar devices. This issue, combined with the wide variety of performance differences in OCDs, often makes it a difficult challenge for patients to consistently maintain proper oxygenation across various portable oxygen systems.

Oxygen dependent patients should always be tested on their oxygen system at different activity levels — sleep, rest, and exercise, as well as at altitude, if possible — to ensure the device meets their oxygenation needs at all levels of activity.

Activity Levels

Several variables may affect a patient's oxygenation while using an oxygen delivery system. Increased respiratory rate will shorten inspiratory time and may reduce the amount of oxygen a patient will receive. In the past, an exercise prescription was written for patients whose increase in respiratory rate with exercise required more oxygen to maintain proper saturation levels. This increase in flow rate was to compensate for a shorter inspiratory time due to the faster respiratory rate. The general rule of thumb was to double the patient's flow rate (e.g. from 2 LPM to 4 LPM) during exercise.

Any change in respiratory rate or pattern may affect the patient's oxygenation. The lack of attention to this variable in the past has created the misperception that conserving devices do not oxygenate effectively. Oxygen dependent patients should be tested on their oxygen system at different activity levels reflecting real life conditions, including at rest, during exercise, while sleeping, and at altitude, where possible. This protocol has been recommended by respiratory clinicians for years, yet still has not hit the mainstream of patient care.

A titration test is the standard method of measuring patients' oxygen needs with exercise. It is a simple method that only requires an oximeter and a place to exercise. If a patient will be doing more strenuous activity, every attempt should be made to simulate that activity to see if the device properly oxygenates the user. Sleeping with an OCD is possible, yet an overnight oximetry test is strongly recommended to determine if the device is triggering with each breath and maintaining patient oxygen saturation.

Altitude

Altitude has an impact on the *pressure* of oxygen and not necessarily the *amount* of oxygen. Oxygen conserving devices will give approximately the same volume of oxygen at higher altitudes (or in an airplane), but the pressure differences at different altitudes may have an impact on oxygenation levels. It is important to understand that if an oxygen system is able to meet a patient's oxygen needs at a lower altitude, it is possible that that same system may not be able to meet the patient's needs at a higher altitude. Unfortunately, it is generally unfeasible to test patients on their oxygen systems at pressures that they would be experiencing at varying altitudes. In general, the common practice has been to double the device's delivery setting when the patient is at altitude. However, if the oxygen system the patient is using is already running at its top setting at a lower altitude, another system should be considered for use at higher altitudes.

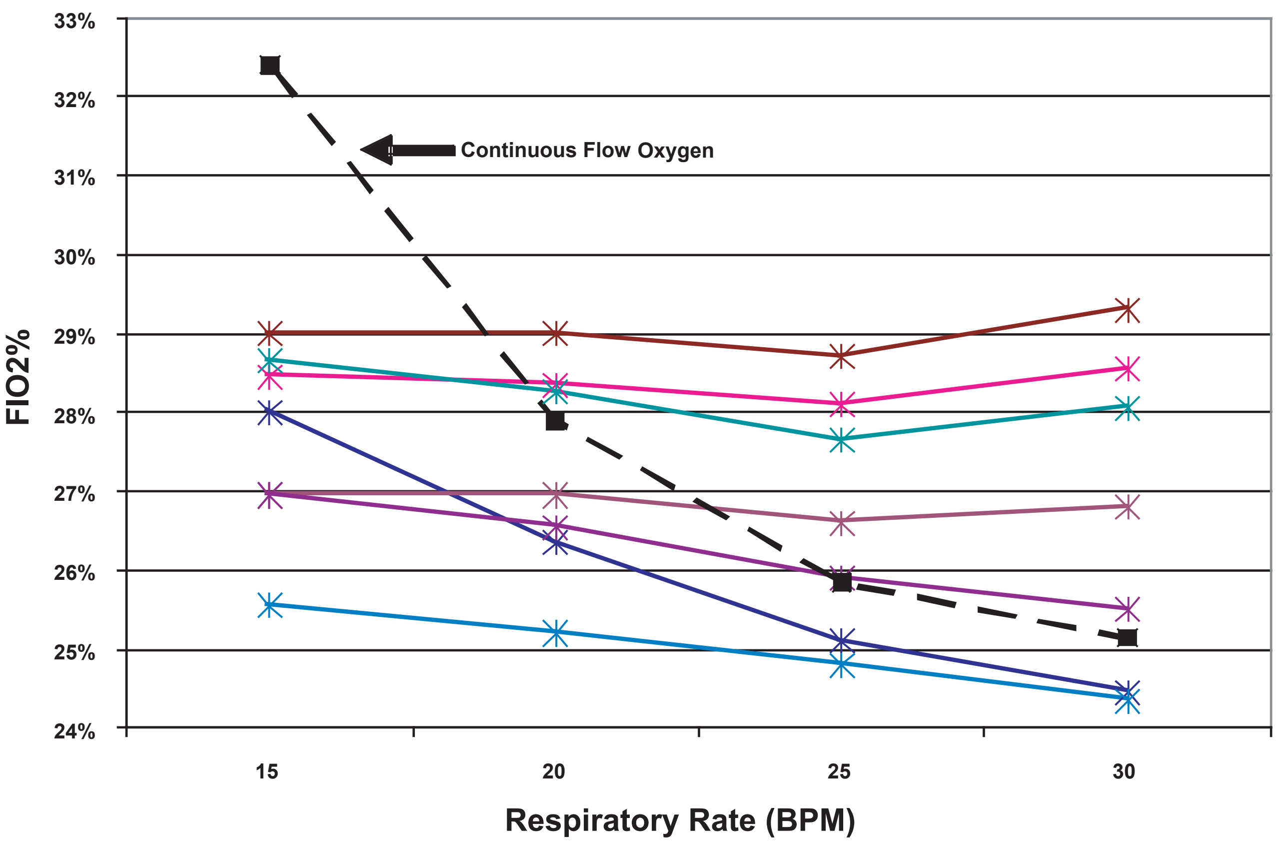
Equivalency

When OCDs first entered the LTOT market, they were revolutionary, not evolutionary. A revolutionary product has no predecessor; therefore, there is nothing to compare the product with. For OCD manufacturers to be able to enter the market and sell their products, OCDs needed a reference point that could be understood by the persons using the device. Continuous Flow Oxygen (CFO) delivery was the gold standard in oxygen therapy up to this point, so an attempt was made to compare the effectiveness and delivery of the OCD to the CFO gold standard.

Intermittent flow devices such as OCDs deliver a certain volume of gas with each sensed patient breath. A patient breathing on a continuous flow device receives a variable volume of gas dependent on their breathing profile. By selecting *one* breathing pattern and *one* breath rate, a delivered dose volume of oxygen can be made equivalent to the volume taken in during continuous flow of oxygen. As a result, manufacturers selected a volume of oxygen for a given device setting that they felt would be equivalent to continuous flow and made that the flow setting on their device. However, this concept only works if the patient never changes their breathing pattern. Obviously that is not the case in real life.

Most OCDs have a number on the selector dial and, even though they may claim to deliver oxygen equivalently to continuous flow at that same setting, they typically are not equivalent to CFO, let alone any other conserving device at that setting.

Inhaled FIO2% in test lung study of seven devices all set on "2"



The graph shown here displays the delivered FIO2 values for seven conserving devices, all of which are set at the device setting of 2. As can be seen, there is a wide range in delivered FIO2, and no device could be considered to have delivered therapy equivalent to CFO.

Standards for OCDs

There are few standards for the development of OCDs. This lack of standards has led to a wide variety in device performance and has fostered confusion in the market. Using the scenario outlined above as an example of this, the setting numbers on the dials do not relate to any manufacturing standard and were generally meant to be used only as a comparison to continuous flow. This is not a viable comparison. So this begs the question, "What does "2" really stand for?" With minimal standards regulating the manufacture of OCDs, the answer must be this: The 2 does not mean "liters per minute" or signify a specific volume of oxygen. In fact, it doesn't mean much of anything. It is only a reference point to be used to test the patient and to turn the selector, if necessary, to obtain the proper oxygen saturation in the patient. (An easy analogy for this situation would be if you just saw the number 50 on a speedometer. Is that kilometers per hour? Miles per minute? Furlongs per day? That kind of information would be nice to know if you found yourself in a speed trap!)

Savings Ratio

Oxygen saving is possible with conserving devices; therefore a ratio of oxygen use by an OCD compared to oxygen use by CFO therapy can be

The numbers on the dial have been the culprit for misleading claims of high oxygen savings.

calculated. One can increase this savings ratio by decreasing the oxygen delivery by the device. This has been the basis for many manufacturers' claims of high oxygen savings.

Here is an example that illustrates how higher savings can easily be claimed: One "E" size cylinder having the same contents as another can last twice as long if the selector knob on the designated "efficient" cylinder is simply turned from "2" to "1". Now, if the flow selector's label on the efficient cylinder, which is currently showing "1", is simply changed to read "2", yet still giving flow at "1", you have an idea of how some OCDs can obtain the claim of high savings ratio.

Dose Volume

The dose volume from an OCD determines the fraction of inspired oxygen (FIO2) by the patient. A higher dose volume generally means a higher FIO2 at a constant, normal breathing volume (tidal volume). Dose volumes from various OCDs are different at the same numerical setting. Prior to using any OCD it should be determined what the dose volume per setting is. Some devices have limited maximum dose volumes and, as a result, are not suitable for patients requiring higher FIO2 at certain activity levels.

Triggering Sensitivity

The triggering sensitivity determines if and when a conserving device will deliver a volume of oxygen. All conserving devices need to sense a patient's inhalation to initiate the flow of oxygen. Some devices are more sensitive than others, meaning those devices will trigger their oxygen flow sooner than the others. The first half of inspiration is important in oxygen delivery—if a conserving device is slow to respond to an inspiratory signal, it may deliver oxygen late in the inspiratory cycle and the delivered oxygen may not go to gas exchange units in the lung. Additionally, if the device does not sense a breath at all, it will not deliver its dose, and the patient will not receive oxygen for that breath. At activity, most patients have a strong signal and most devices will trigger without issue. However, sleeping patients may not generate much of an inspiratory signal and oxygen delivery may be missed on weak breaths. It is recommended that a patient wishing to use their conserving device while sleeping undergo an overnight oximetry study with the device prior to using it in the home.

If the device does not sense a breath, the patient will not receive oxygen for that breath.

Timing of Oxygen Delivery

There is an undefined "sweet spot" where oxygen delivery is most effective. Any oxygen delivery outside that sweet spot is wasted and does not provide oxygen to the patient's gas exchange units (alveoli). Typically, oxygen delivered in the first half of inspiration goes to the alveoli. Oxygen delivered after a certain point in the second half of inspiration remains in the conductive passages in the upper airway, where no gas exchange occurs, and is eventually exhaled.

Most pulse delivery style conserving devices attempt to deliver most of their entire oxygen dose within the first half of inspiration. Demand and hybrid conserving devices, by design, deliver oxygen all the way to the end of the inspiratory cycle, only turning off when the patient exhales. This means that the oxygen delivered near the end of inhalation is generally wasted, but the patient still receives the majority of the delivered volume.

Continuous Flow Back Up

Some devices provide an option for continuous flow operation in the event that the conserving device fails to operate. Typically this setting is a one-flow setting back up (e.g. 2 LPM continuous flow), though some devices do feature multiple CFO settings. Some OCDs have a fail open feature that allows the device to open to continuous flow if there is no inspiration sensed within a specific time frame. It is important for the user to note what CFO options are available to them on their device of choice.

Power Options
Pneumatic devices operate from the gas pressure in the supply system. These systems do not need an outside power source, therefore no power source needs to be checked or changed.

Electronic conserving devices, however, are battery operated and need to have the batteries changed as needed for continued operation. An advantage of using an electronic OCD is that it is able to provide a light to indicate that the device is operating normally. Be aware that an electronic light may flash, signifying the device acted on the breath signal, even if no oxygen is delivered. Additionally, the device may sound an alarm or change if the device does not sense a breath or cycle to oxygen delivery.

Portable oxygen concentrators require use of a power source to operate. All POCs use a rechargeable battery pack for portable operation. These devices also usually come equipped with a power pack that is able to be plugged into a wall outlet, which serves as both the power to the unit and the source for recharging the battery pack. Additional power source accessories are usually available, including car lighter adaptors.

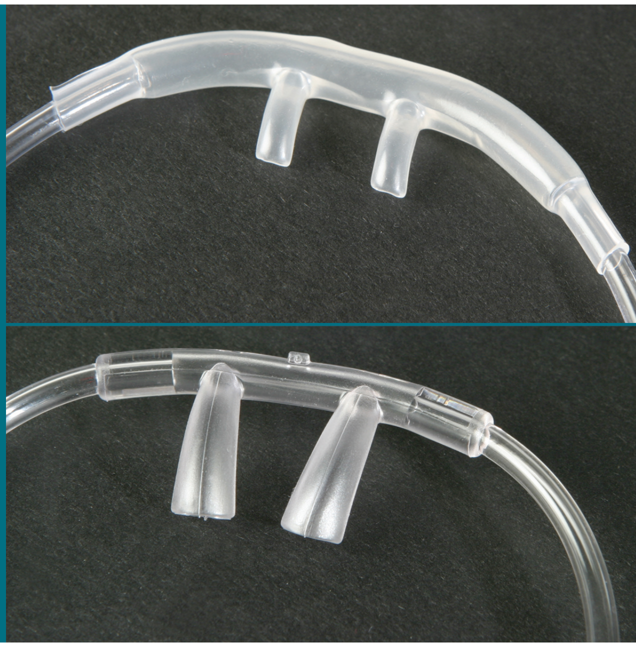
Cannula: Single Lumen vs. Dual Lumen; Nasal Prong Style
Most pneumatic conserving devices require use of a dual lumen cannula—one lumen to sense the breath and the other lumen to deliver the oxygen. Some pneumatic devices use a single lumen and thus have a unique way of ending oxygen delivery. Electronic devices only need a single lumen cannula since a circuit times the end of the delivery.

The size and shape of the cannula nasal prongs is also an issue to be aware of when using OCDs. Some cannula feature flared tips, some straight tips, and others tapered tips. These design differences can alter the resistance to flow inside the cannula, which can affect the amount of oxygen being delivered to the patient.

Pediatric or low flow cannulas are not recommended for most conserving devices as the resistance to flow can impact the triggering of the device and can cause the conserver to auto cycle.

Note that dual lumen cannula cannot be used with transtracheal oxygen delivery.

Cannula Comparison: Straight-Tip (Top) vs. Flared-Tip Cannula (Bottom)



Cylinder Operating Pressure
OCDs utilizing oxygen cylinders are usually rated for a specific cylinder operating pressure, often from 500psi to 2000psi. It is important that the OCD be switched to a compatible tank when the current tank pressure is outside of the specified pressure range for operation.

Also, many conserving regulators' delivery volumes change with a change in tank pressure. Some devices will deliver slightly lower dose volumes at 500psi than they will at 2000psi. These volumes are usually not significant, but should be noted. Devices with continuous flow capability will usually see delivered flow rates drop as the cylinder pressure drops.

Ease of Use
Extra features and benefits are often not utilized by patients using conserving devices. Adding clinical features are only an advantage if the patient's clinician sets the device up and knows how and why a

special feature is a benefit to the patient. The "keep it simple" philosophy is an advantage for patients and helps keep confusion using a device to a minimum. That said, there have been a few devices that have been released recently that have additional product features unique to that device.

Testing Operation of a Conserving Device

Since conserving devices have entered the market, it has been difficult for users questioning whether or not their device is operating correctly to see if that is indeed the case. Since conserving devices deliver a volume of gas as opposed to the "gold standard" of continuous flow oxygen, you cannot use a liter meter—the device used to spot check flow on a CFO system—to test OCD operation.

Pulse Volume Meter

This device measures pulse volumes of single lumen, pulse delivery OCDs.

A device called a Pulse Volume Meter is available to test pulse type conserving devices. This unit is a volume-measuring device, and is used by connecting the OCD to the device and triggering oxygen delivery. The user is able to quickly spot check the amount of oxygen being delivered to the meter. Each OCD manufacturer should provide the volume of gas delivered per setting, so if the volume is incorrect, the device can be returned for repair. If the device appears to be delivering its O2 dose correctly, other reasons for the perception of an OCD malfunction would need to be investigated. Note that a pulse volume meter cannot be used to test a demand system.

New Technology

Many manufacturers are developing new methods of using oxygen conservation concepts and techniques to improve the response of their systems in meeting the patient's constantly changing oxygen requirements due to their continually varying levels of activity. Methods utilized by an OCD of responding to a patient's changing oxygen needs include:

Movement: The device senses movement and changes the oxygen dose to a higher setting. When movement stops the OCD then switches back to the lower dose setting. There is already approved product featuring the ability to change dose setting as a result of device movement currently on the market.

Oximetery: The OCD device monitors the patient's oxygen saturation. An algorithm in the device changes the oxygen dose based on oxygen saturation. There is an FDA cleared product with this feature, but it is not currently on the market.

Respiratory Rate: The device monitors the patient's respiratory rate and has an algorithm that switches the dose setting to a higher dose with a higher respiratory rate. There are no currently approved devices with this feature on the market.

Other Application Issues

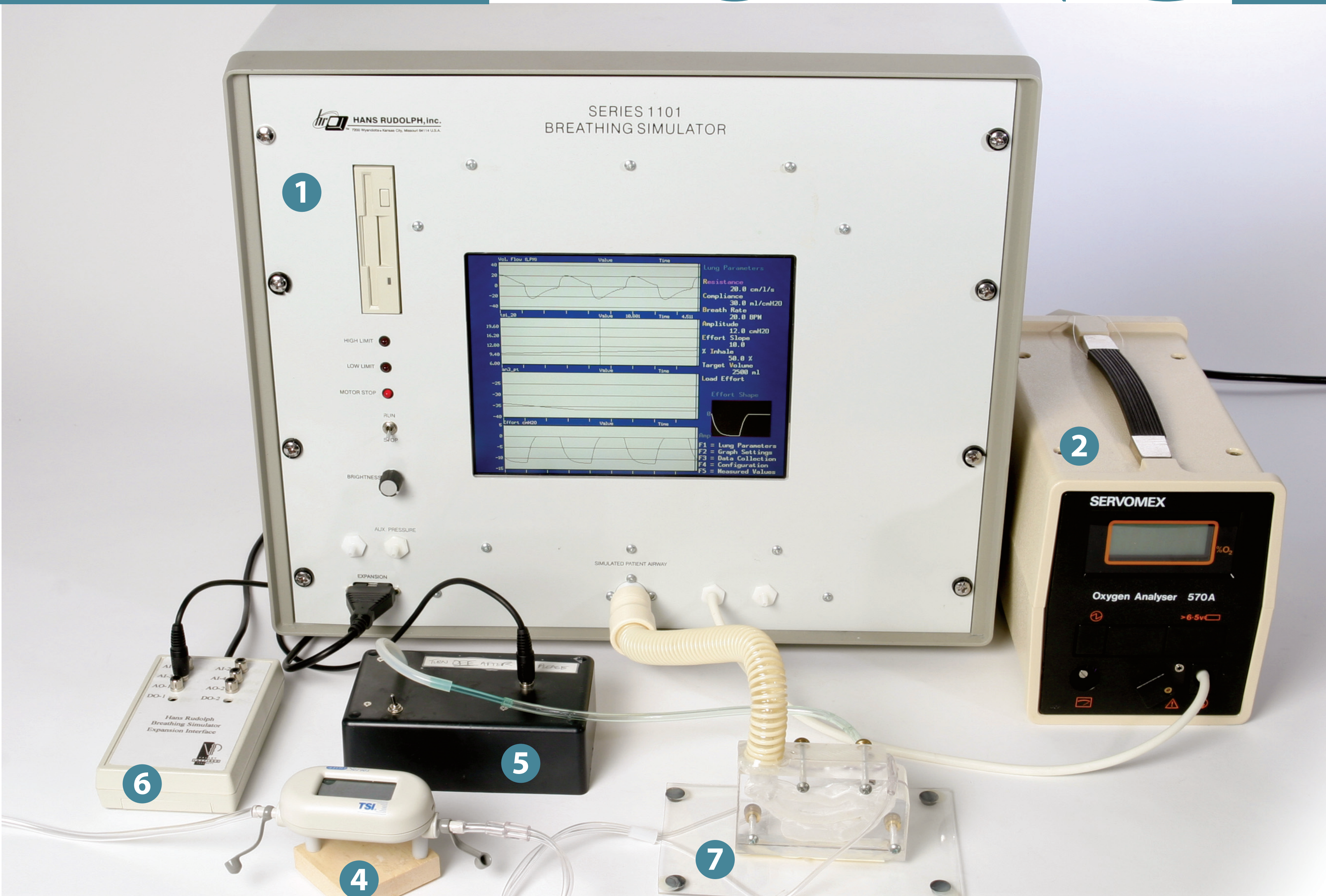
OCDs should never be used with in-line humidifiers as the OCD will not be properly triggered.

Long delivery tubing will slow the gas delivery and may affect device sensitivity. Refer to individual manufacturer recommendations before using non-standard lengths of tubing, and always test the patient's saturation when using longer delivery tubing.

OCDs should not be used with masks as the OCD will not sense an inspiratory signal and there is no oxygen delivery during exhalation to flush the dead space volume.

OCDs should not be used to bleed oxygen to a CPAP or Bi-Level device as the OCD will not properly trigger and oxygen flow/volume will not be adequate to change FIO2.

Methods of TESTING



Protocol

On this and the following pages are descriptions of how each oxygen conserving device was set up for testing in our lab. Listed below is the equipment we used to test and acquire data on each OCD.

1 - Series 1101 Breathing Simulator
2 - Oxygen Analyzer, Model 570A
3 - BTC-II Miniature Diaphragm Pump (Not Shown)
4 - Model 4140 Mass Flowmeter
5 - Model 24PC Pressure Sensor
6 - Breathing Simulator Expansion Interface
7 - Artificial Nose
8 -Ref. 1104 Single Lumen Nasal Cannula with Flared Nasal Tips 9 (Not Shown)
9 - Ref. 1851 Dual Lumen Cannula (Not Shown)

1 - Series 1101 Breathing Simulator, Hans Rudolph, Inc.

This device operates as the "patient". Several patient variables can be controlled, including lung resistance, lung compliance, breath rate, and patient effort. A moving bellows serves as the patient's lung. On-screen displays show instantaneous readings of patient flow, airway pressure, patient effort, and several other parameters. The simulator can be programmed to read analog signals from external devices such as flowmeters and pressure transducers. There is built-in data acquisition software that can record data for all parameters, as well as from external devices. Recorded data files are in Microsoft Excel format, and can easily be transferred to a PC for analysis.

2 - Oxygen Analyzer / Model 570A, Servomex

This device measures oxygen purity, or the percentage of oxygen making up a given sample of air. Analyzing a sample of room air, for example, will yield a percentage reading of 20.9. The oxygen analyzer is used here for measuring the fraction of inspired oxygen (FIO2).

3 - BTC-II Miniature Diaphragm Pump, Hargraves Technology Corp.

This device is used to pull a small air sample from the breathing simulator bellows and send it to the oxygen analyzer for reading. Air samples are pulled from the lung bellows at 0.7 LPM.

4 - Model 4140 Mass Flowmeter, TSI, Inc.

This device measures instantaneous oxygen flow. This particular model—the 4140—is rated to read flows from 0—20 LPM. It is used here to record oxygen delivery profiles.

5 - Model 24PC Pressure Sensor, Honeywell

This device measures instantaneous pressure, and is used here to measure the pressures inside the nose during breathing for testing of device sensitivity.

6 - Breathing Simulator Expansion Interface, Valley Inspired Products

This device allows the breathing simulator to read analog signals from other test equipment. Here it is used to allow the breathing simulator to read and record signals from the flowmeter and pressure sensor.

7 - Artificial Nose, Valley Inspired Products

This is a manufactured nose that mimics the shape of a human nasal cavity. A pressure port on the side of the device allows for the reading of the pressure just inside the "nostrils". Nasal cannula fit into the nares as though they would on an oxygen patient. A small section of smooth bore CPAP tubing allows the nose to connect to the breathing simulator's patient airway.

8 - Ref. 1104 Single Lumen Nasal Cannula with Flared Nasal Tips, Hudson RCI

This is a single lumen nasal cannula that features tips that flare out from the nosepiece. This type of cannula was chosen for use as it offers the least resistance to flow compared to cannula with tapered or straight nasal tips.

9 - Ref. 1851 Dual Lumen Cannula, Hudson RCI

This is a dual lumen cannula that features two separate sections of tubing that meet at the nosepiece. One section of tubing is the "sensing" side, and the other section is the "delivery" side. Both nasal tips are divided down the middle to allow both "sides" to sense/deliver.

For each type of test used for data analysis in this guide, one or all of the following breathing patterns will be utilized by the breathing simulator to simulate a patient:

Pattern	Resistance	Compliance	Rate	Amplitude	Slope %	Inhale	VT
1	20	30	15	20	40	34	~500
2	20	30	20	22.5	40	34	~500
3	20	30	25	26.5	40	34	~500
4	20	30	30	29	40	34	~500

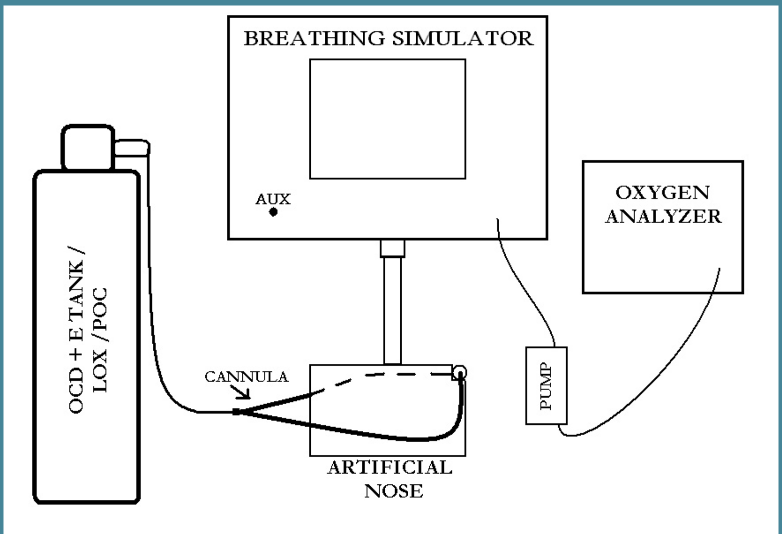
*note that the only adjusted parameters are Breath Rate and Amplitude

When a specific pattern is referred to in this section, it will be as 'Pattern x', where 'x' is the corresponding number from the 'Pattern' column above.

Test Procedure for FIO2 Output

The purpose of this test is to measure the fraction of inspired oxygen (FIO2) in a given breath from each OCD at various settings and breath rates. Even if two OCDs deliver the same oxygen volume at one setting, the FIO2 values may be very different. Several factors may contribute to this, including delivery time, bolus volume, and peak flow rates.

To test for FIO2, set up the test equipment as shown in the diagram to the right.

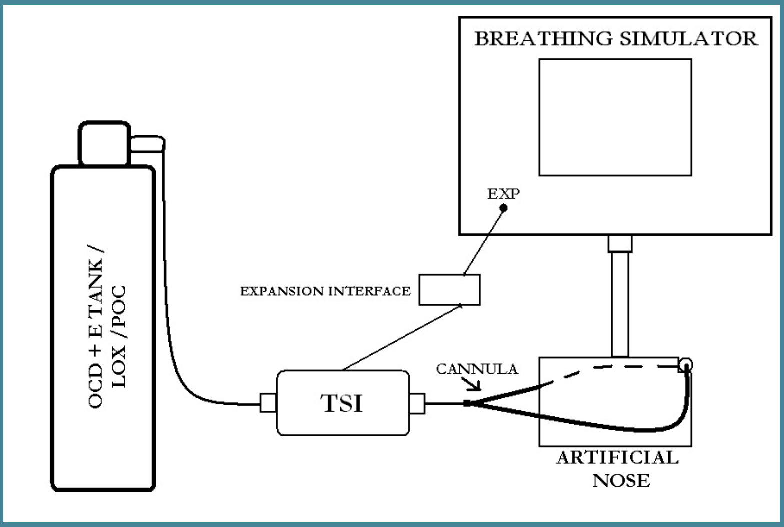


When ready to test, turn the breathing simulator on and set the lung parameters to Pattern 1. Then set the device under test to its conserving mode and at a setting of "1" (or the first integer setting available if "1" is not an option). Turn on the pump so that a small sample of air is taken from the simulator lung bellows and moved through the oxygen analyzer. The oxygen analyzer will display the amount of oxygen in the air sample. At first you will see the percentage increase slowly, but after approximately two to three minutes, the value shown on the display will stabilize. This value is the FIO2. Record this FIO2 value from the oxygen analyzer. Repeat this same test for all integer settings available on the device (i.e. 1, 2, 3 …). Then repeat the entire process for breathing Patterns 2-4. Data collection is complete when there are FIO2 values recorded for all integer settings on the device at each of the four breath rates.

Test Procedure for Volume Delivery and Delivery Flow Profiles

The purpose of this test is to determine the dose volumes at various settings for each OCD, as well as to chart how each of those volumes is delivered. Each OCD delivers its volume in different ways. Some of the differences between two given devices may be minor, while differences between two other OCDs may be quite significant. By charting how the oxygen is delivered, insight is gained as to when the patient receives the oxygen, how long the oxygen is delivered, and at what flow rates these doses are delivered.

To test for oxygen delivery flow profiles, set up the test equipment as shown in the diagram to the right.

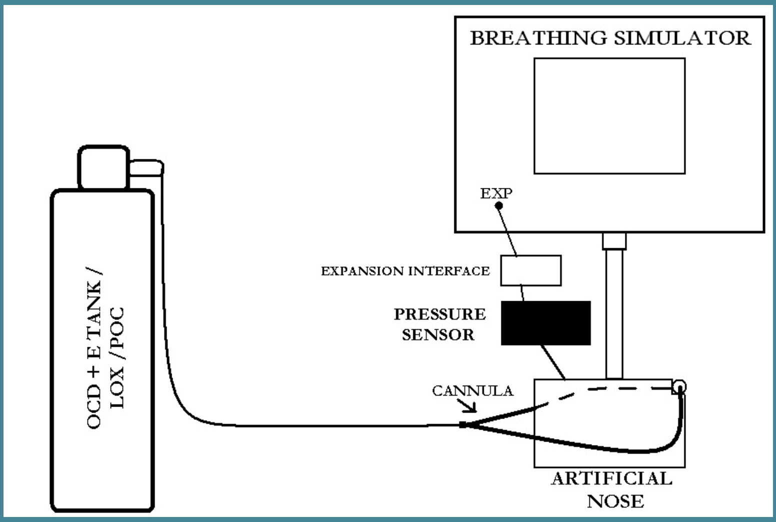


Oxygen flow from the OCD under test is run through the TSI flowmeter by connecting the flowmeter in-line with the cannula approximately one inch below the cannula wye. When ready to begin testing, set the breathing parameters on the simulator to those in Pattern 1, set the OCD under test to setting "1" in the conserving mode (or the first integer setting if "1" is not available). Start the patient simulation on the breathing simulator. Record the flow profile data from the flowmeter by configuring the breathing simulator to read data provided by the flowmeter through the expansion port and interface. Repeat this same test for all integer settings available on the device (i.e. 1, 2, 3 …). Then repeat this process for breathing Patterns 2-4. Data collection for flow profiles is complete when flow profiles are recorded for all integer settings on the OCD at each of the four breath rates. Once all data is collected, open each data file and calculate the delivered oxygen dose volume for each Pattern/setting by integrating the flow data for each breath recorded and averaging the resulting volumes. Calculation of dose volumes is complete when there is dose volume values from each device at all integer settings and breathing patterns.

Test Procedure for Device Sensitivity

The purpose of this test is to determine the amount of negative pressure inside the nose required for the OCD to actuate. Devices that are not very sensitive will simply not deliver their oxygen dose consistently, as the OCD is not sensing a patient breath. Devices that are too sensitive may deliver oxygen at inappropriate times, including during exhalation. It is important that an OCD be able to accurately sense a patient breath otherwise the benefit of using a conserving device is negated. Use of the VIP artificial nose in this test setup reflects use of the device in an open system, i.e. a real patient scenario. Other test methods may yield different results.

To test for device sensitivity, set up the test equipment as shown in the diagram to the right.



When ready to test for device sensitivity, turn on the breathing simulator and set the parameters to those in Pattern 2, but set the Amplitude value to 17 and the Effort Slope value to 10 (instead of 22.5 and 40, respectively). This creates a moderately shallow breathing pattern by the "patient". Configure the breathing simulator to read and record data provided by the pressure sensor through the expansion port and interface at intervals of 5ms. Set the OCD under test to the "1" setting (or the first integer setting if "1" is not available). As the breathing pattern runs, monitor the pressure inside the artificial nose using the breathing simulator's on-screen graphics. The onset of oxygen delivery from the OCD will be noticeable on the graph by a sharp increase in pressure within the nasal cavity. If the device is consistently delivering oxygen on each breath, lower the Amplitude parameter in intervals of 1.0 until the OCD no longer responds in a consistent, breath-to-breath manner to the breathing pattern. Increase the Amplitude by 1, ensure that the device again responds consistently, and record the pressure profile in the nasal cavity. If the device does not respond to the initial breathing pattern parameters, increase the Amplitude in intervals of 1.0 until the device responds in a consistent manner and record the pressure profile in the nasal cavity. Repeat this test procedure for all integer settings available on the unit (i.e. 1, 2, 3 …). Data collection for sensitivity is complete when all devices have been tested at each integer setting on this breathing pattern. Once all data files have been collected, open each file and note the pressure inside the nasal cavity immediately preceding the onset of flow from the device. Calculate the overall device sensitivity by averaging the recorded sensitivity values for all flow settings recorded. Note: For devices with multiple sensitivity settings, only the most sensitive setting was tested for this guide.

Calculated Savings Ratios (CSR)

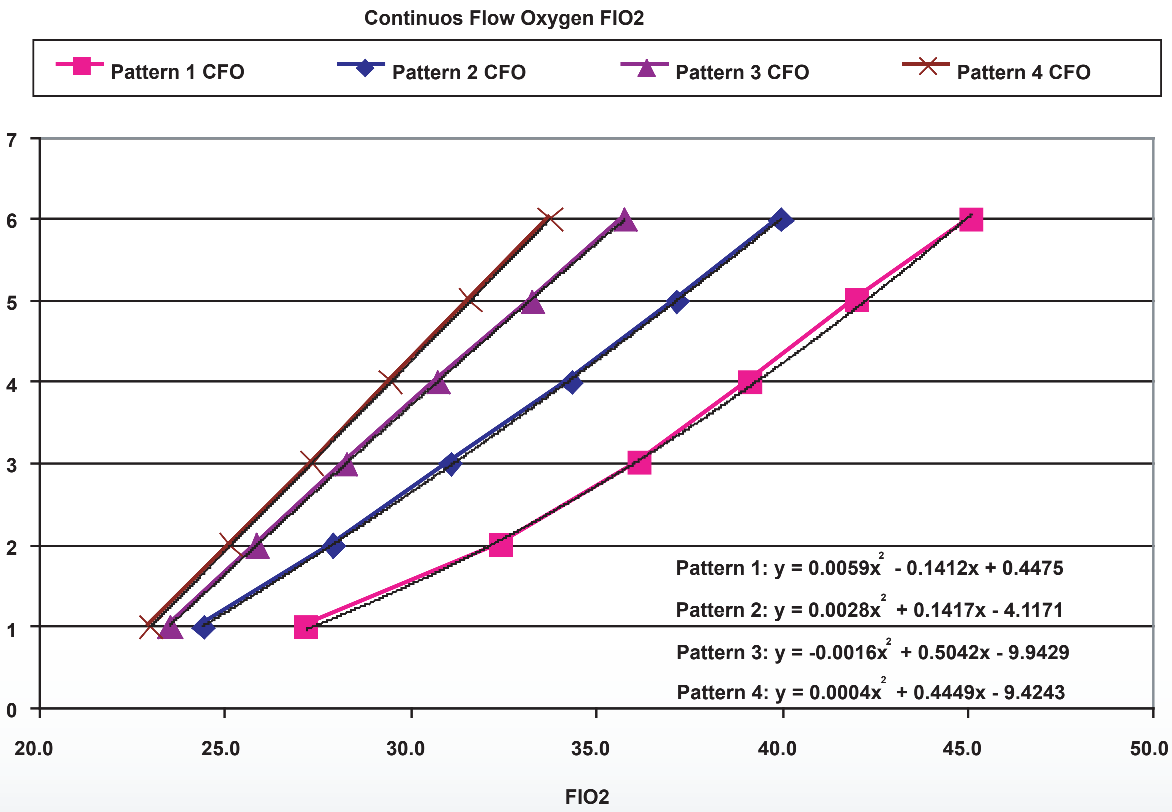
The purpose of determining an OCD's calculated savings ratio is to make a qualitative measure of relative efficiency, based on similar oxygenation to continuous flow. To determine the Calculated Savings Ratio for an OCD at a given setting and breath rate, take the Equivalent CFO value (EqCFO) at each setting and divide by the product of the total oxygen volume delivered at that setting (in liters) and the breath rate. Symbolically, this can be written as $CSR = EqCFO / (VO_2 \times BPM)$. In order to find the EqCFO values, first the FIO2 values resulting from continuous flow oxygen needed to be recorded for each of the four breathing patterns used for device testing. Using an oxygen cylinder equipped with an adjustable flow regulator, FIO2 values from continuous flow were recorded using the same method as outlined in the Test Procedure for FIO2 Output section, and by adjusting the flow rate from the regulator so that the flow was exactly the specified amount (1.0 LPM, 2.0 LPM, etc.).

FIO2 values resulting from continuous flow oxygen (CFO) from 1 LPM up to 6 LPM are noted in the table below:

FIO2

SETTING	Pattern 1	Pattern 2	Pattern 3	Pattern 4
1	27.2	24.4	23.5	23.0
2	32.4	27.9	25.9	25.2
3	36.2	31.1	28.3	27.4
4	39.2	34.3	30.7	29.5
5	42.0	37.2	33.3	31.6
6	45.1	40.0	35.8	33.8

From these values, the chart seen below was made, and best-fit lines were calculated.



With FIO2 values now recorded from continuous flow oxygen, the calculated savings ratio for a specific OCD can be determined. Using the FIO2 values from the OCD under test at each setting and breath rate, substitute the relevant values into the respective best fit line. The resultant number is an 'Equivalent to CFO' value (EqCFO).

Below is an example taken from the FIO2 values recorded from an example conserving device on Pattern 2, along with the resulting calculated equivalent to CFO.

Setting	% O2	Eq CFO
1	24.8	1.1
2	28.4	2.2
3	32.0	3.3

What this table illustrates is that this OCD, at a "1" setting and 20 BPM, is delivering its oxygen such that it is equivalent to receiving continuous flow therapy at 1.1 LPM.

To determine the Calculated Savings Ratio for this OCD at these settings and breath rate, take the Equivalent CFO value at each setting and divide by the product of the total oxygen volume delivered at that setting (in liters) and the breath rate using the equation CSR = EqCFO / (VO_2 x BPM).

Below is an example of the resulting CSR values from the same OCD on Pattern 2 (which used a parameter of 20BPM).

Setting	Eq CFO	Vo_2	CSR
1	1.1	16.4	3.4
2	2.2	31.9	3.4
3	3.3	47.3	3.5

At a setting of "1" and a breath rate of 20bpm, the total volume delivered by the device was 16.4mL, or .0164L. Thus, the CSR calculation is 1.1 / (.0164 x 20), which results in a CSR value of 3.4. CSR values for a given breath rate are calculated by averaging the per-setting CSR values at that breath rate. The overall CSR value can then be calculated by averaging the CSR values for each breath rate.

Clinical studies have documented higher savings ratios when comparing certain OCD devices to continuous flow. These patient studies involve multiple patient variables that may account for different savings ratios than what we calculated on the bench, yet these were comparatively small studies. For comparison purposes, these calculated savings ratios provide a reference for device operating times. In the real world, for a given oxygen patient on an OCD, it is important to remember that "mileage may vary".

We compared 29 devices featuring oxygen conserving technology, provided to us by manufacturers. A bench lung model was used to trigger the devices in simulated patient breathing conditions. See the Testing Methods & Material section for information on how data was collected.

Data collected from each device is reported in the following pages. Each device is presented here with a product photo, brief description, data summary, and two graphs. One graph shows the device's delivery profile for each integer setting at 20 BPM. The second graph details the recorded FIO2% at each tested setting and breath rate.

PRODUCT Comparisons

The following is a brief description of the different attributes we have noted for each device.

Manufacturer
The name of the OCD manufacturer.

Device Type
Pneumatic Conserving Regulator, Electronic Conserving Regulator, Liquid Portable, or Portable Oxygen Concentrator. Single or Dual Lumen Cannula. Demand/Hybrid, or Pulse Delivery.

Selectable Delivery Settings
Available device settings for intermittent flow oxygen delivery.

Selectable Continuous Flow Settings
Available device settings for continuous flow oxygen delivery.

Battery
Battery type and number of batteries required for use.

Weight
Weight of device. Weight with/without accessories included where applicable.

Dimensions
Device measurements.

Maximum Dose (mL)
Maximum dose volumes (in mL) at all tested breath rates.

Maximum Dose (mL) in 60% of Inspiratory Time
Maximum dose volumes (in mL) within the first 60% of patient inhalation at all tested breath rates.

Average mL per Setting
Average dose volume per setting at all tested breath rates as well as an overall average.

Maximum FIO2%
Maximum FIO2 percentage recorded at each tested breath rate.

Sensitivity
Negative pressure inside the nose required to trigger oxygen delivery at 20BPM.

Calculated Savings Ratio
CSR values at each breath rate as well as an overall average.

Product Index

At the end of this section are bar charts comparing specific performance characteristics as well as a table compiling specific data for all of the devices included in this guide.

Though CHAD Therapeutics initially provided devices for testing, at the company's request, products manufactured by CHAD are not included in this guide. CHAD has several conserving devices on the market, including the Cypress (pneumatic), Oxymatic 400 (electronic), and the recently released Lotus (electronic).

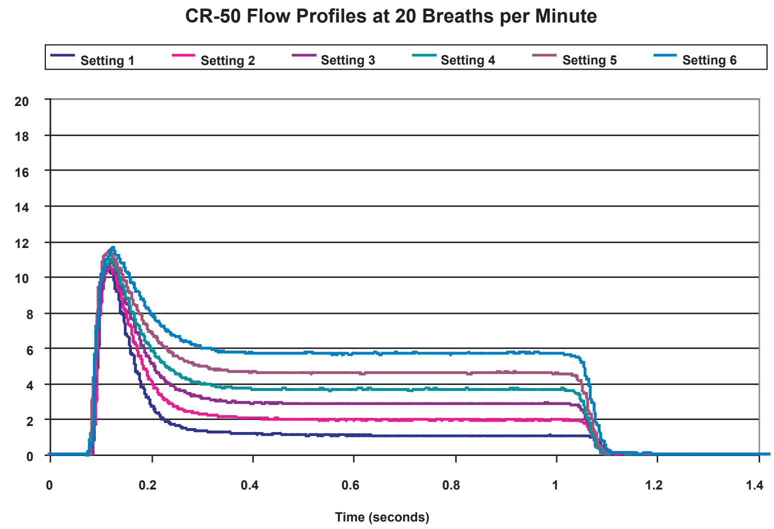
Also not included in this guide are the Flo-Rite pneumatic conservers from Pro-Basics by PMI. Both the single lumen and dual lumen version of these conservers employ a unique method of oxygen delivery, delivering a series of short pulses over the course of patient inspiration. While PMI courteously provided equipment, we do not feel that the data we recorded was an accurate representation of the device, as we were not able to achieve consistency in delivery volume and profiles. Device sensitivity was a primary issue, as both units had lower sensitivity values compared to most other OCDs in this guide.

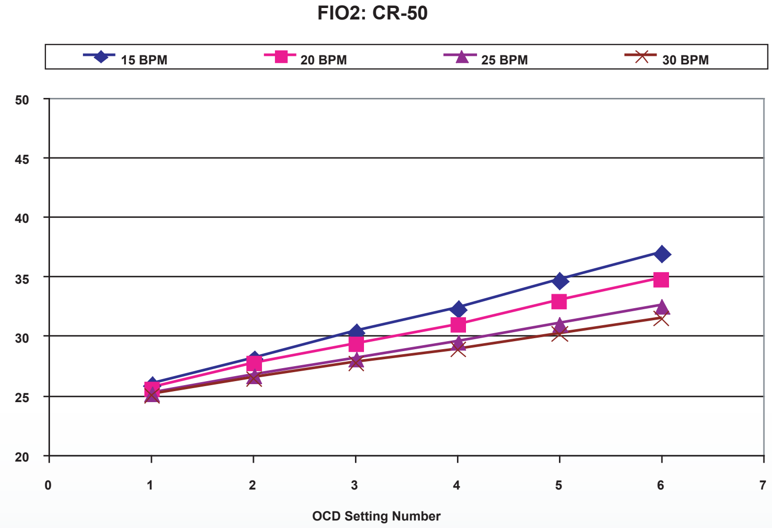
CR-50

Puritan Bennett's CR-50 is one of the oldest conserving devices still on the market today. A Demand/Hybrid delivery style conserver, it is one of the only devices where the tail flow rate during delivery closely matches the setting number on the dial, meaning that when the device is set at "4", it delivers approximately 4 LPM oxygen flow after the initial bolus delivery and through to patient exhalation. In the past, an accessory was sold that allowed the user to be able to switch to continuous flow at all settings available on the device; however, without the accessory, only continuous flow settings at 0.25, 0.5, and 0.75 LPM are available on the unit.

Testing Results	
Maximum Dose (mL):	105.8 at 15 BPM | 103.3 at 20 BPM 92.8 at 25 BPM | 82.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	79.3 at 15 BPM | 61.0 at 20 BPM 50.0 at 25 BPM | 42.9 at 30 BPM
Average mL per Setting:	20.7 at 15 BPM | 20.7 at 20 BPM 18.8 at 25 BPM | 16.9 at 30 BPM (19.3 Overall)
Maximum FIO2%:	37.0 at 15 BPM | 34.8 at 20 BPM 32.5 at 25 BPM | 31.5 at 30 BPM
Sensitivity:	0.17 cmH2O
Calculated Savings Ratio:	1.4 at 15 BPM | 2.1 at 20 BPM 2.8 at 25 BPM | 3.4 at 30 BPM (2.4 Overall)

Product Specifications	
Manufacturer:	Puritan Bennett
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	0.25, 0.5, 0.75 LPM
Battery:	N/A
Weight:	1lb. 2oz.
Dimensions:	5" x 4 1/4" x 3"

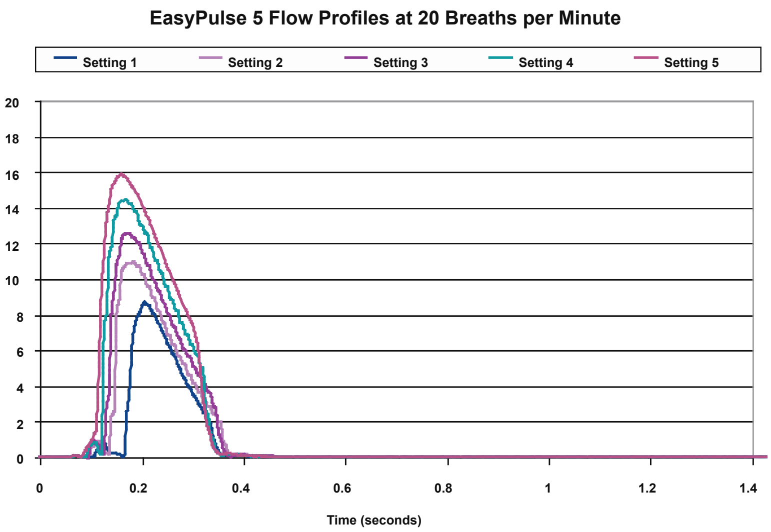


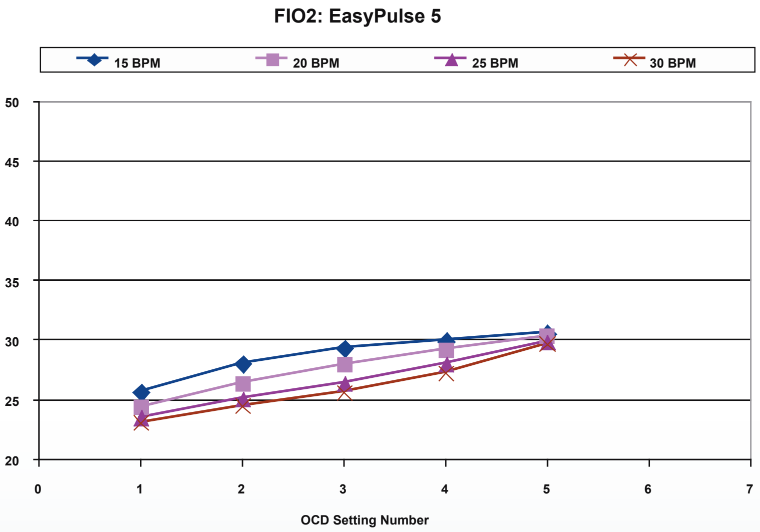


EasyPulse 5

The EasyPulse 5 is one of the smallest and lightest conserving devices on the market. While not one of the most sensitive devices in this guide, the EasyPulse 5 delivers its entire dose in approximately 0.4 seconds at all settings, meaning that the delivered oxygen has a better chance of reaching the alveoli and not remaining in dead space, even at higher breath rates.

The EasyPulse 5 is one of a few conserving devices that utilizes a minute volume delivery method, lowering the delivered dose volume at a given setting as the breath rate increases. Continuous flow delivery is limited to one setting—2 LPM—and is accessed by turning the selection knob past the maximum dose setting of 5.





Testing Results	
Maximum Dose (mL):	41.4 at 15 BPM | 41.6 at 20 BPM 40.7 at 25 BPM | 40.0 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	41.4 at 15 BPM | 41.6 at 20 BPM 40.7 at 25 BPM | 40.0 at 30 BPM
Average mL per Setting:	13.2 at 15 BPM | 11.2 at 20 BPM 9.6 at 25 BPM | 8.4 at 30 BPM (10.6 Overall)
Maximum FIO2%:	30.6 at 15 BPM | 30.3 at 20 BPM 29.8 at 25 BPM | 29.7 at 30 BPM
Sensitivity:	0.21 cmH2O
Calculated Savings Ratio:	1.8 at 15 BPM | 3.2 at 20 BPM 4.3 at 25 BPM | 5.0 at 30 BPM (3.6 Overall)

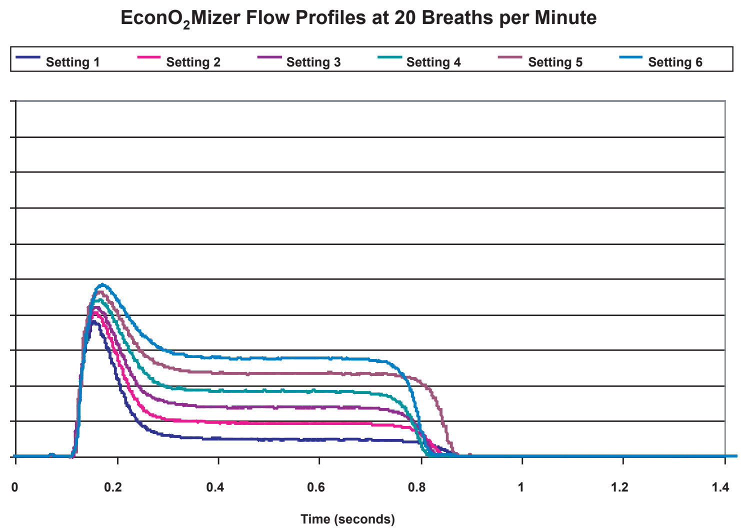
Product Specifications	
Manufacturer:	Precision Medical
Device Type:	Pneumatic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5
Selectable Continuous Flow Settings:	2 LPM
Battery:	N/A
Weight:	10oz.
Dimensions:	5 1/8" x 2 1/2" x 2 5/8"

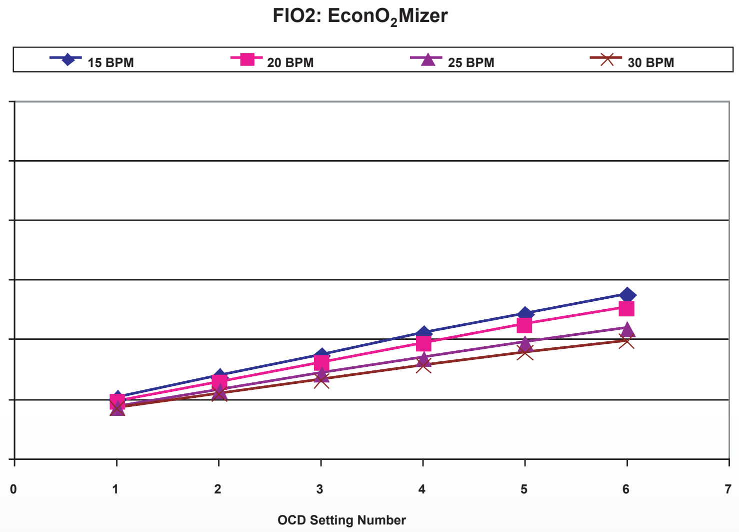
EconO2Mizer

Medline's EconO2Mizer pneumatic conserving device features 11 selectable delivery settings in both intermittent and continuous flow delivery methods. Switching between continuous and intermittent flow delivery is accomplished by turning a dial on the top face of the device—care should always be taken to ensure that the patient is using the right mode of delivery. The EconO2Mizer device is one of the least sensitive devices in this guide. Patients with shallow breathing patterns may have difficulty triggering flow when using the device.

Testing Results	
Maximum Dose (mL):	56.4 at 15 BPM | 67.4 at 20 BPM 77.0 at 25 BPM | 68.8 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	56.4 at 15 BPM | 52.9 at 20 BPM 43.0 at 25 BPM | 36.0 at 30 BPM
Average mL per Setting:	11.9 at 15 BPM | 13.9 at 20 BPM 15.1 at 25 BPM | 13.8 at 30 BPM (13.7 Overall)
Maximum FIO2%:	33.8 at 15 BPM | 32.6 at 20 BPM 31.0 at 25 BPM | 29.9 at 30 BPM
Sensitivity:	0.44 cmH2O
Calculated Savings Ratio:	1.9 at 15 BPM | 2.6 at 20 BPM 2.9 at 25 BPM | 3.4 at 30 BPM (2.7 Overall)

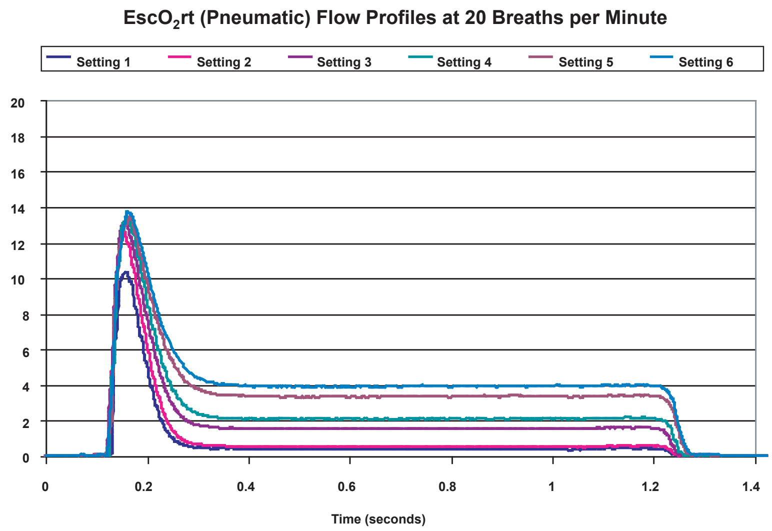
Product Specifications	
Manufacturer:	Medline
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1—6 in 0.5 increments
Selectable Continuous Flow Settings:	1—6 LPM in 0.5 LPM increments
Battery:	N/A
Weight:	14oz.
Dimensions:	6" x 2 1/2" x 2 3/4"

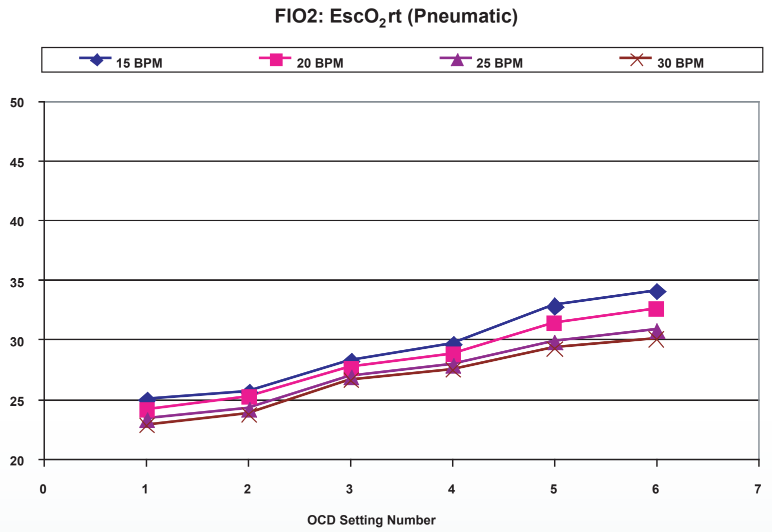




EscO2rt

TRG's EscO2rt (Pneumatic Conserver) is a dual lumen pneumatic conserver that features user selectable settings for both intermittent and continuous flow delivery. However, a patient or seller of the device should note that there are two numbers in the setting window, and that the smaller sized number is the continuous flow setting while the larger number is the "pulse" setting (while the unit delivers a pulse volume at the start of delivery, it is a hybrid style device, and so does not turn off until the patient exhales). The EscO2rt name is used by TRG for their two liquid portables as well, so care should be taken when describing the device to avoid confusion.





Testing Results	
Maximum Dose (mL):	87.3 at 15 BPM | 87.2 at 20 BPM 77.8 at 25 BPM | 71.4 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	59.0 at 15 BPM | 46.6 at 20 BPM 39.0 at 25 BPM | 33.6 at 30 BPM
Average mL per Setting:	15.4 at 15 BPM | 14.6 at 20 BPM 12.9 at 25 BPM | 11.6 at 30 BPM (13.6 Overall)
Maximum FIO2%:	34.1 at 15 BPM | 32.6 at 20 BPM 30.9 at 25 BPM | 30.1 at 30 BPM
Sensitivity:	0.18 cmH2O
Calculated Savings Ratio:	1.3 at 15 BPM | 2.3 at 20 BPM 3.0 at 25 BPM | 3.5 at 30 BPM (2.5 Overall)

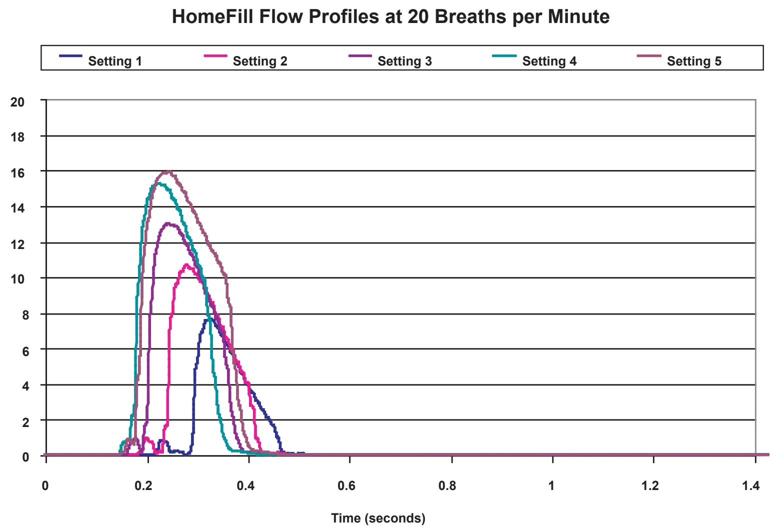
Product Specifications	
Manufacturer:	The Respiratory Group
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	0.25, 0.4, 0.5, 0.6, 0.75, 1, 2, 2.5, 4, 4.5 LPM
Battery:	N/A
Weight:	15oz.
Dimensions:	7 1/2" x 2 1/2" x 2 3/4"

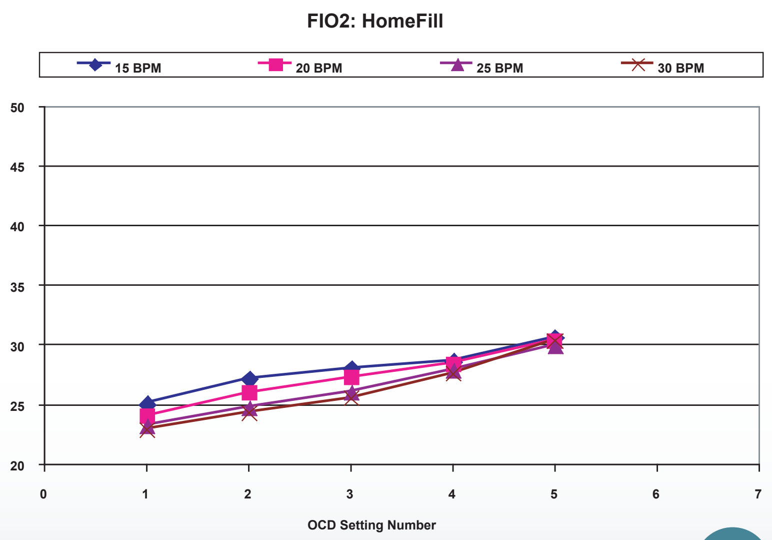
HomeFill

Invacare's' HomeFill is currently a unique product available to oxygen patients. Patients using the HomeFill device fill a small, portable cylinder equipped with a conserving device (manufactured by Precision Medical with similar characteristics to that of the EasyPulse 5) in their home with one of Invacare's stationary oxygen concentrators. Since the cylinder is filled using oxygen from a concentrator, note that the delivered dose volume is not 100% oxygen. The HomeFill device had the lowest sensitivity of all devices we tested, though sensitivity tended to increase with an increase in setting (This is notable in the 20BPM graph below—as the setting increased, the time to respond to inspiration can be seen to decrease). As with the other Precision Medical products tested in this guide, the dose volume on a given setting decreased with an increase in breath rate.

Testing Results	
Maximum Dose (mL):	41.9 at 15 BPM | 42.6 at 20 BPM 42.4 at 25 BPM | 42.6 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	41.9 at 15 BPM | 42.6 at 20 BPM 42.4 at 25 BPM | 42.6 at 30 BPM
Average mL per Setting:	12.0 at 15 BPM | 10.4 at 20 BPM 9.1 at 25 BPM | 8.1 at 30 BPM (9.9 Overall)
Maximum FIO2%:	30.6 at 15 BPM | 30.4 at 20 BPM 30.0 at 25 BPM | 30.4 at 30 BPM
Sensitivity:	0.50 cmH2O
Calculated Savings Ratio:	1.7 at 15 BPM | 3.2 at 20 BPM 4.2 at 25 BPM | 5.2 at 30 BPM (3.6 Overall)

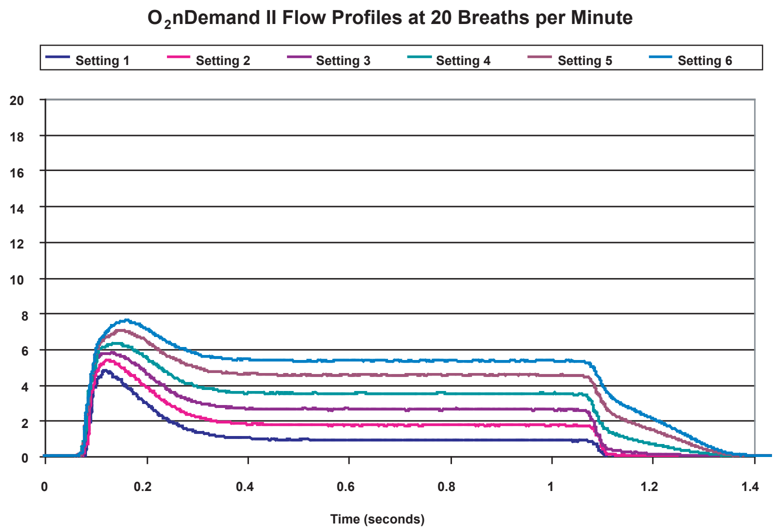
Product Specifications	
Manufacturer:	Invacare / Precision Medical
Device Type:	Cylinder with built-on Pneumatic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5
Selectable Continuous Flow Settings:	2 LPM
Battery:	N/A
Weight:	Dependent on cylinder size in use; ML6 = 4lb. 4oz. full
Dimensions:	Dependent on cylinder size in use; ML6 = 4 1/4" diam. x 11 1/4"

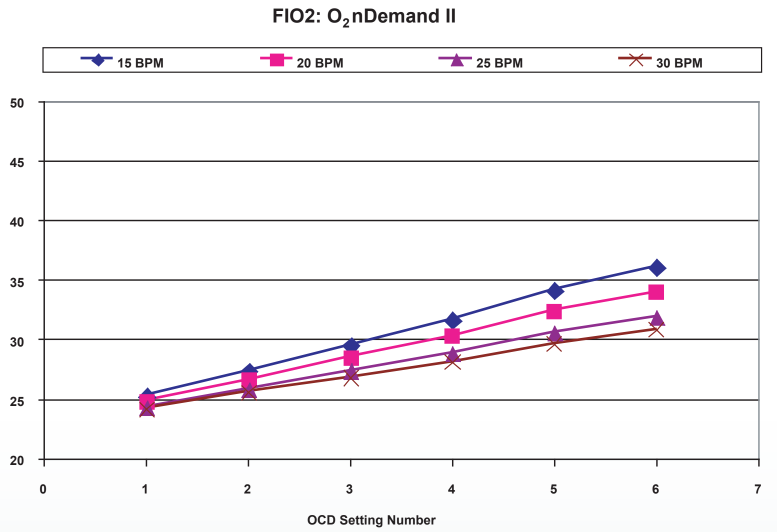




O2nDemand

Victor Medical's O2nDemand II is one of the few conservers that feature both intermittent and continuous flow options for all available settings on the device—a simple dial on the top of the unit makes it easy to switch from continuous flow delivery to intermittent delivery and back when needed. This pneumatic device features settings ranging from 1—6 in 0.5 increments, selectable by a dial on the front of the unit that it able to be fully turned continuously in both directions, another feature unique to only a few devices. Delivery volumes at all settings tend to be higher compared to most other devices, however with the demand style nature of delivery, not all of these delivered volumes are reaching the lungs.





Testing Results	
Maximum Dose (mL):	117.7 at 15 BPM | 102.9 at 20 BPM 89.0 at 25 BPM | 81.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	70.7 at 15 BPM | 53.3 at 20 BPM 43.0 at 25 BPM | 36.0 at 30 BPM
Average mL per Setting:	20.4 at 15 BPM | 18.5 at 20 BPM 16.3 at 25 BPM | 14.8 at 30 BPM (17.5 Overall)
Maximum FIO2%:	36.1 at 15 BPM | 34.0 at 20 BPM 31.9 at 25 BPM | 30.9 at 30 BPM
Sensitivity:	0.12 cmH2O
Calculated Savings Ratio:	1.2 at 15 BPM | 2.1 at 20 BPM 2.9 at 25 BPM | 3.4 at 30 BPM (2.4 Overall)

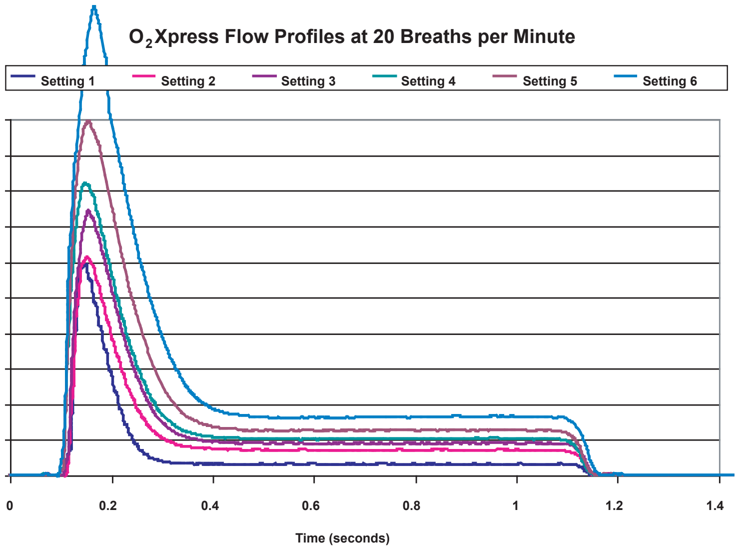
Product Specifications	
Manufacturer:	Victor Medical
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand / Hybrid Delivery
Selectable Delivery Settings:	1—6 in 0.5 increments
Selectable Continuous Flow Settings:	1—6 LPM in 0.5 LPM increments
Battery:	N/A
Weight:	1lb. 6oz.
Dimensions:	6 1/4" x 3" x 3"

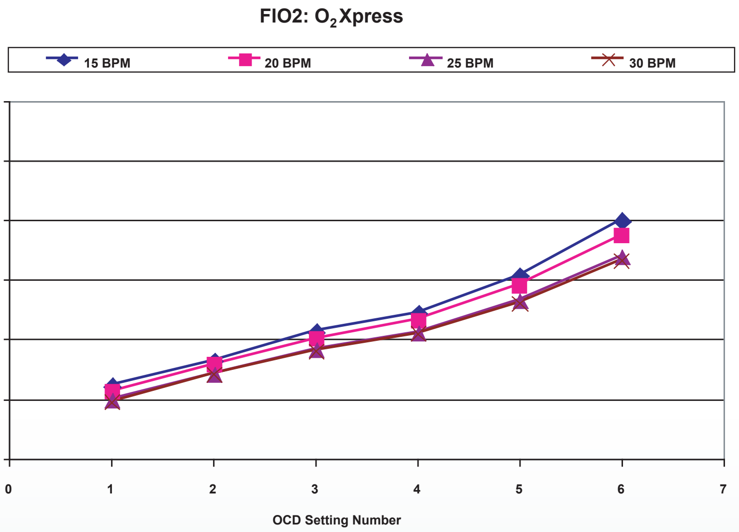
O2Xpress

Salter Labs' O2Xpress is notable for being one of only a few pneumatic devices that increases its bolus size with an increase in setting. Also notable is the flow rates at which the bolus' are delivered- at the "6" setting the flow rate from the device exceeded the 20 LPM limit of the flowmeter used for recording oxygen delivery. Peak flow rates at lower settings were also higher than that on comparable devices. This combination of delivery characteristics gives the O2Xpress some of the largest delivery volumes in this guide. With the delivery flow rate exceeding 20LPM at a "6" setting, some patients might find this type of oxygen delivery uncomfortable. Note that there is no continuous flow option available with this unit.

Testing Results	
Maximum Dose (mL):	111.2 at 15 BPM | 101.8 at 20 BPM 91.7 at 25 BPM | 83.7 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	85.0 at 15 BPM | 74.1 at 20 BPM 67.9 at 25 BPM | 62.6 at 30 BPM
Average mL per Setting:	19.8 at 15 BPM | 18.4 at 20 BPM 16.1 at 25 BPM | 14.5 at 30 BPM (17.2 Overall)
Maximum FIO2%:	40.0 at 15 BPM | 38.8 at 20 BPM 37.0 at 25 BPM | 36.6 at 30 BPM
Sensitivity:	0.13 cmH2O
Calculated Savings Ratio:	1.6 at 15 BPM | 2.6 at 20 BPM 3.7 at 25 BPM | 4.6 at 30 BPM (3.1 Overall)

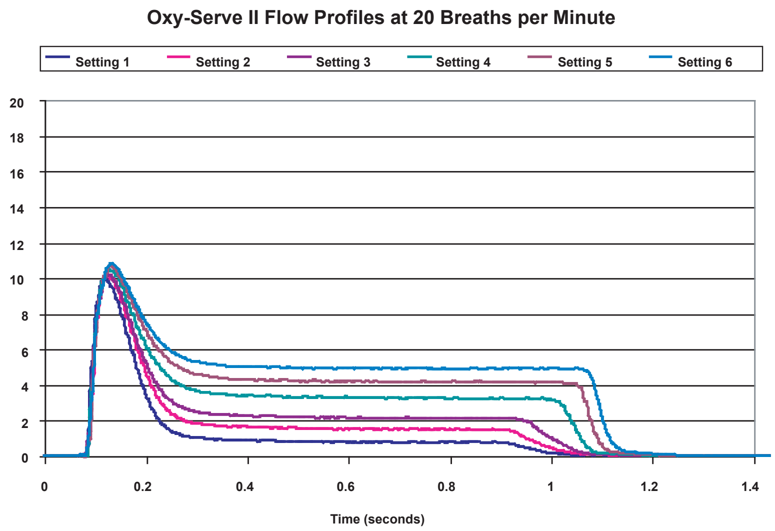
Product Specifications	
Manufacturer:	Salter Labs
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	None
Battery:	N/A
Weight:	1lb. 1oz.
Dimensions:	5 1/2" x 3 1/2" x 3"

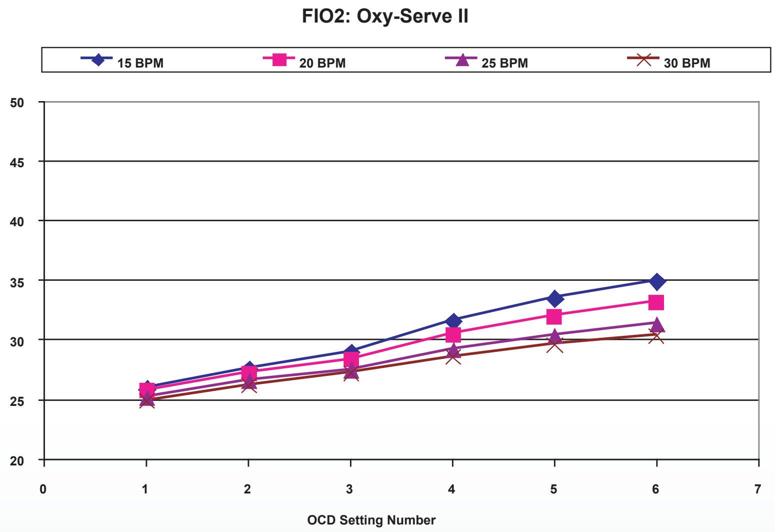




Oxy-Serv II

Developed by TAGA Medical, the Oxy-Serve II from Superior Products is a uniquely designed dual lumen pneumatic conserver. A switch on the front allows the user to switch from an intermittent flow conserving mode to a continuous flow mode, though this switch may be difficult for some patients to move. Conserving mode and continuous mode settings are labeled on the same dial—users should be aware that numbers without circles are intermittent flow settings while numbers inside of a circle are the continuous flow settings.





Testing Results	
Maximum Dose (mL):	100.3 at 15 BPM | 93.2 at 20 BPM 81.7 at 25 BPM | 72.9 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	70.2 at 15 BPM | 54.4 at 20 BPM 45.0 at 25 BPM | 38.5 at 30 BPM
Average mL per Setting:	17.6 at 15 BPM | 17.8 at 20 BPM 16.5 at 25 BPM | 15.0 at 30 BPM (16.7 Overall)
Maximum FIO2%:	35.0 at 15 BPM | 33.2 at 20 BPM 31.3 at 25 BPM | 30.4 at 30 BPM
Sensitivity:	0.22 cmH2O
Calculated Savings Ratio:	1.4 at 15 BPM | 2.3 at 20 BPM 3.0 at 25 BPM | 3.6 at 30 BPM (2.6 Overall)

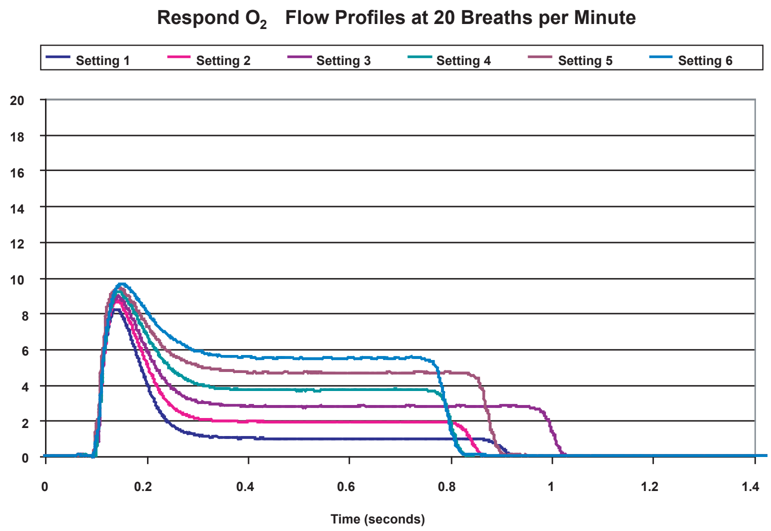
Product Specifications	
Manufacturer:	Superior Products
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1—6 in 0.5 increments
Selectable Continuous Flow Settings:	1—5 LPM, in 1.0 LPM increments
Battery:	N/A
Weight:	14oz.
Dimensions:	4 1/2" x 4" x 3"

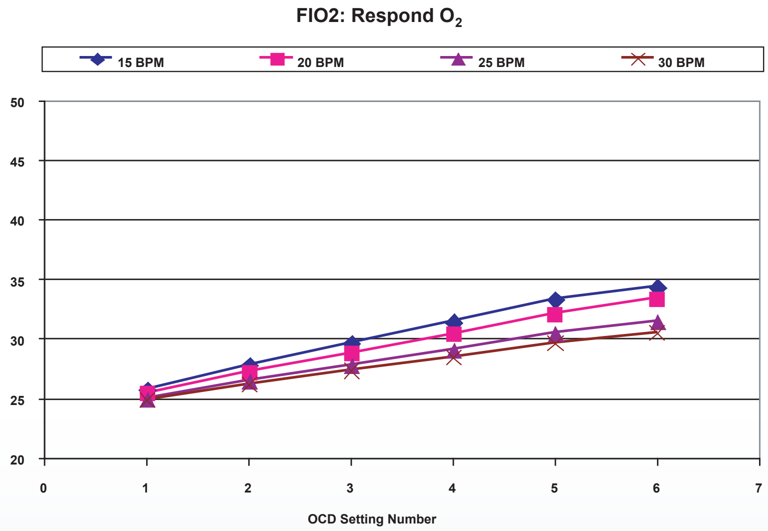
Respond O2

The Respond O2 conserver from Responsive Respiratory is a dual lumen pneumatic conserver that features both continuous and intermittent flow delivery options at all available settings on the device. A small dial on the top of the unit is used to switch between continuous and conserving modes. The Respond O2 was one of the least sensitive devices tested for this guide. The inconsistencies in shut off times as seen in the flow profile graph below are an illustration of this sensitivity issue.

Testing Results	
Maximum Dose (mL):	61.3 at 15 BPM | 70.7 at 20 BPM 79.5 at 25 BPM | 70.0 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	61.3 at 15 BPM | 54.8 at 20 BPM 44.9 at 25 BPM | 38.1 at 30 BPM
Average mL per Setting:	14.0 at 15 BPM | 16.0 at 20 BPM 16.3 at 25 BPM | 14.8 at 30 BPM (15.3 Overall)
Maximum FIO2%:	34.4 at 15 BPM | 33.4 at 20 BPM 31.5 at 25 BPM | 30.5 at 30 BPM
Sensitivity:	0.41 cmH2O
Calculated Savings Ratio:	1.8 at 15 BPM | 2.6 at 20 BPM 3.1 at 25 BPM | 3.7 at 30 BPM (2.8 Overall)

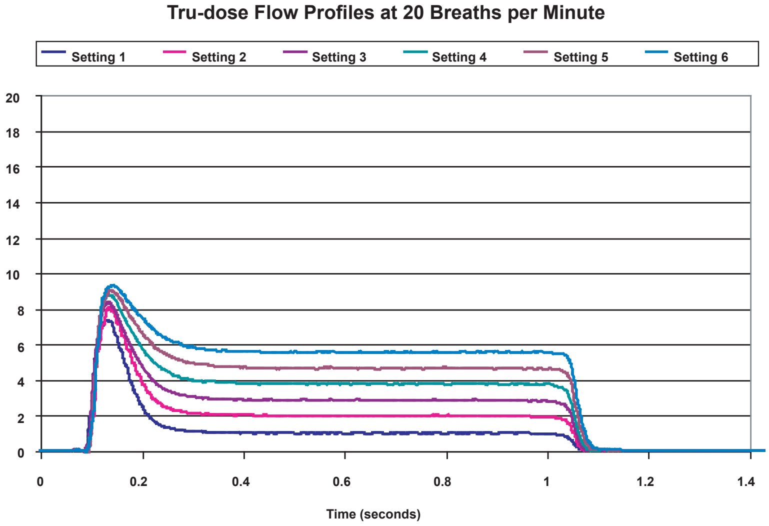
Product Specifications	
Manufacturer:	Responsive Respiratory
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1—6 in 0.5 increments
Selectable Continuous Flow Settings:	1—6 LPM in 0.5 LPM increments
Battery:	N/A
Weight:	14oz.
Dimensions:	6 1/4" x 2 1/2" x 2 3/4"

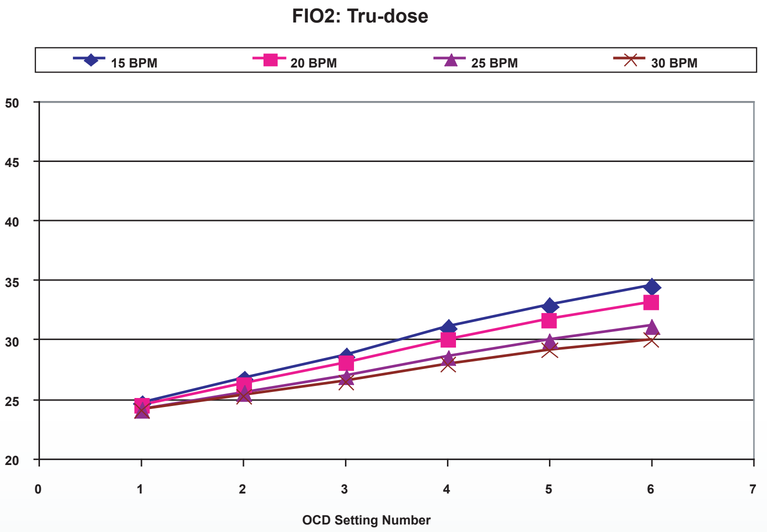




Tru-Dose

Western Medica's Tru-dose conserver is another dual lumen, pneumatic conserver featuring both continuous and intermittent flow capabilities at all numerical settings on the dial. Turning a circular knob on the top part of the device will switch between conserving and continuous modes of oxygen delivery. Bolus size at each setting tended to be lower than in comparable devices, with peak flows between 7 and 9 LPM, though this style of delivery may be more comfortable for a patient who experiences discomfort from devices that deliver their bolus volumes at much higher flow rates.





Testing Results	
Maximum Dose (mL):	86.0 at 15 BPM | 94.7 at 20 BPM 82.3 at 25 BPM | 73.3 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	71.3 at 15 BPM | 54.7 at 20 BPM 43.9 at 25 BPM | 37.1 at 30 BPM
Average mL per Setting:	16.8 at 15 BPM | 18.4 at 20 BPM 16.4 at 25 BPM | 14.8 at 30 BPM (16.6 Overall)
Maximum FIO2%:	34.5 at 15 BPM | 33.1 at 20 BPM 31.2 at 25 BPM | 30.0 at 30 BPM
Sensitivity:	0.21 cmH2O
Calculated Savings Ratio:	1.3 at 15 BPM | 2.0 at 20 BPM 2.7 at 25 BPM | 3.2 at 30 BPM (2.3 Overall)

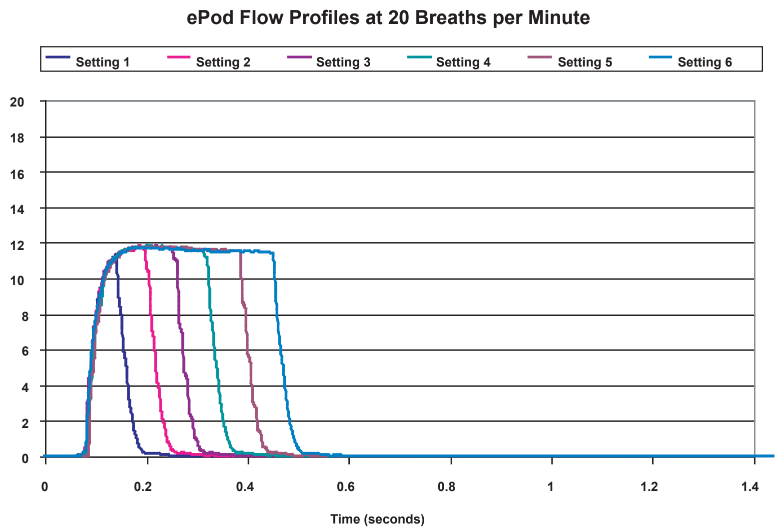
Product Specifications	
Manufacturer:	Western Medica
Device Type:	Pneumatic Conserving Regulator, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1—6, in increments of 0.5
Selectable Continuous Flow Settings:	1—6 LPM, in 0.5 LPM increments
Battery:	N/A
Weight:	1lb.
Dimensions:	2 1/4" x 6" x 3"

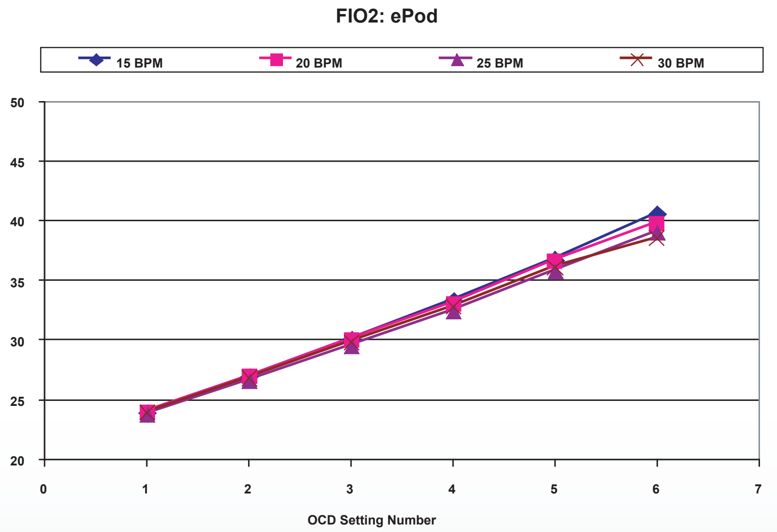
ePod

Respironics' ePod is one of the newer conserving devices to hit the market. Due to the need for 4 AA-size batteries to be used to operate, the ePod is one of the bulkier conserving devices, weighing in at approximately 1.25 lbs with batteries. Colored LED lights inform the user of battery status. The device delivers setting specified fixed-volume pulses regardless of the patient's breath rate. Pulse settings from 1 to 6 are chosen by turning the settings dial to the right from the 'Off' position, while continuous flow settings up to 4 LPM are selected by turning the dial left from the 'Off' position.

Testing Results	
Maximum Dose (mL):	71.9 at 15 BPM | 72.0 at 20 BPM 71.5 at 25 BPM | 71.8 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	71.9 at 15 BPM | 72.0 at 20 BPM 71.4 at 25 BPM | 65.6 at 30 BPM
Average mL per Setting:	11.8 at 15 BPM | 11.8 at 20 BPM 11.7 at 25 BPM | 11.7 at 30 BPM (11.8 Overall)
Maximum FIO2%:	40.6 at 15 BPM | 39.8 at 20 BPM 39.0 at 25 BPM | 38.5 at 30 BPM
Sensitivity:	0.17 cmH2O
Calculated Savings Ratio:	2.3 at 15 BPM | 3.9 at 20 BPM 5.0 at 25 BPM | 6.0 at 30 BPM (4.3 Overall)

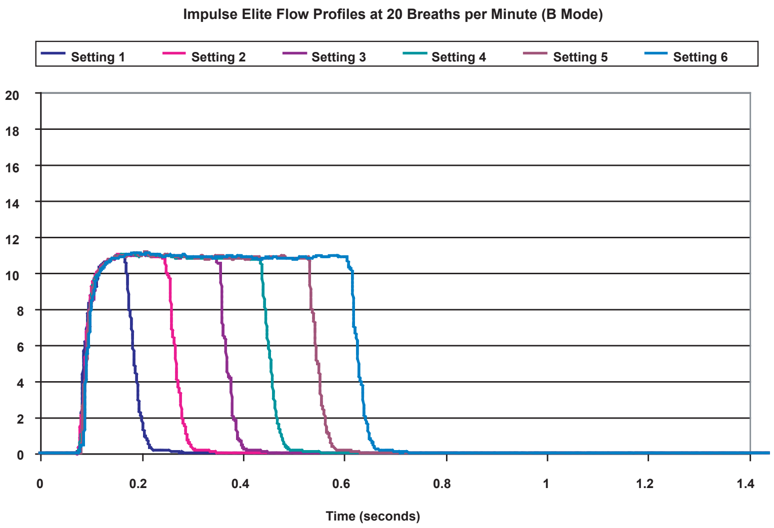
Product Specifications	
Manufacturer:	Respironics
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5, 6
Selectable Continuous Flow Settings:	0.5, 1, 2, 3, 4 LPM
Battery:	4 AA-size
Weight:	1lb. 6oz. with batteries
Dimensions:	6 3/4" x 4" x 2 3/4"

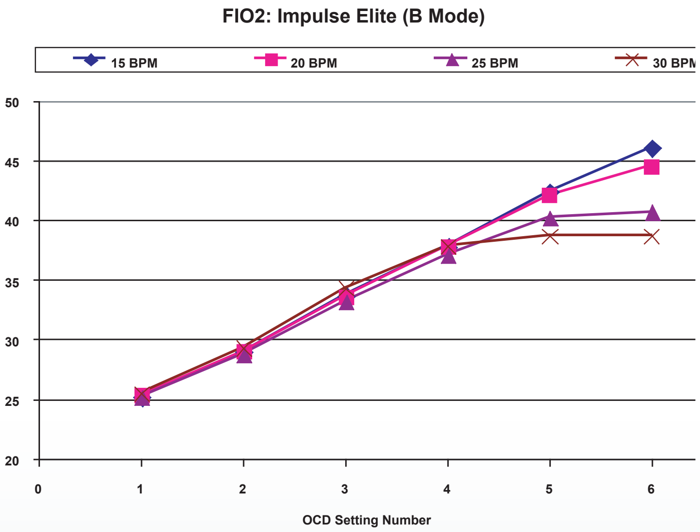




Impulse Elite

AirSep's Impulse Elite is another unique conserving device in that there are two modes of delivery that can be selected by the clinician and/or patient. In the devices "A" mode, the delivery volume at a given setting is approximately half of the volume delivered in the "B" mode. Device sensitivity is equivalent in both Mode settings. The Impulse Elite is one of the bulkier conservers, requiring a D size battery and weighing 1lb 8oz with the battery installed. There is a switch for backup 2 LPM continuous flow. The charts here display performance characteristics of the device in "B" mode.





Testing Results	
Maximum Dose (mL):	50.4A/97.2B at 15 | 50.6A/97.2B at 20 BPM 50.5A/97.6B at 25 | 50.5A/97.5B at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	50.4A/97.2B at 15 | 50.6A/96.0B at 20 BPM 50.5A/75.0B at 25 | 50.5A/60.9B at 30 BPM
Average mL per Setting:	8.6A/16.6B at 15 | 8.6A/16.6B at 20 BPM 8.6A/16.6B at 25 | 8.6A/16.7B at 30 BPM (8.6A/16.6B Overall)
Maximum FIO2%:	34.3A/46.1B at 15 | 34.3A/44.5B at 20 BPM 33.9A/40.7B at 25 | 34.6A/38.7B at 30 BPM
Sensitivity:	0.10 cmH2O in both A/B Mode
Calculated Savings Ratio:	2.0A/2.5B at 15 | 3.8A/3.9B at 20 BPM 5.1A/4.8B at 25 | 6.3A/5.6B at 30 BPM (4.3A/4.2B Overall)

Product Specifications	
Manufacturer:	AirSep
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	1 D-size
Weight:	1lb. 8oz. with battery
Dimensions:	4 1/4" x 5 1/2" x 3"

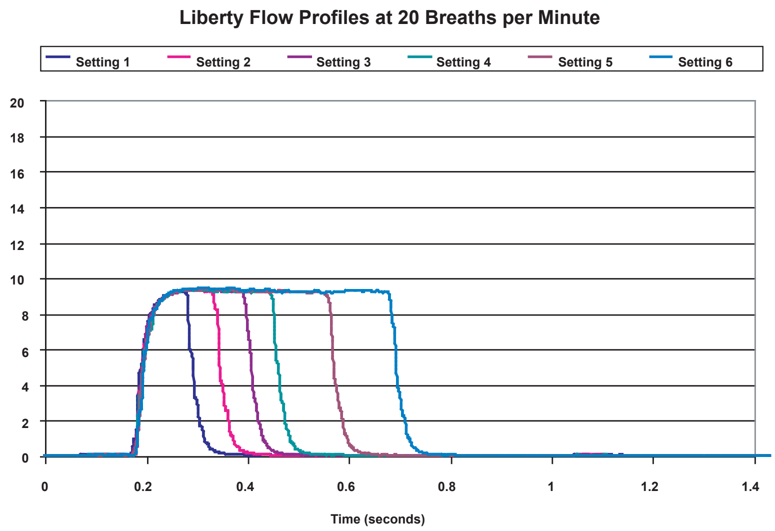
Liberty

Allied Healthcare's Liberty Conserver features 6 selectable pulse delivery settings and a continuous flow backup of ~2 LPM, though this value can be adjusted up to 6 LPM with an allen wrench provided with the device. The device uses a single "C" size battery for operation.

LED's on the face of the device alert the user to when battery replacement is needed. Some patients may have trouble gripping the small switch used to change the delivery setting.

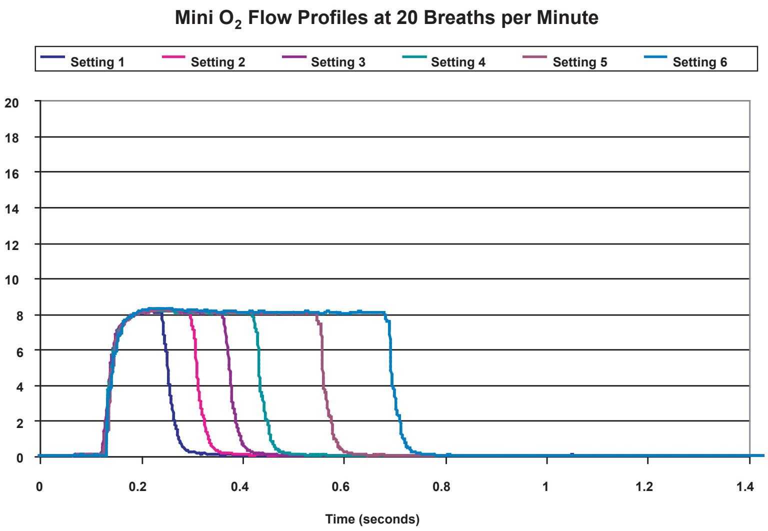
Testing Results	
Maximum Dose (mL):	76.7 at 15 BPM | 78.0 at 20 BPM 78.9 at 25 BPM | 79.4 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	76.7 at 15 BPM | 67.8 at 20 BPM 53.7 at 25 BPM | 43.5 at 30 BPM
Average mL per Setting:	12.1 at 15 BPM | 12.5 at 20 BPM 12.7 at 25 BPM | 12.8 at 30 BPM (12.5 Overall)
Maximum FIO2%:	36.3 at 15 BPM | 34.4 at 20 BPM 32.4 at 25 BPM | 30.9 at 30 BPM
Sensitivity:	0.23 cmH2O
Calculated Savings Ratio:	1.8 at 15 BPM | 2.9 at 20 BPM 3.6 at 25 BPM | 4.1 at 30 BPM (3.1 Overall)

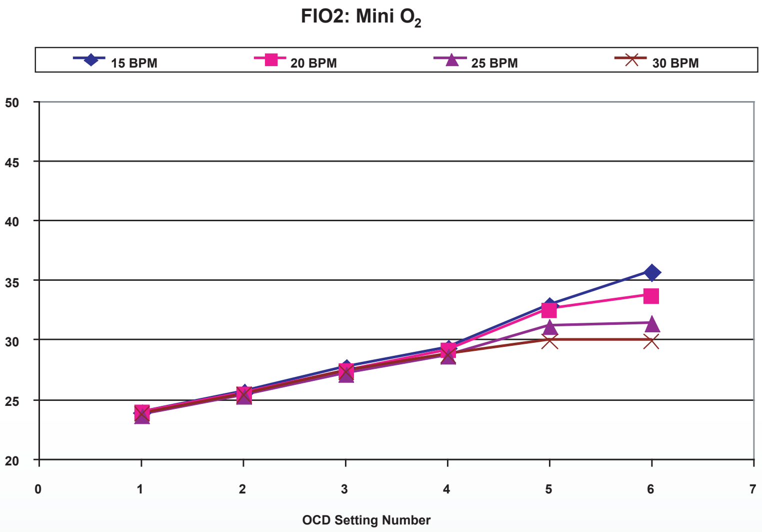
Product Specifications	
Manufacturer:	Allied Healthcare
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM adjustable
Battery:	1 C-size
Weight:	1lb. 2oz. with batteries
Dimensions:	5 3/4" x 3 1/4" x 2 1/2"



MiniO2

Medline's Mini O2 is similar in performance to that of Allied's Liberty device in both device operation and dose volumes, though the methods of delivery are slightly different, with the Mini O2 delivering its dose over a slightly longer period and at a reduced peak flow rate. The Mini O2 uses one AA size battery for operation. A moveable switch selects delivery settings, and another switch on the underside of the unit can change to ~2 LPM continuous flow.





Testing Results	
Maximum Dose (mL):	74.9 at 15 BPM | 75.8 at 20 BPM 76.1 at 25 BPM | 76.7 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	74.8 at 15 BPM| 65.6 at 20 BPM 52.3 at 25 BPM | 42.2 at 30 BPM
Average mL per Setting:	12.0 at 15 BPM | 12.1 at 20 BPM 12.3 at 25 BPM | 12.3 at 30 BPM (12.2 Overall)
Maximum FIO2%:	35.7 at 15 BPM | 33.7 at 20 BPM 31.4 at 25 BPM | 29.9 at 30 BPM
Sensitivity:	0.23 cmH2O
Calculated Savings Ratio:	1.6 at 15 BPM | 2.8 at 20 BPM 3.5 at 25 BPM | 4.0 at 30 BPM (3.0 Overall)

Product Specifications	
Manufacturer:	Medline
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	1 AA-size
Weight:	15oz. with battery
Dimensions:	4 3/4" x 3 1/2" x 2 1/2"

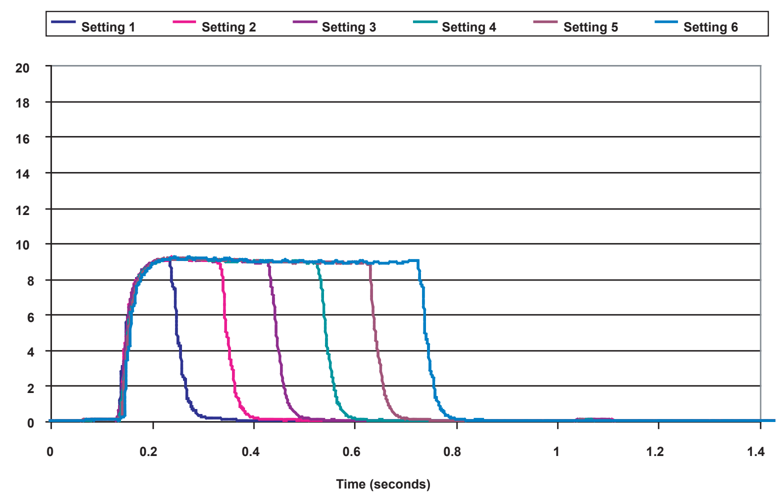
PD1000

The PD1000 is one of two electronic "PulseDose" conservers from Sunrise Medical and requires 2 AA size batteries for operation. There is a 2 LPM continuous flow setting, and batteries are not required for the unit to operate in this mode. However, should the batteries lose their charge during use, the user will need to manually switch to the continuous flow setting. Average dose volumes are higher than many comparable devices; however the on-time at higher settings is longer than some devices as well, so at high breath rates, not all of the dose will reach the lungs. Sensitivity on the PD1000 was the lowest of the electronic devices.

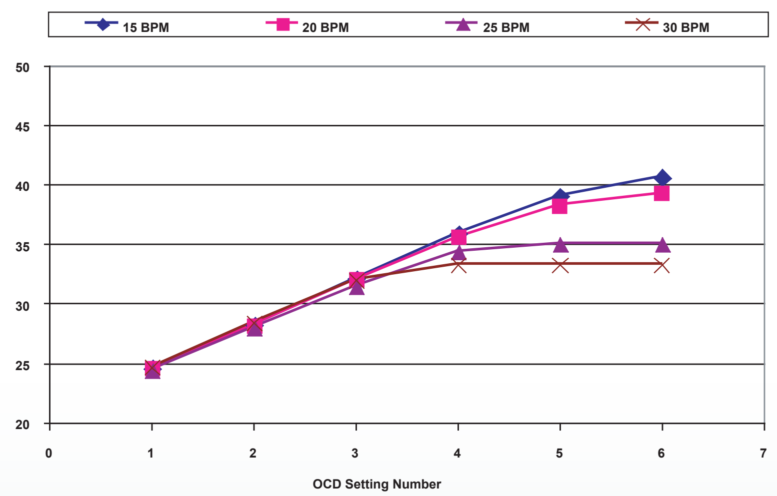
Testing Results	
Maximum Dose (mL):	88.1 at 15 BPM | 88.3 at 20 BPM 88.4 at 25 BPM | 88.8 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	88.0 at 15 BPM | 70.3 at 20 BPM 55.6 at 25 BPM | 46.0 at 30 BPM
Average mL per Setting:	14.7 at 15 BPM | 14.9 at 20 BPM 15.0 at 25 BPM | 15.1 at 30 BPM (14.9 Overall)
Maximum FIO2%:	40.7 at 15 BPM | 39.3 at 20 BPM 35.0 at 25 BPM | 33.3 at 30 BPM
Sensitivity:	0.25 cmH2O
Calculated Savings Ratio:	2.3 at 15 BPM | 3.6 at 20 BPM 4.3 at 25 BPM | 4.9 at 30 BPM (3.8 Overall)

Product Specifications	
Manufacturer:	Sunrise Medical
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	2 AA-size
Weight:	1lb. with batteries
Dimensions:	6" x 3 3/4" x 2 3/4"

PD1000 Flow Profiles at 20 Breaths per Minute

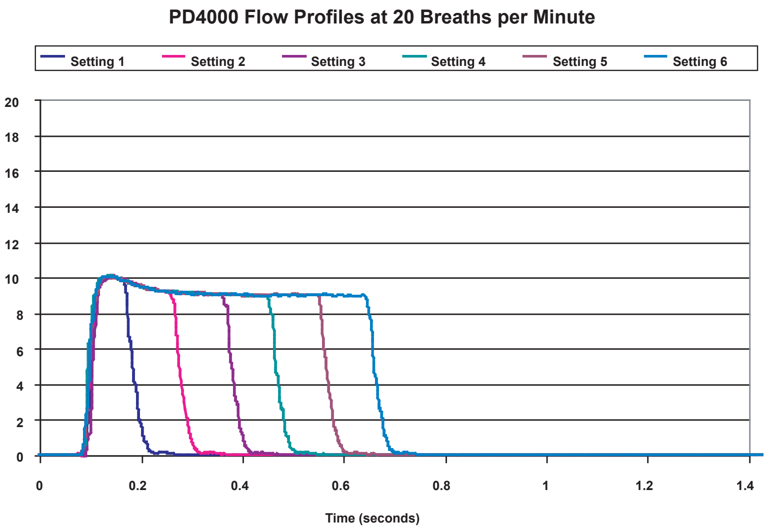


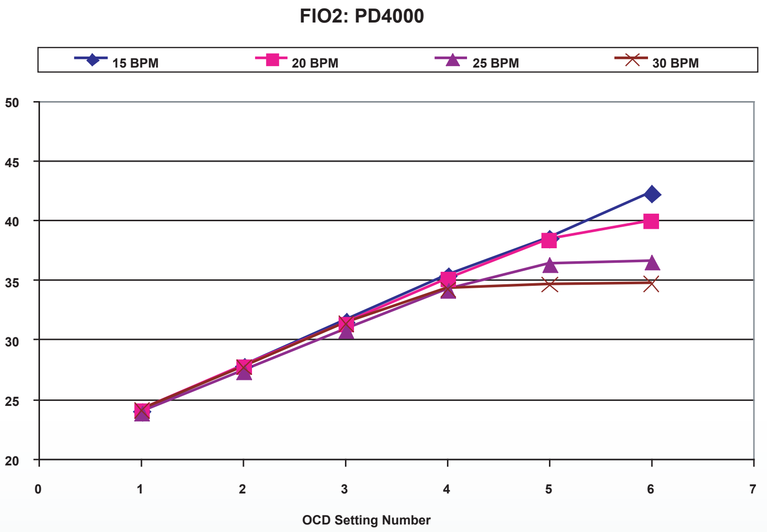
FIO2: PD1000



PD4000

Sunrise Medical's PD4000 is a "donut" style electronic conserver that has similar oxygen delivery characteristics to the PD1000 with a few extra features. A rotary dial is used to select the delivery settings, with the continuous flow option the last available setting on the dial. When the PD4000 is set to the continuous flow setting, the actual flow rate at which continuous flow therapy is provided can be manually adjusted by using a flathead screwdriver to turn a screw on the underside of the unit. The unit also features an alarm that activates when the tank pressure is low and when a breath is not detected for more than 30 seconds.





Testing Results	
Maximum Dose (mL):	87.3 at 15 BPM | 87.3 at 20 BPM 87.2 at 25 BPM | 87.4 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	87.3 at 15 BPM | 81.6 at 20 BPM 64.2 at 25 BPM | 52.3 at 30 BPM
Average mL per Setting:	14.5 at 15 BPM | 14.4 at 20 BPM 14.4 at 25 BPM | 14.4 at 30 BPM (14.4 Overall)
Maximum FIO2%:	42.3 at 15 BPM | 39.9 at 20 BPM 36.6 at 25 BPM | 34.7 at 30 BPM
Sensitivity:	0.14 cmH2O
Calculated Savings Ratio:	2.2 at 15 BPM | 3.5 at 20 BPM 4.3 at 25 BPM | 5.0 at 30 BPM (3.8 Overall)

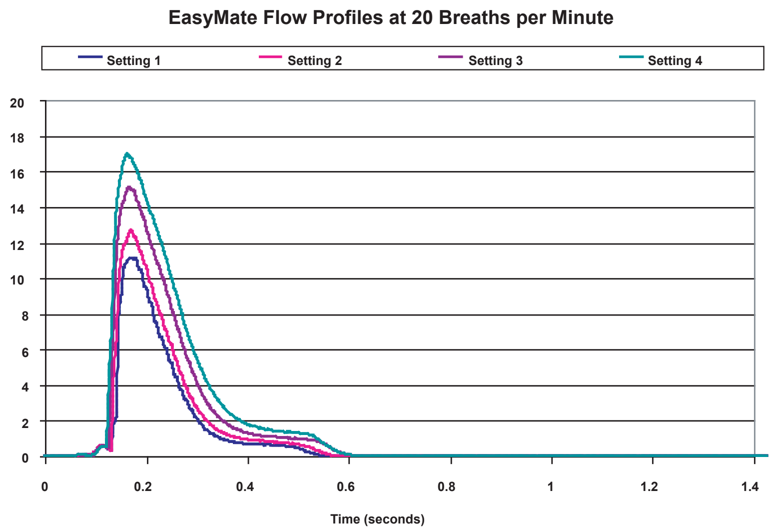
Product Specifications	
Manufacturer:	Sunrise Medical
Device Type:	Electronic Conserving Regulator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 3.5, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM adjustable
Battery:	1 C-size
Weight:	1lb. 9oz. with battery
Dimensions:	6" x 5 1/4" x 3"

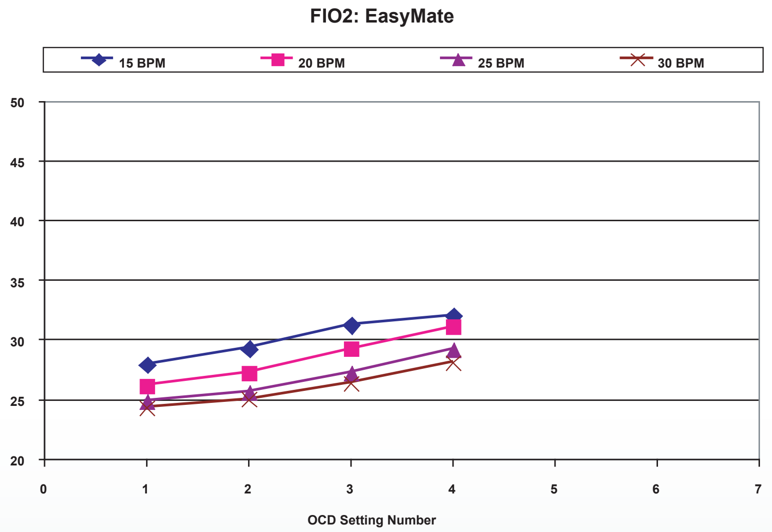
EasyMate

Precision Medical's EasyMate is the company's first foray into liquid portable oxygen systems. In terms of size, it is currently the smallest LOX system available to patients. There are only four selectable settings (1—4), so a patient who cannot be oxygenated properly with the EasyMate at it's highest setting should be moved to a different system. Like Precision's EasyPulse 5, the EasyMate is a minute volume delivery style device, and so the dose volume decreases as the respiratory rate increases. There is no continuous flow option available on the EasyMate.

Testing Results	
Maximum Dose (mL):	46.7 at 15 BPM | 43.9 at 20 BPM 39.1 at 25 BPM | 34.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	46.7 at 15 BPM | 43.9 at 20 BPM 37.7 at 25 BPM | 31.2 at 30 BPM
Average mL per Setting:	18.2 at 15 BPM | 14.7 at 20 BPM 12.1 at 25 BPM | 10.2 at 30 BPM (13.8 Overall)
Maximum FIO2%:	32.0 at 15 BPM | 31.1 at 20 BPM 29.2 at 25 BPM | 28.1 at 30 BPM
Sensitivity:	0.23 cmH2O
Calculated Savings Ratio:	2.0 at 15 BPM | 3.4 at 20 BPM 4.4 at 25 BPM | 5.2 at 30 BPM (3.7 Overall)

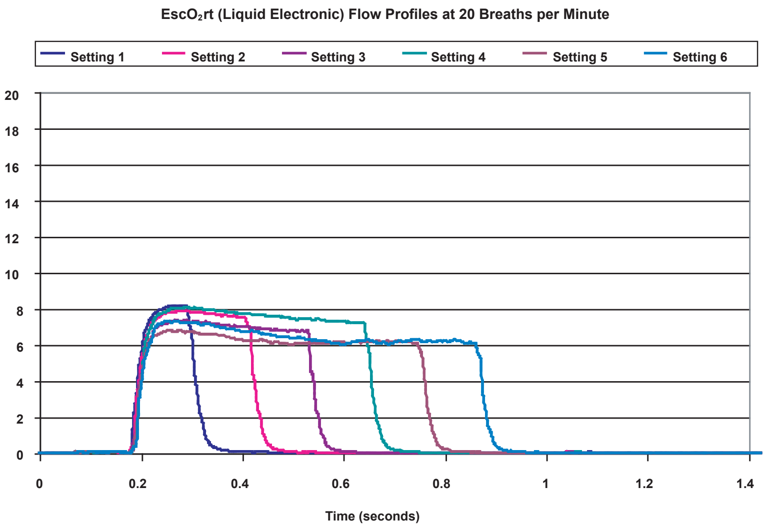
Product Specifications	
Manufacturer:	Precision Medical
Device Type:	Pneumatic Liquid Portable, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4
Selectable Continuous Flow Settings:	None
Battery:	N/A
Weight:	4lb. 8oz. full, with carrying accessories
Dimensions:	4" x 5" x 8 1/4"

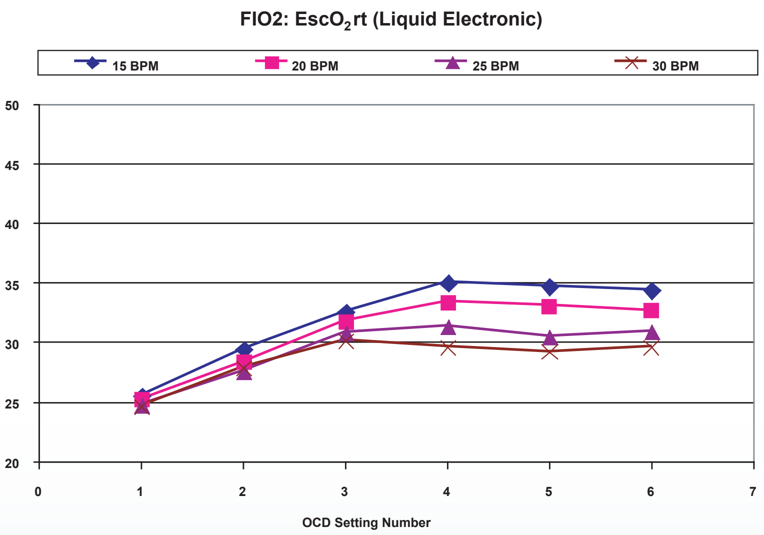




EscO2rt (Single Lumen, Electronic)

Penox/TRG's EscO2rt Portable Liquid Electronic system is one of two liquid portable models made by the company. Both devices function very differently, so it should not be assumed that they perform similarly. Possibly further confusing matters is that not only do the two liquid portables use the EscO2rt name, Penox/TRG's pneumatic demand conserver does as well. The EscO2rt Liquid Electronic device requires the use of two AA batteries to operate correctly, though the 2 LPM flow option (selected by flipping a switch on the front panel) will work even if batteries are not present in the device.





Testing Results	
Maximum Dose (mL):	83.6 at 15 BPM | 74.5 at 20 BPM 74.2 at 25 BPM | 76.7 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	76.0 at 15 BPM | 48.0 at 20 BPM 37.9 at 25 BPM | 33.2 at 30 BPM
Average mL per Setting:	17.6 at 15 BPM | 13.8 at 20 BPM 13.1 at 25 BPM | 13.4 at 30 BPM (14.5 Overall)
Maximum FIO2%:	34.4 at 15 BPM | 32.7 at 20 BPM 31.0 at 25 BPM | 29.6 at 30 BPM
Sensitivity:	0.26 cmH2O
Calculated Savings Ratio:	1.7 at 15 BPM | 3.3 at 20 BPM 4.3 at 25 BPM | 4.5 at 30 BPM (3.5 Overall)

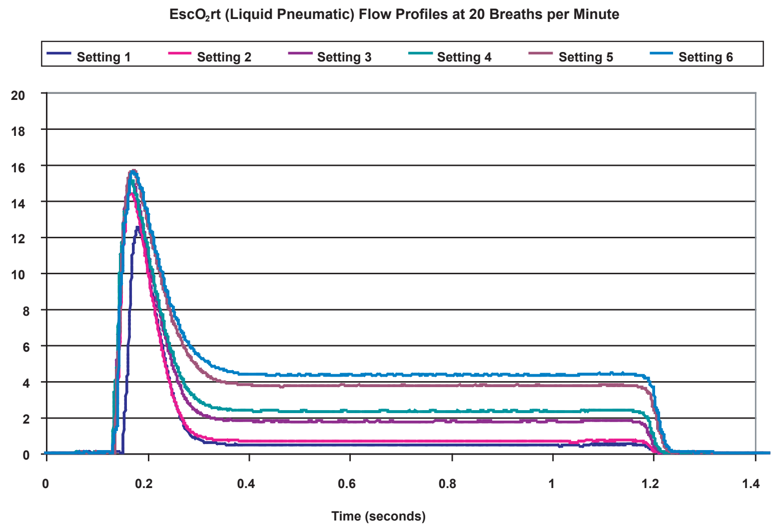
Product Specifications	
Manufacturer:	Penox Technologies / The Respiratory Group
Device Type:	Electronic Liquid Portable, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	2 AA-size
Weight:	4lb. full
Dimensions:	5 3/4" x 4" x 11"

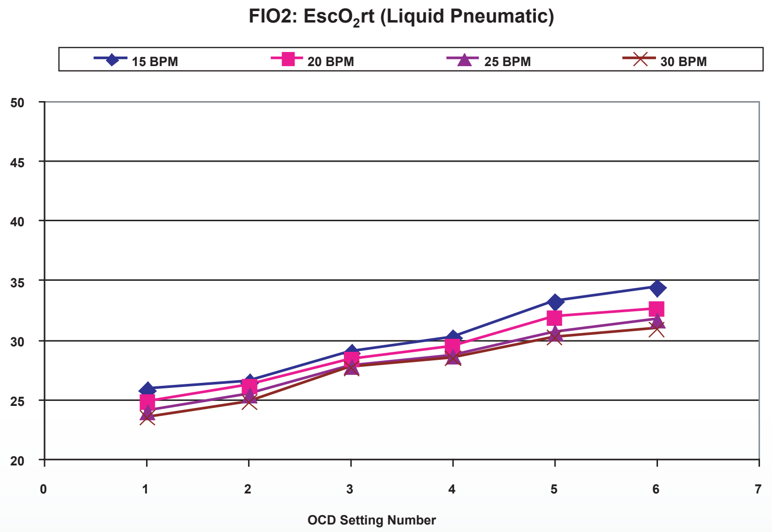
EscO2rt (Dual Lumen, Pneumatic)

The Liquid Pneumatic EscO2rt is one of two types of liquid portables offered by Penox/TRG. This particular LOX unit employs demand-style delivery, requires a dual lumen cannula and does not require batteries to operate. In addition to the typical integer settings found on most oxygen devices, the EscO2rt features fractional settings from 0.25 up to 2.5. As with most demand style devices, dose volumes decrease with increased patient breath rates. Remaining liquid contents can be spot-checked using the built-in weight scale on the back side of the unit. A 2 LPM continuous flow setting can be activated by flipping a switch on the front face of the unit.

Testing Results	
Maximum Dose (mL):	90.6 at 15 BPM | 94.3 at 20 BPM 84.7 at 25 BPM | 77.7 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	66.6 at 15 BPM | 52.0 at 20 BPM 43.2 at 25 BPM | 37.4 at 30 BPM
Average mL per Setting:	16.8 at 15 BPM | 16.4 at 20 BPM 14.5 at 25 BPM | 13.0 at 30 BPM (15.2 Overall)
Maximum FIO2%:	34.4 at 15 BPM | 32.6 at 20 BPM 31.7 at 25 BPM | 30.9 at 30 BPM
Sensitivity:	0.18 cmH2O
Calculated Savings Ratio:	1.4 at 15 BPM | 2.2 at 20 BPM 3.1 at 25 BPM | 3.7 at 30 BPM (2.6 Overall)

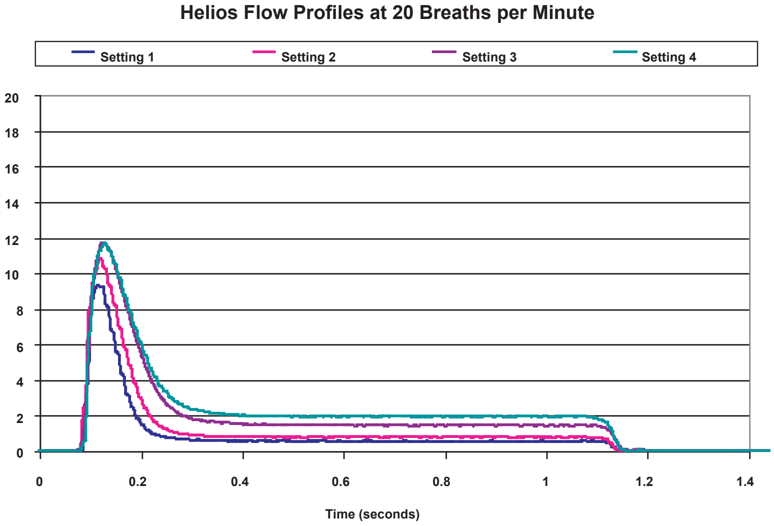
Product Specifications	
Manufacturer:	Penox Technologies / The Respiratory Group
Device Type:	Pneumatic Liquid Portable, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	N/A
Weight:	3lb. 8oz. full
Dimensions:	5 3/4" x 4" x 11"

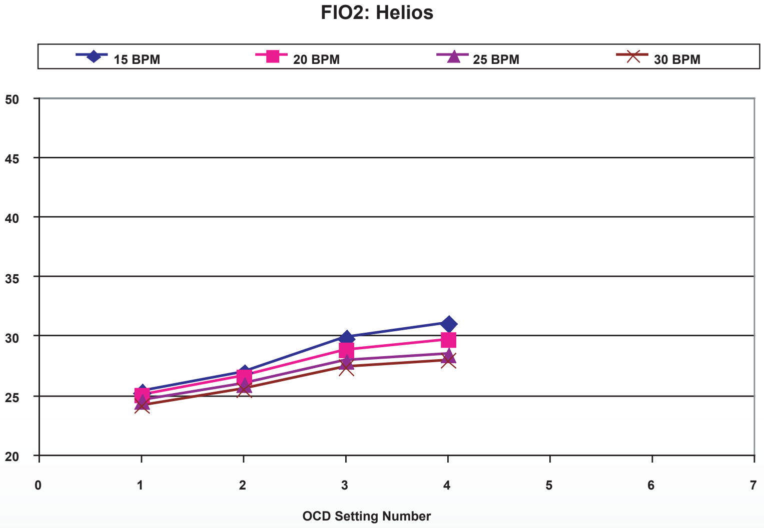




Helios

Puritan Bennett's Helios LOX portable is one of the more widely available LOX systems to oxygen patients. On inhalation, bolus delivery size increases with an increase in setting number, though at the 3 and 4 settings at all but the 30BPM rate tested showed little difference in bolus volume. Tail flow rates during the remainder of the inhalation tended to be about half the flow rate implied by the delivery setting. Continuous flow settings are limited to a range of flow rates between 0.12 and 0.75LPM.





Testing Results	
Maximum Dose (mL):	60.6 at 15 BPM | 50.0 at 20 BPM 43.0 at 25 BPM | 44.9 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	42.6 at 15 BPM | 33.7 at 20 BPM 27.9 at 25 BPM | 29.7 at 30 BPM
Average mL per Setting:	17.5 at 15 BPM | 15.0 at 20 BPM 12.8 at 25 BPM | 11.8 at 30 BPM (14.3 Overall)
Maximum FIO2%:	31.1 at 15 BPM | 29.7 at 20 BPM 28.5 at 25 BPM | 27.9 at 30 BPM
Sensitivity:	0.18 cmH2O
Calculated Savings Ratio:	1.4 at 15 BPM | 2.8 at 20 BPM 4.1 at 25 BPM | 4.7 at 30 BPM (3.2 Overall)

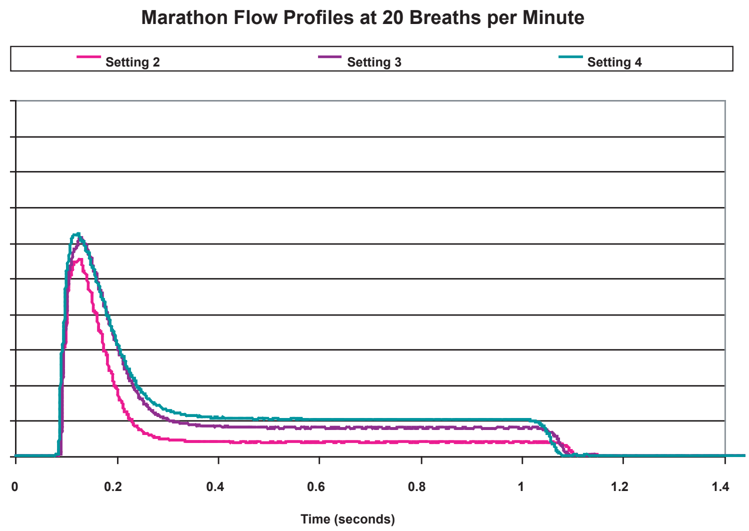
Product Specifications	
Manufacturer:	Puritan Bennett
Device Type:	Pneumatic Liquid Portable, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1—4 in 0.5 increments
Selectable Continuous Flow Settings:	0.12, 0.25, 0.5, 0.75 LPM
Battery:	N/A
Weight:	4lb. full; 4lb 7oz. with carry case
Dimensions:	5 3/4" x 3 3/4" x 10 1/2"

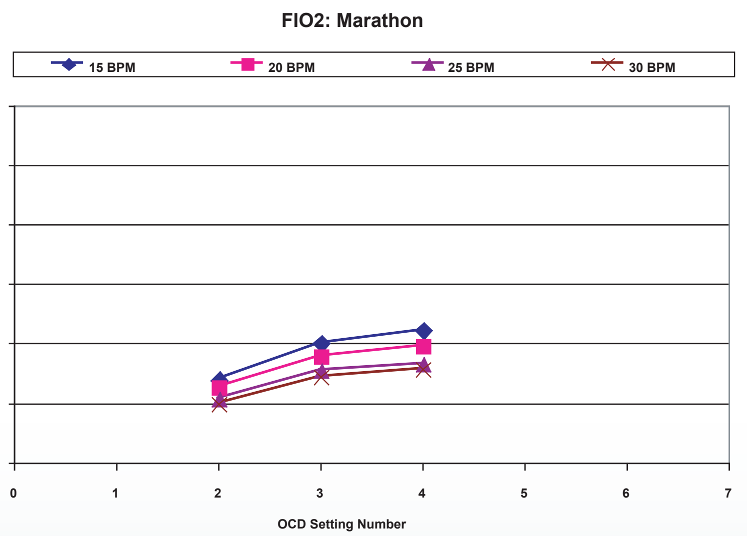
Marathon

Puritan Bennett's Marathon is a larger version of its Helios liquid portable system, with additional capabilities as a result of the Marathon's larger liquid oxygen storage capacity. Intermittent flow settings are chosen by turning the dial one way from the "0" setting; continuous flow settings, ranging from 1—6 LPM—can be selected by turning the dial the opposite direction from "0". The settings for intermittent flow range from 1.5 to 4. In addition to the typical shoulder strap carrying bag provided with LOX units, accessories available include a backpack for easier carrying of the unit.

Testing Results	
Maximum Dose (mL):	51.5 at 15 BPM | 51.4 at 20 BPM 46.9 at 25 BPM | 41.6 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	44.6 at 15 BPM | 36.6 at 20 BPM 31.8 at 25 BPM | 28.3 at 30 BPM
Average mL per Setting:	13.9 at 15 BPM | 13.8 at 20 BPM 12.7 at 25 BPM | 11.3 at 30 BPM (12.9 Overall)
Maximum FIO2%:	31.2 at 15 BPM | 29.8 at 20 BPM 28.4 at 25 BPM | 27.9 at 30 BPM
Sensitivity:	0.23 cmH2O
Calculated Savings Ratio:	1.7 at 15 BPM | 2.7 at 20 BPM 3.4 at 25 BPM | 4.1 at 30 BPM (3.0 Overall)

Product Specifications	
Manufacturer:	Puritan Bennett
Device Type:	Pneumatic Liquid Portable, Dual Lumen, Demand/Hybrid Delivery
Selectable Delivery Settings:	1.5, 2, 2.5, 3, 4
Selectable Continuous Flow Settings:	1, 2, 3, 4, 5, 6 LPM
Battery:	N/A
Weight:	5lb. 8oz. full
Dimensions:	5 3/4" x 3 3/4" x 15"

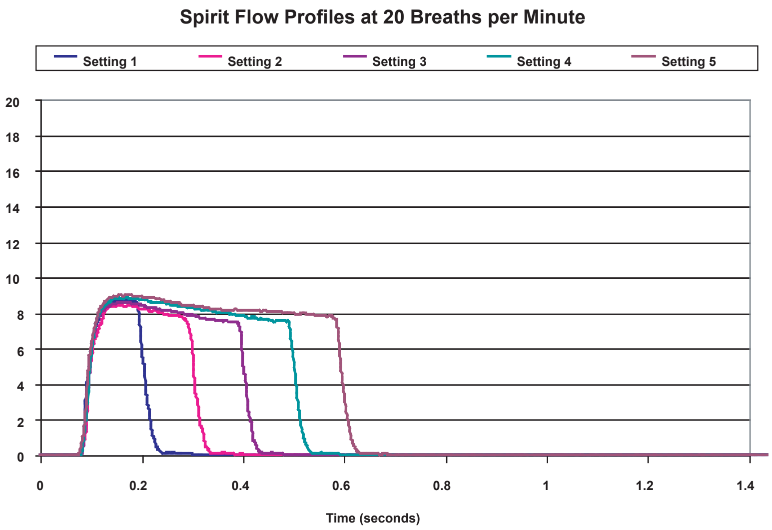


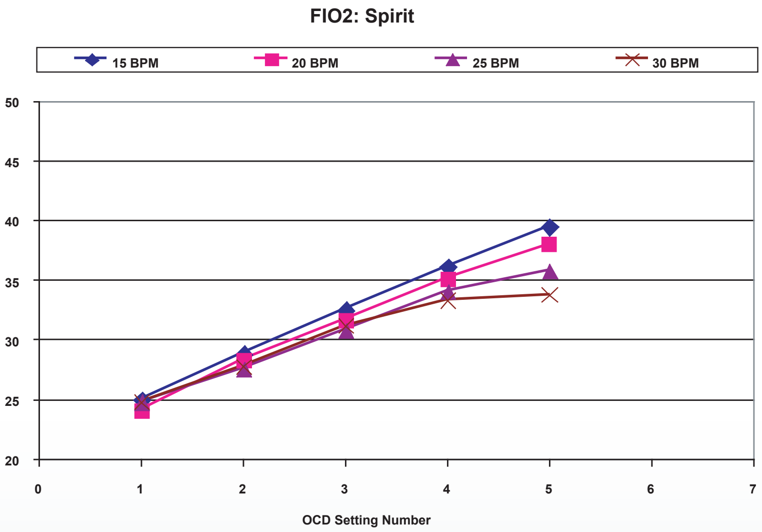


Spirit 300 / 600 / 1200

CAIRE Inc.'s Spirit line of LOX systems, offered in three different sizes (the larger the unit, the more liquid oxygen it holds), are one of the highest dosing liquid portables in the guide. Settings are selected by a dial on the top of the unit, and there is a 2 LPM continuous flow option. An LED indicator by the dial blinks green when a breath is detected, and illuminates in red when the battery is low.

All units operates from 2 C-size batteries, which are stored in a pocket on the left face of the device. The units are available in both side-fill and top-fill varieties, and also has a variety of outer casing styles—hard plastic, faux-leather finish, or "soft" case.





Testing Results	
Maximum Dose (mL):	72.5 at 15 BPM | 73.5 at 20 BPM 73.4 at 25 BPM | 71.7 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	72.5 at 15 BPM | 73.4 at 20 BPM 61.1 at 25 BPM | 49.0 at 30 BPM
Average mL per Setting:	15.3 at 15 BPM | 14.9 at 20 BPM 14.7 at 25 BPM | 14.5 at 30 BPM (14.8 Overall)
Maximum FIO2%:	39.5 at 15 BPM | 38.1 at 20 BPM 35.6 at 25 BPM | 33.9 at 30 BPM
Sensitivity:	0.14 cmH2O
Calculated Savings Ratio:	2.2 at 15 BPM | 3.6 at 20 BPM 4.6 at 25 BPM | 5.3 at 30 BPM (3.9 Overall)

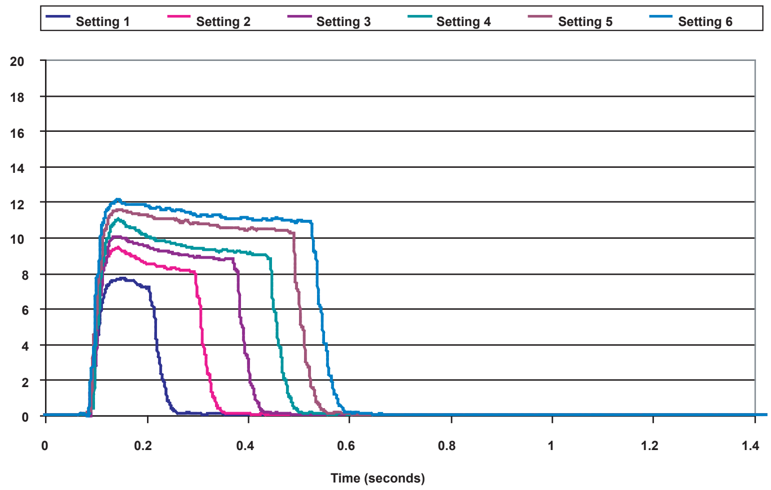
Product Specifications	
Manufacturer:	CAIRE, Inc.
Device Type:	Electronic Liquid Portable, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 1.5, 2, 3, 4, 5, 6
Selectable Continuous Flow Settings:	2 LPM
Battery:	2 C-size
Weight:	300: 4lb. 4oz. full 600: 6lb. full 1200: 8lb. 12oz. full
Dimensions:	300: 6 1/2" x 4 1/2" x 10" 600: 6 1/2" x 4 1/2" x 12 1/2" 1200: 6 1/2" x 4 1/2" x 14 1/2"

Eclipse

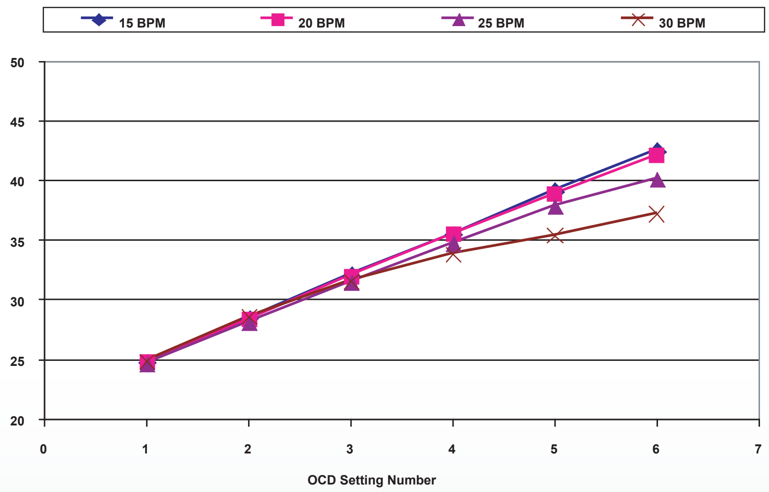
SeQual Technologies enters the Portable Oxygen Concentrator market with the Eclipse. Weighing in at over 17 pounds and with dimensions 19 1/4 inches high and just over a foot wide, the Eclipse is larger than all other POCs currently available. However, due to its ability to produce up to 3000mL of gas per minute, the Eclipse gives the user more options for both pulse delivery and continuous flow settings than the other POCs in this guide. Pulse doses are fixed, meaning that the patient will receive the same dose volume at a given setting no matter their breath rate. The Eclipse also features six sensitivity settings. Several accessories are available, including a wheeled cart and various power adapters.

Testing Results	
Maximum Dose (mL):	90.0 at 15 BPM | 88.5 at 20 BPM 93.6 at 25 BPM | 95.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	90.0 at 15 BPM | 88.4 at 20 BPM 85.9 at 25 BPM | 72.4 at 30 BPM
Average mL per Setting:	15.5 at 15 BPM | 15.6 at 20 BPM 15.9 at 25 BPM | 16.1 at 30 BPM (15.8 Overall)
Maximum FIO2%:	42.5 at 15 BPM | 42.1 at 20 BPM 40.2 at 25 BPM | 37.2 at 30 BPM
Sensitivity:	0.11cmH2O at minimum setting
Calculated Savings Ratio:	2.2 at 15 BPM | 3.6 at 20 BPM 4.4 at 25 BPM | 4.9 at 30 BPM (3.8 Overall)
Product Specifications	
Manufacturer:	SeQual Technologies
Device Type:	Portable Concentrator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1—6, in 0.5 increments
Selectable Continuous Flow Settings:	0.5—3 LPM in 0.5 LPM increments
Battery:	Rechargeable Power Cartridge
Weight:	17.6lbs. with power cartridge
Dimensions:	12 1/2" x 19 1/4" x 7 1/4"

Eclipse Flow Profiles at 20 Breaths per Minute

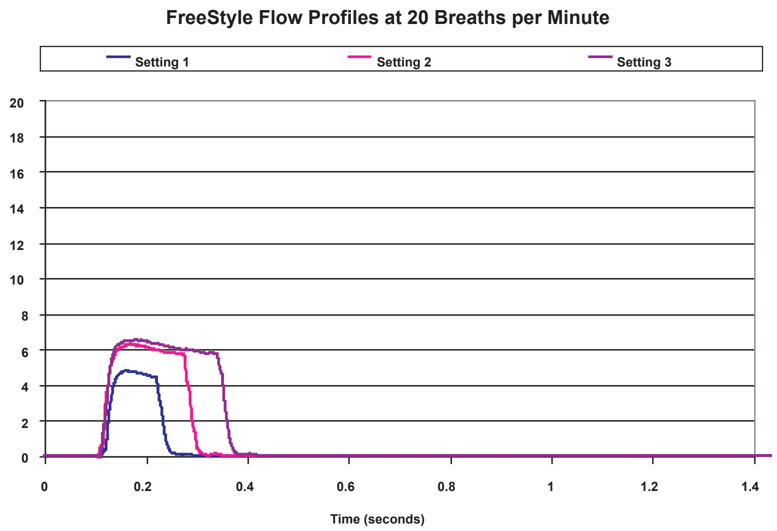


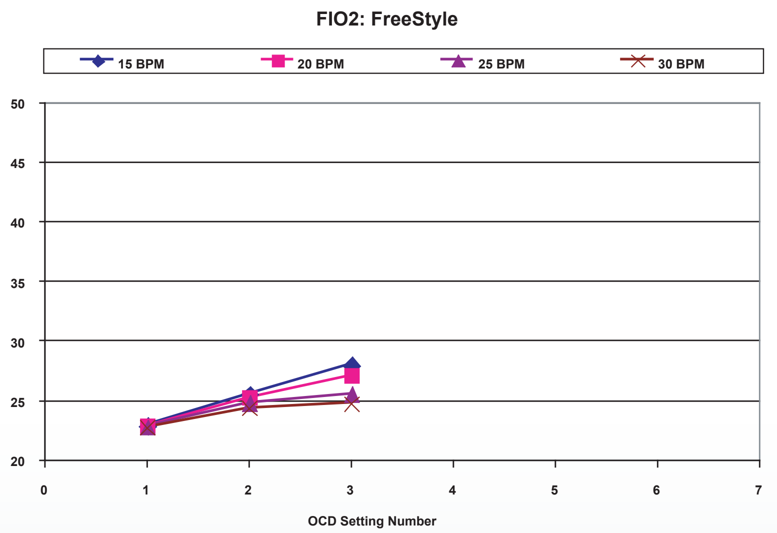
FIO2: Eclipse



FreeStyle

AirSep's FreeStyle is one of the newest portable oxygen concentrators to hit the market. It is also the smallest POC; however, with the reduced size of the unit, delivery volume is limited by the units maximum production capability of 480mL of gas per minute. The FreeStyle offers only three delivery settings, so if a patient cannot be properly titrated on the FreeStyle's maximum setting of "3", then this unit is not recommended for use. In addition to a rechargeable internal battery source, AirSep offers an optional battery belt that extends the life of the unit when away from a stationary power source, though this belt adds approximately two pounds to the total weight of the device.





Testing Results	
Maximum Dose (mL):	25.7 at 15 BPM | 25.7 at 20 BPM 25.2 at 25 BPM | 26.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	25.7 at 15 BPM | 25.7 at 20 BPM 25.2 at 25 BPM | 26.1 at 30 BPM
Average mL per Setting:	8.7 at 15 BPM | 8.6 at 20 BPM 8.5 at 25 BPM | 8.7 at 30 BPM (8.6 Overall)
Maximum FIO2%:	28.0 at 15 BPM | 27.1 at 20 BPM 25.6 at 25 BPM | 24.7 at 30 BPM
Sensitivity:	0.10 cmH2O
Calculated Savings Ratio:	1.9 at 15 BPM | 3.5 at 20 BPM 4.2 at 25 BPM | 4.4 at 30 BPM (3.5 Overall)

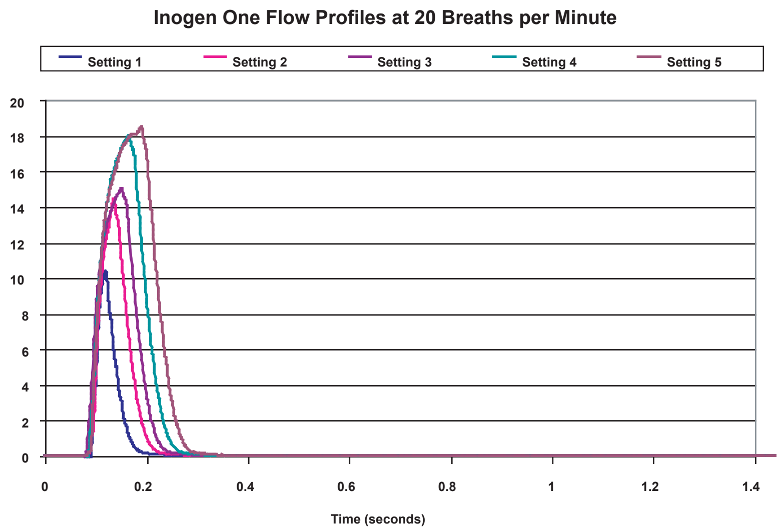
Product Specifications	
Manufacturer:	AirSep
Device Type:	Portable Oxygen Concentrator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3
Selectable Continuous Flow Settings:	None
Battery:	Rechargeable Battery Pack
Weight:	4lb. 6oz. without battery belt, 6lb. 4oz. with battery belt
Dimensions:	8 3/4" x 6" x 3 3/4"

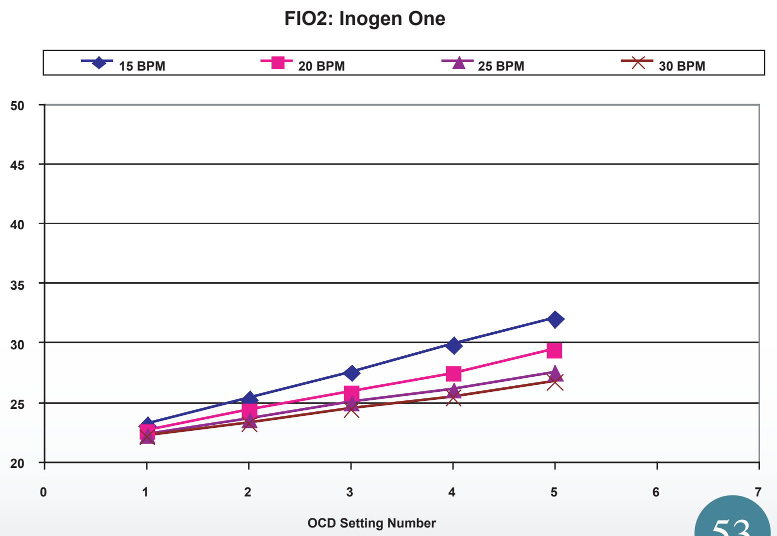
Inogen One

The Inogen One portable oxygen concentrator is a minute volume delivery device, decreasing its dose volume at a given setting when respiratory rate increases. The maximum production capability of the Inogen One is 750mL of gas per minute. At all settings and breath rates, the entire oxygen dose is delivered within 0.4 seconds of inhalation. Recently the device underwent some changes—older Inogen One's feature two selectable sensitivity settings; on new units there is only the default setting. Also eliminated on new units were the 0.5 incremental settings. The type of compressor inside the unit was also changed, and new units are slightly louder during use. Several accessories are included with the unit to make portability of the ~10lb device easier, including a wheeled cart, stationary and mobile power chargers, and the Satellite conserver.

Testing Results	
Maximum Dose (mL):	50.4 at 15 BPM | 38.2 at 20 BPM 30.6 at 25 BPM | 26.1 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	50.4 at 15 BPM | 38.2 at 20 BPM 30.6 at 25 BPM | 26.1 at 30 BPM
Average mL per Setting:	10.2 at 15 BPM | 7.6 at 20 BPM 6.1 at 25 BPM | 5.0 at 30 BPM (7.2 Overall)
Maximum FIO2%:	32.0 at 15 BPM | 29.4 at 20 BPM 27.5 at 25 BPM | 26.7 at 30 BPM
Sensitivity:	0.09 cmH2O at minimum setting
Calculated Savings Ratio:	1.7 at 15 BPM | 3.2 at 20 BPM 4.3 at 25 BPM | 5.6 at 30 BPM (3.7 Overall)

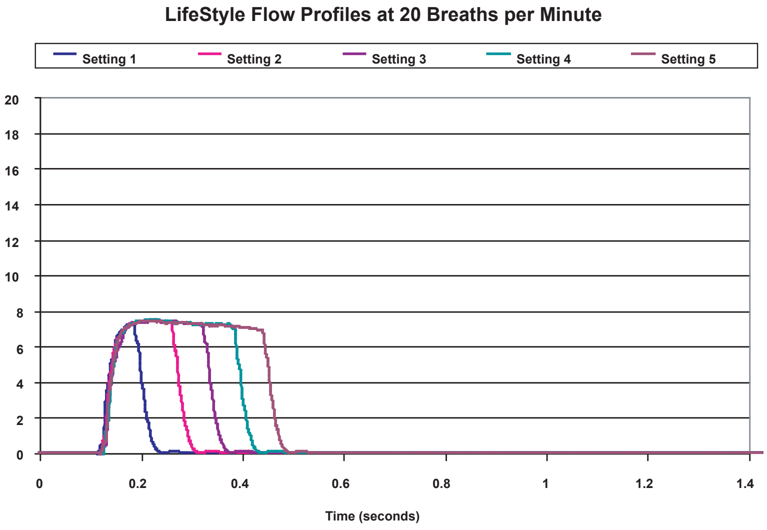
Product Specifications	
Manufacturer:	Inogen
Device Type:	Portable Oxygen Concentrator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5
Selectable Continuous Flow Settings:	None
Battery:	Rechargeable Battery Pack
Weight:	9lb. 12oz. with battery pack
Dimensions:	11 3/4" x 6" x 12 1/4"

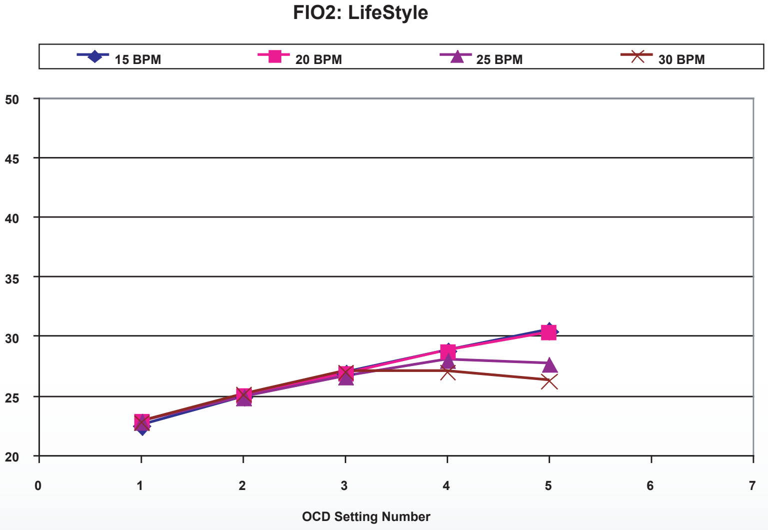




LifeStyle

AirSep's LifeStyle portable oxygen concentrator was the first POC to enter the market and paved the way for the current devices now available. Utilizing a rechargeable battery pack, the LifeStyle allowed oxygen patients to take their concentrator with them for the first time. Accessories for the device include stationary and mobile chargers/power sources, and additional battery packs to allow for longer away times. The unit's conserver operates similarly to that of AirSep's Impulse Elite set in the "A" mode. However, because the Impulse Elite delivers 100% oxygen, the actual oxygen volume delivered on the LifeStyle is slightly less depending on the oxygen purity. Due to the 750mL per minute maximum volume output, users should be aware of any drop in purity when using the LifeStyle at high settings and and breath rates greater than 20BPM.





Testing Results	
Maximum Dose (mL):	40.1 at 15 BPM | 40.1 at 20 BPM 40.3 at 25 BPM | 40.6 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	40.1 at 15 BPM | 40.1 at 20 BPM 40.3 at 25 BPM | 37.7 at 30 BPM
Average mL per Setting:	7.7 at 15 BPM | 8.6 at 20 BPM 8.5 at 25 BPM | 8.7 at 30 BPM (8.4 Overall)
Maximum FIO2%:	30.5 at 15 BPM | 30.3 at 20 BPM 28.0 at 25 BPM | 27.0 at 30 BPM
Sensitivity:	0.11 cmH2O
Calculated Savings Ratio:	1.8 at 15 BPM | 3.3 at 20 BPM 4.2 at 25 BPM | 4.7 at 30 BPM (3.5 Overall)

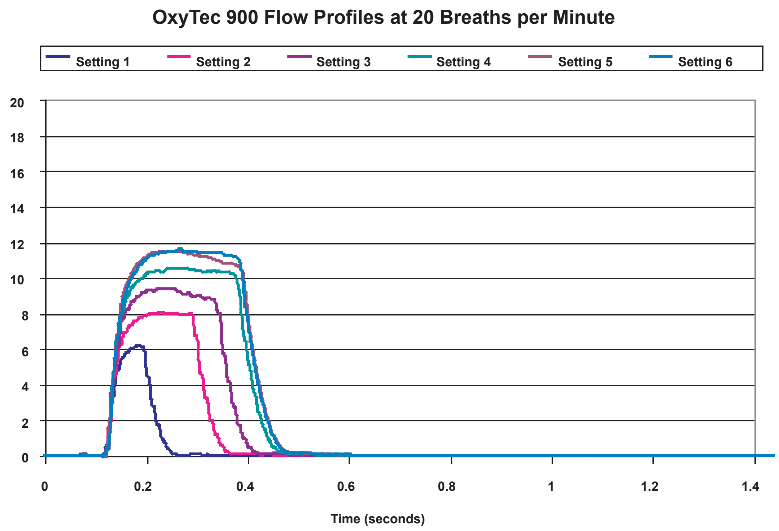
Product Specifications	
Manufacturer:	AirSep
Device Type:	Portable Oxygen Concentrator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1, 2, 3, 4, 5
Selectable Continuous Flow Settings:	None
Battery:	Rechargeable Battery Pack
Weight:	10lbs. with soft outer casing and battery pack
Dimensions:	5 3/4" x 16" x 6"

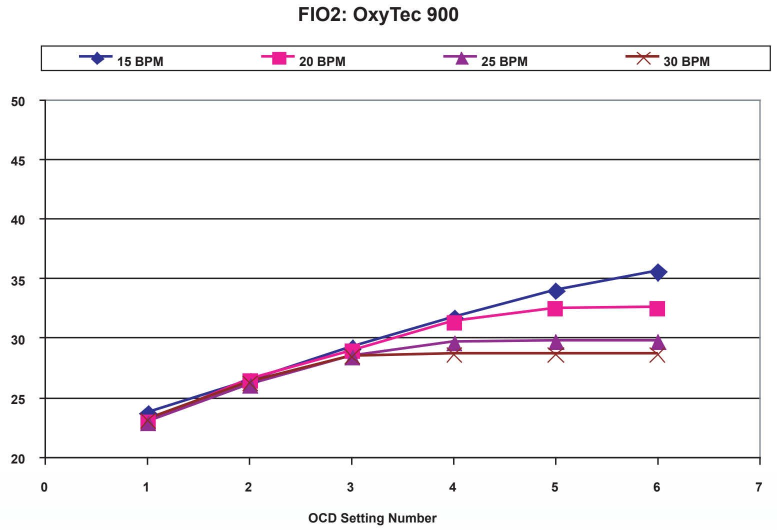
OxyTec 900 / EverGo

The OxyTec 900 / EverGo is another addition to the growing portable oxygen concentrator market. It features a soft casing unique to the concentrator, as well as a touch-screen for the operation of power and setting functions. The POC can function on one rechargeable battery pack, though two slots on either side of the device enable two battery packs to be used in unison, extending the life of the concentrator outside of a stationary power source. The OxyTec 900 / EverGo delivers a fixed pulse volume until its maximum production capability of 1050mL per minute is reached, at which point a minute volume delivery method is used. There is no continuous flow option on the device.

Testing Results	
Maximum Dose (mL):	71.6 at 15 BPM | 53.2 at 20 BPM 41.9 at 25 BPM | 36.4 at 30 BPM
Maximum Dose (mL) in 60% of Inspiratory Time:	71.6 at 15 BPM | 53.2 at 20 BPM 41.9 at 25 BPM | 36.2 at 30 BPM
Average mL per Setting:	12.2 at 15 BPM | 11.0 at 20 BPM 10.0 at 25 BPM | 9.3 at 30 BPM (10.6 Overall)
Maximum FIO2%:	35.6 at 15 BPM | 32.5 at 20 BPM 29.8 at 25 BPM | 28.6 at 30 BPM
Sensitivity:	0.08 cmH2O
Calculated Savings Ratio:	1.8 at 15 BPM | 3.2 at 20 BPM 4.3 at 25 BPM | 5.2 at 30 BPM (3.6 Overall)

Product Specifications	
Manufacturer:	OxyTec/Respironics
Device Type:	Portable Oxygen Concentrator, Single Lumen, Pulse Delivery
Selectable Delivery Settings:	1—6 in 0.5 increments
Selectable Continuous Flow Settings:	None
Battery:	Rechargeable Battery Pack
Weight:	10lbs. with carrying case
Dimensions:	12 1/4" x 6" x 8 1/2"





The OxyTec 900 was initially produced by OxyTec Medical, which has since been acquired by Respironics, and the OxyTec 900 has been rebranded the EverGo. Though no major changes to the design and its performance are expected, this may yet change, and as a result the data shown here may not be accurate when the EverGo enters the market.

Product Comparison Table

This table can be used as a quick-reference guide to compare each oxygen conserving

Model	Manufacturer	Cannula Lumen Style	Delivery Style	Selectable Delivery Settings	Selectable Continuous Flow Settings (LPM)	Battery	Weight, lbs	Dimensions
Pneumatic Conserving Regulators								
CR-50	Puritan Bennett	Dual	Hybrid	1, 1.5, 2, 2.5, 3, 4, 5, 6	0.25, 0.5, 0.75	N/A	1lb. 2oz.	5" x 4 1/4" x 3"
EasyPulse 5	Precision Medical	Single	Pulse	1--5, in 1.0 increments	2	N/A	10oz.	5 1/8" x 2 1/2" x 2 5/8"
EconO_2mizer	Medline	Dual	Hybrid	1--6, in 0.5 increments	1--6, in 0.5 increments	N/A	14oz.	6" x 2 1/2" x 2 3/4"
EscO_2rt	The Respiratory Group	Dual	Hybrid	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6	0.25, 0.4, 0.5, 0.6, 0.75, 1, 2, 2.5, 4, 4.5	N/A	15oz.	7 1/2" x 2 1/2" x 2 3/4"
HomeFill	Invacare	Single	Pulse	1--5, in 1.0 increments	2	N/A	Varies	Varies
O_2nDemand	Victor Medical	Dual	Hybrid	1--6, in 0.5 increments	1--6, in 0.5 increments	N/A	1lb. 6oz.	6 1/4" x 3" x 3"
O_2Xpress	Salter Labs	Dual	Hybrid	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6	None	N/A	1lb. 1oz.	5 1/2" x 3 1/2" x 3"
Oxy Serve II	Superior Products	Dual	Hybrid	1--6, in 0.5 increments	1--5, in 1.0 increments	N/A	14oz.	4 1/2" x 4" x 3"
Respond O_2	Responsive Respiratory	Dual	Hybrid	1--6, in 0.5 increments	1--6, in 0.5 increments	N/A	14oz.	6 1/4" x 2 1/2" x 2 3/4"
Tru-Dose	Western Medica	Dual	Hybrid	1--6, in 0.5 increments	1--6, in 0.5 increments	N/A	1lb.	6" x 2 1/4" x 3"
Electronic Conserving Regulators								
ePod	Respironics, Inc.	Single	Pulse	1--6, in 1.0 increments	0.5, 1, 2, 3, 4	4AA	1lb. 6oz.	6 3/4" x 4" x 2 3/4"
Impulse Elite (A/B)	AirSep Corporation	Single	Pulse	1--6, in 1.0 increments	2	1D	1lb. 8oz.	4 1/4" x 5 1/2" x 3"
Liberty	Allied Healthcare	Single	Pulse	1--6, in 1.0 increments	2 (Adjustable)	1C	1lb. 2oz.	5 3/4" x 3 1/4" x 2 1/2"
MiniO_2	Medline	Single	Pulse	1--6, in 1.0 increments	2	1AA	15oz.	4 3/4" x 3 1/2" x 2 1/2"
PD1000	Sunrise Medical	Single	Pulse	1, 1.5, 2, 2.5, 3, 4, 5, 6	2	2AA	1lb.	6" x 3 3/4" x 2 3/4"
PD4000	Sunrise Medical	Single	Pulse	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 3.5, 4, 5, 6	2 (Adjustable)	1C	1lb. 9oz.	6" x 5 1/4" x 3"
Liquid Portables								
EasyMate	Precision Medical	Single	Pulse	1, 2, 3, 4	None	N/A	4lb. 8oz.	4" x 5" x 8 1/4"
EscO_2rt (Electronic)	The Respiratory Group	Single	Pulse	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6	2	2AA	4lb.	5 3/4" x 4" x11"
EscO_2rt (Pneumatic)	The Respiratory Group	Dual	Hybrid	0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 5, 6	2	N/A	3lb. 8oz.	5 3/4" x 4" x11"
Helios	Puritan Bennett	Dual	Hybrid	1--4, in 0.5 increments	0.12, 0.25, 0.5, 0.75	N/A	4lb. 7oz.	5 3/4" x 3 3/4" x 10 1/2"
Marathon	Puritan Bennett	Dual	Hybrid	1.5, 2, 2.5, 3, 4	1--6, in 1.0 increments	N/A	5lb. 8oz.	5 3/4" x 3 3/4" x 15"
Spirit 300/600/900	CAIRE, Inc.	Single	Pulse	1, 1.5, 2, 3, 4, 5, 6	2	2C	4lb. 4oz.	6 1/2" x 4 1/2" x Variable
Portable Concentrators								
Eclipse	SeQual Technologies	Single	Pulse	1--6, in 0.5 increments	0.5--3, in 0.5 increments	Rechargeable	17lb. 10oz.	12 1/2" x 19 1/4" x 7 1/4"
FreeStyle	AirSep Corporation	Single	Pulse	1, 2, 3	None	Rechargeable	4lb. 6oz.	8 3/4" x 6" x 3 3/4"
Inogen One	Inogen, Inc.	Single	Pulse	1--5, in 1.0 increments	None	Rechargeable	9lb. 12oz.	11 3/4" x 6" x 12 1/4"
LifeStyle	AirSep Corporation	Single	Pulse	1--5, in 1.0 increments	None	Rechargeable	10lb.	5 3/4" x 16" x 6"
OxyTec 900 / EverGo	OxyTec / Respironics, Inc.	Single	Pulse	1--6, in 0.5 increments	None	Rechargeable	10lb.	12 1/4" x 6" x 8 1/2"

Manufacturer
The name of the OCD manufacturer.

Device Type
Single or Dual Lumen Cannula. Demand/Hybrid, or Pulse Delivery.

Selectable Delivery Settings
Available device settings for intermittent flow oxygen delivery.

Selectable Continuous Flow Settings
Available device settings for continuous flow oxygen delivery.

Battery
Battery type and number of batteries required for use.

Weight
Weight of device. Weight with/without accessories included where applicable.

Dimensions
Device measurements.

device across all major categories outlined in the individual product pages.

Maximum Dose, mL				Maximum Dose in 60% of I-time, mL				mL/Setting					Maximum FIO2%				Sensitivity cmH2O (-)	Calculated Savings Ratio				
15	20	25	30	15	20	25	30	15	20	25	30	Overall	15	20	25	30		15	20	25	30	Overall
106	103	93	82	79	61	50	43	21	21	19	17	19	37.0	34.8	32.5	31.5	0.17	1.4	2.1	2.8	3.4	2.4
41	42	41	40	41	42	41	40	13	11	10	8	11	30.6	30.3	29.8	29.7	0.21	1.8	3.2	4.3	5.0	3.6
56	67	77	69	56	53	43	36	12	14	15	14	14	33.8	32.6	31.0	29.9	0.44	1.9	2.6	2.9	3.4	2.7
87	87	78	71	59	47	39	34	15	15	13	12	14	34.1	32.6	30.9	30.1	0.18	1.3	2.3	3.0	3.5	2.5
42	43	42	43	42	43	42	43	12	10	9	8	10	30.6	30.4	30.0	30.4	0.50	1.7	3.2	4.2	5.2	3.6
118	103	89	81	71	53	43	36	20	19	16	15	18	36.1	34.0	31.9	30.9	0.12	1.2	2.1	2.9	3.4	2.4
111	102	92	84	85	74	68	63	20	18	16	15	17	40.0	38.8	37.0	36.6	0.13	1.6	2.6	3.7	4.6	3.1
100	93	82	73	70	54	45	39	18	18	17	15	17	35.0	33.2	31.3	30.4	0.22	1.4	2.3	3.0	3.6	2.6
61	71	80	70	61	55	45	38	14	16	16	15	15	34.4	33.4	31.5	30.5	0.41	1.8	2.6	3.1	3.7	2.8
86	95	82	73	71	55	44	37	17	18	16	15	17	34.5	33.1	31.2	30.0	0.21	1.3	2.0	2.7	3.2	2.3
72	72	72	71	72	72	71	66	12	12	12	12	12	40.6	39.8	39.0	38.5	0.17	2.3	3.9	5.0	6.0	4.3
50/97	51/97	51/98	51/98	50/97	51/96	51/75	51/61	9/17	9/17	9/17	9/17	9/17	34.3/46.1	34.3/44.5	33.9/40.7	34.6/38.7	0.10	2.0/2.5	3.8/3.9	5.1/4.8	6.3/5.6	4.3/4.2
77	78	79	79	77	68	54	44	12	13	13	13	13	36.3	34.4	32.4	30.9	0.23	1.8	2.9	3.6	4.1	3.1
75	76	76	77	75	66	52	42	12	12	12	12	12	35.7	33.7	31.4	29.9	0.23	1.6	2.8	3.5	4.0	3.0
88	88	88	89	88	70	56	46	15	15	15	15	15	40.7	39.3	35.0	33.3	0.25	2.3	3.6	4.3	4.9	3.8
87	87	87	87	87	82	64	52	15	14	14	14	14	42.3	39.9	36.6	34.7	0.14	2.2	3.5	4.3	5.0	3.8
47	44	39	34	47	44	38	31	18	15	12	10	14	32.0	31.1	29.2	28.1	0.23	2.0	3.4	4.4	5.2	3.7
84	75	74	77	76	48	38	33	18	14	13	13	15	34.4	32.7	31.0	29.6	0.26	1.7	3.3	4.3	4.5	3.5
91	94	85	78	67	52	43	37	17	16	15	13	15	34.4	32.6	31.7	30.9	0.18	1.4	2.2	3.1	3.7	2.6
61	50	43	45	43	34	28	30	18	15	13	12	14	31.1	29.7	28.5	27.9	0.18	1.4	2.8	4.1	4.7	3.2
52	51	47	42	45	37	32	28	14	14	13	11	13	31.2	29.8	28.4	27.9	0.23	1.7	2.7	3.4	4.1	3.0
73	74	73	72	73	73	61	49	15	15	15	15	15	39.5	38.1	35.6	33.9	0.14	2.2	3.6	4.6	5.3	3.9
90	89	94	95	90	88	86	72	16	16	16	16	16	42.5	42.1	40.2	37.2	0.20	2.2	3.6	4.4	4.9	3.8
26	26	25	26	26	26	25	26	9	9	9	9	9	28.0	27.1	25.6	24.7	0.10	1.9	3.5	4.2	4.4	3.5
50	38	31	26	50	38	31	26	10	8	6	5	7	32.0	29.4	27.5	26.7	0.20	1.7	3.2	4.3	5.6	3.7
40	40	40	41	40	40	40	38	8	9	9	9	8	30.5	30.3	28.0	27.0	0.11	1.8	3.3	4.2	4.7	3.5
72	53	42	36	72	53	42	36	12	11	10	9	11	35.6	32.5	29.8	28.6	0.08	1.8	3.2	4.3	5.2	3.6

Maximum Dose (mL)
Maximum dose volumes (in mL) at all tested breath rates.

Maximum Dose (mL) in 60% of Inspiratory Time
Maximum dose volumes (in mL) within the first 60% of patient inhalation at all tested breath rates.

Average mL per Setting
Average dose volume per setting at all tested breath rates as well as an overall average.

Maximum FIO2%
Maximum FIO2 percentage recorded at each tested breath rate.

Sensitivity
Negative pressure inside the nose required to trigger oxygen delivery at 20BPM.

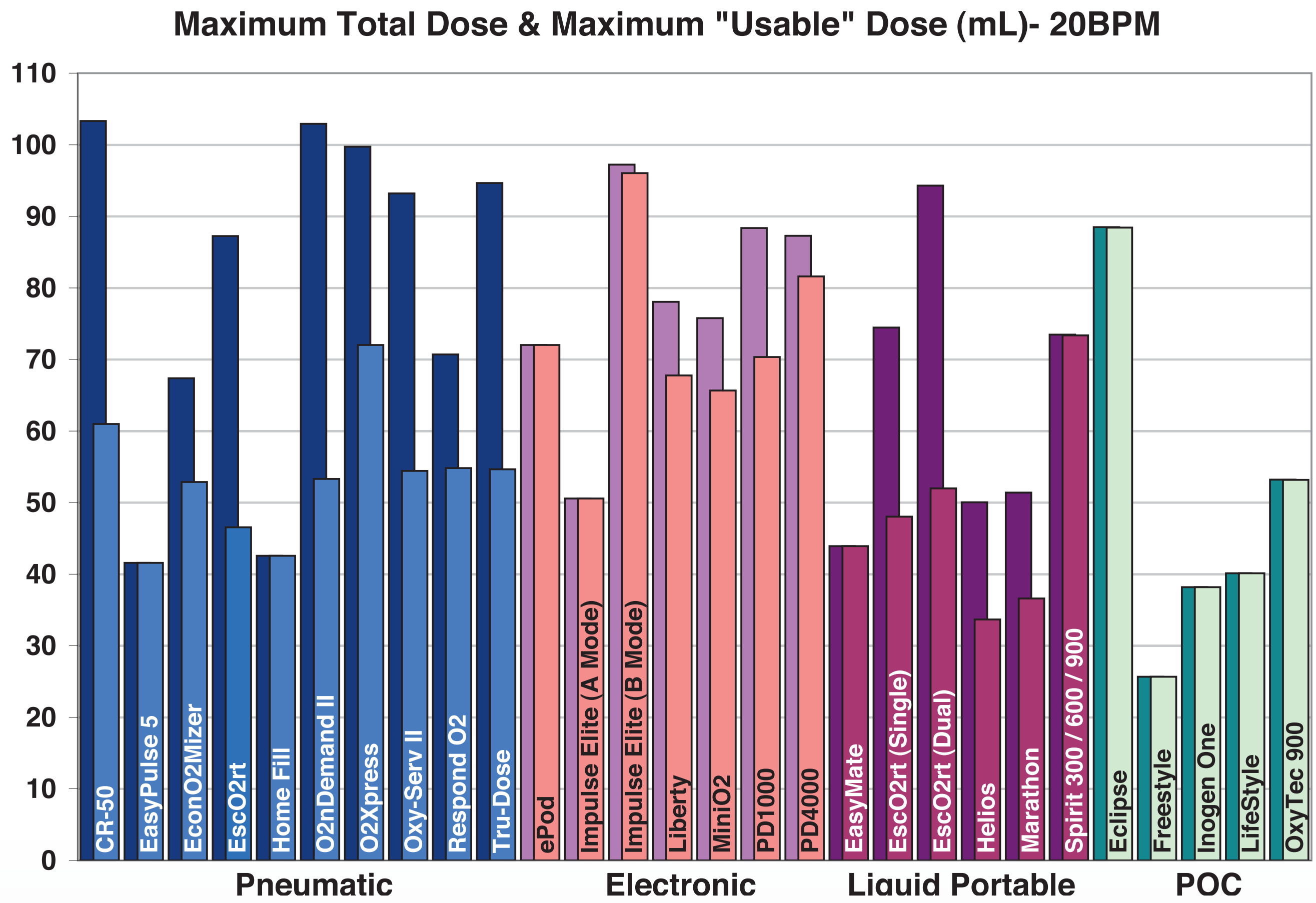
Calculated Savings Ratio
CSR values at each breath rate as well as an overall average.

Maximum O_2 Dose per Breath at 20BPM

Some OCDs may be very small and lightweight, but that is usually at the cost of the amount of oxygen able to be delivered in a given breath. Because the maximum amount of oxygen delivered is limited, some of these smaller devices may not be suitable for all patients during all activities.

We report here the maximum amount of oxygen delivered at each device's highest selectable setting at 20BPM, as well as the maximum volume delivered within the first 0.6 seconds of patient inhalation. We choose to report the maximum oxygen delivery within this time frame as oxygen delivered after this point in inhalation may not reach the alveoli and instead remains in dead space until exhalation. So, this chart also illustrates the amount of "usable" oxygen delivered by each device at 20BPM. The total dose volume is noted by the bar in the background of the chart; "usable" volume is noted by the bar in the foreground of the chart.

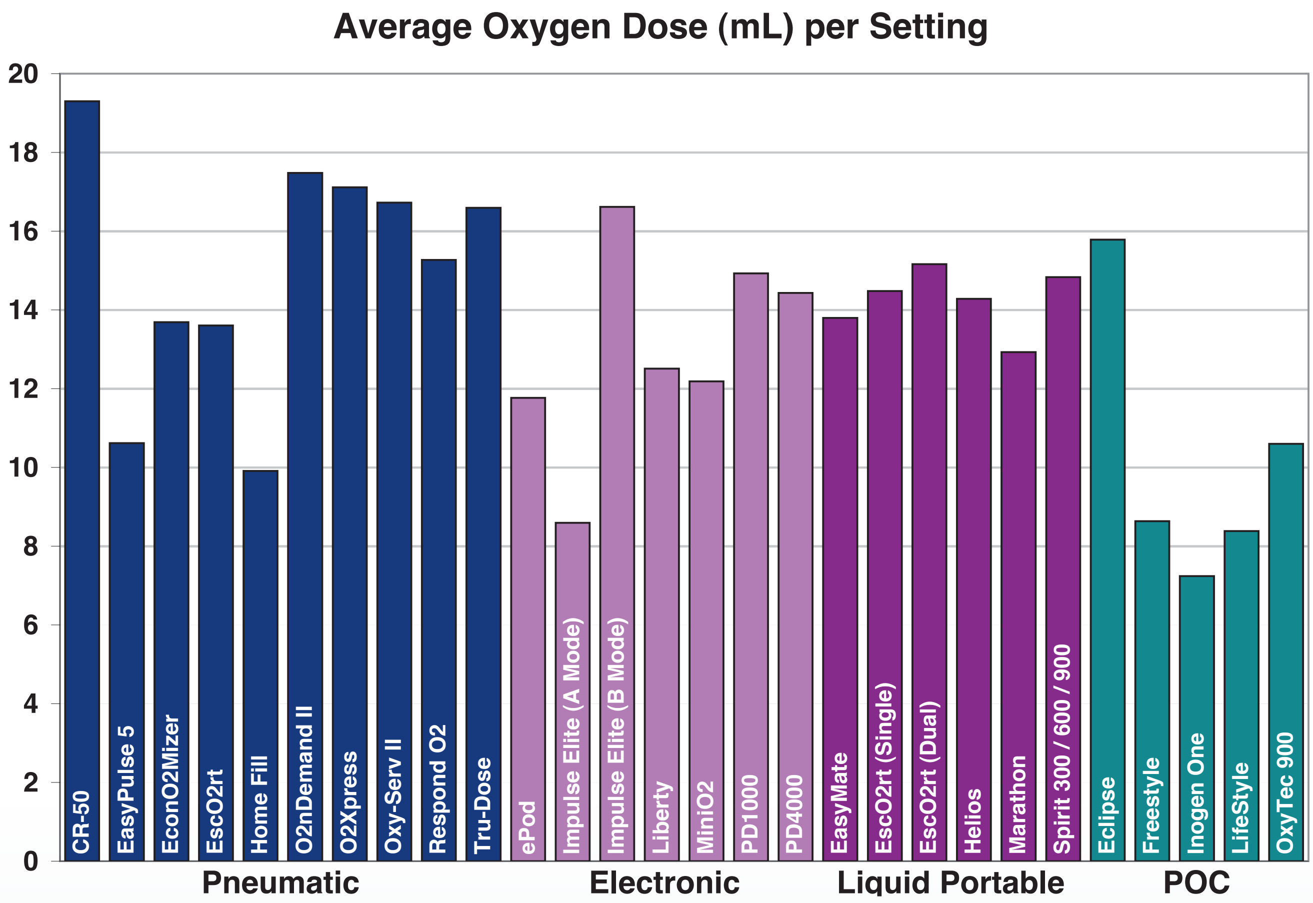
Note that this timed oxygen volume measurement also takes into consideration any delay time occurring between the beginning of inhalation and the actuation of oxygen delivery. For example, if a device did not commence gas delivery until 100 ms into inhalation, then only 500 ms of any delivered gas flow is counted.



mL/Setting

There is much discrepancy between devices (even within a given manufacturer's product offerings) as to how much gas is delivered at a particular numerical setting. Set to the same value, one device may deliver as much as twice the oxygen dose as another. While there is variation in delivered volume based on the style of flow delivery (High Flow/Short On-Time vs. Low Flow/Long On-Time, for example), in general, and at moderate doses and typical breathing rates, the same volume of gas from one device will have the same therapeutic benefit as that volume from another device.

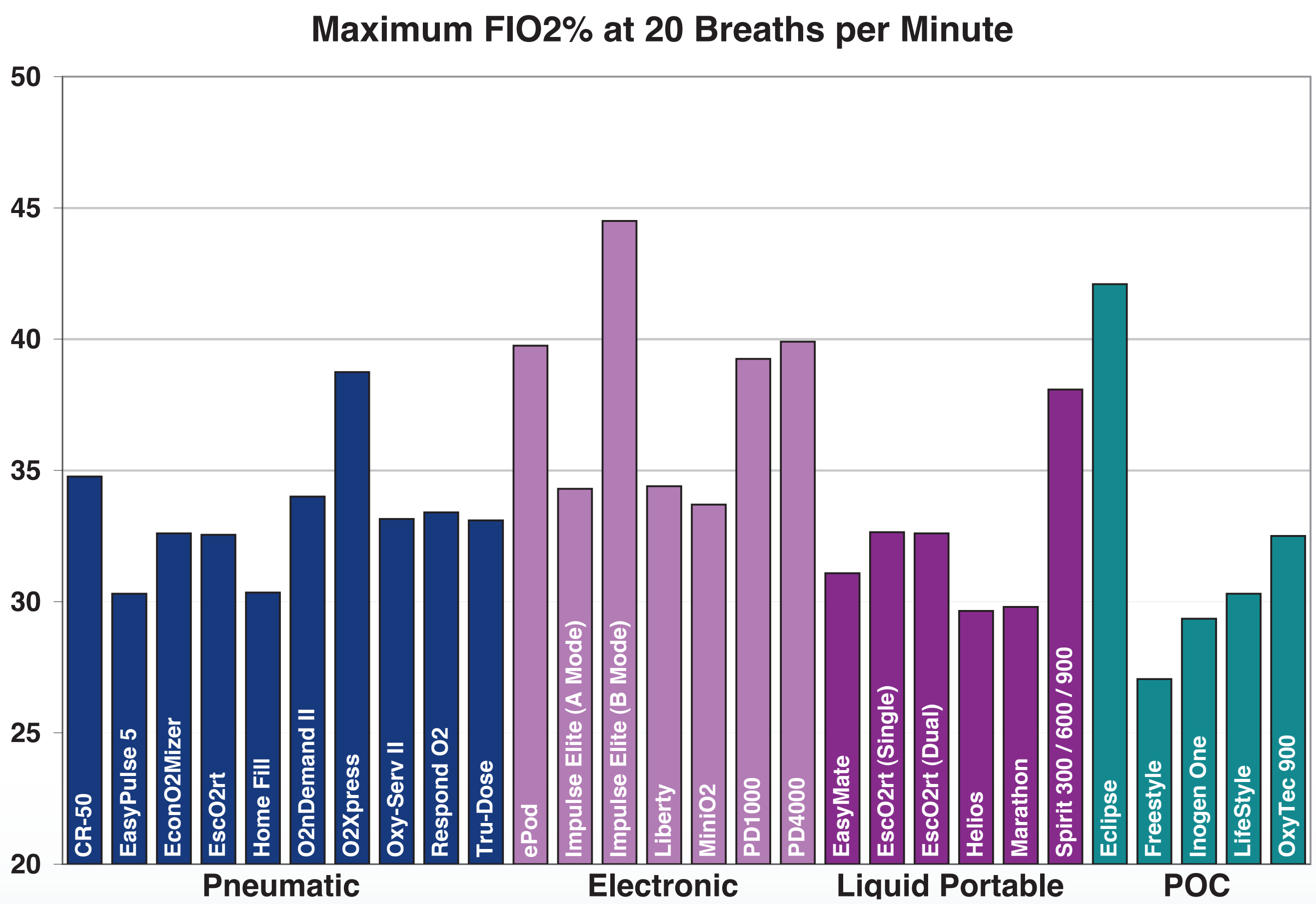
Below is a chart that outlines each device's average O2 dose per numerical setting. This is based on our findings at all tested breathing rates (15, 20, 25 and 30 BPM). For pulse devices, these numbers will generally be consistent no matter the breath rate. For hybrid demand devices and devices with minute volume conservers, the numbers will vary depending on the breath rate. Nonetheless, this comparison of overall average dose per setting provides a general feel for oxygen delivery that is more accurate than simply the numbers printed on the dial.



Maximum FIO2% per Breath at 20BPM

The percentage of oxygen in the air that is inhaled during a given breath plays a key role in how patients on oxygen are able to maintain healthy oxygenation levels throughout their daily activities. Oxygen patients are regularly instructed to increase their delivery setting to their exercise prescription when they are active—this is because the patient needs more O_2 to maintain proper oxygenation; increasing the setting number increases the dose volume, and as a result, the FIO2% in a given breath usually increases. We say "usually" because, simply, this is not always the case. For example, take a pulse device that increases its dose volumes by lengthening the delivery on-time only. Assuming the patient's breath rate is consistent, if some of the oxygen delivered on a "5" setting after 60% of the patient's inspiratory cycle is completed is not reaching the lungs, changing the setting to "6" will yield the same FIO2%. Why? Because the additional volume comes from the increase in the on-time of the device, and not from a change in the bolus or flow rate. So, not only is oxygen being "wasted" on a "5" setting as it is not reaching the lungs, changing the device to a "6" means that the additional oxygen volume resulting from the setting change is "wasted" as well.

We report here the maximum FIO2 recording from each device at 20 breaths per minute. Generally these values resulted from the device being set at its maximum delivery setting, but as noted above, this is not always the case.

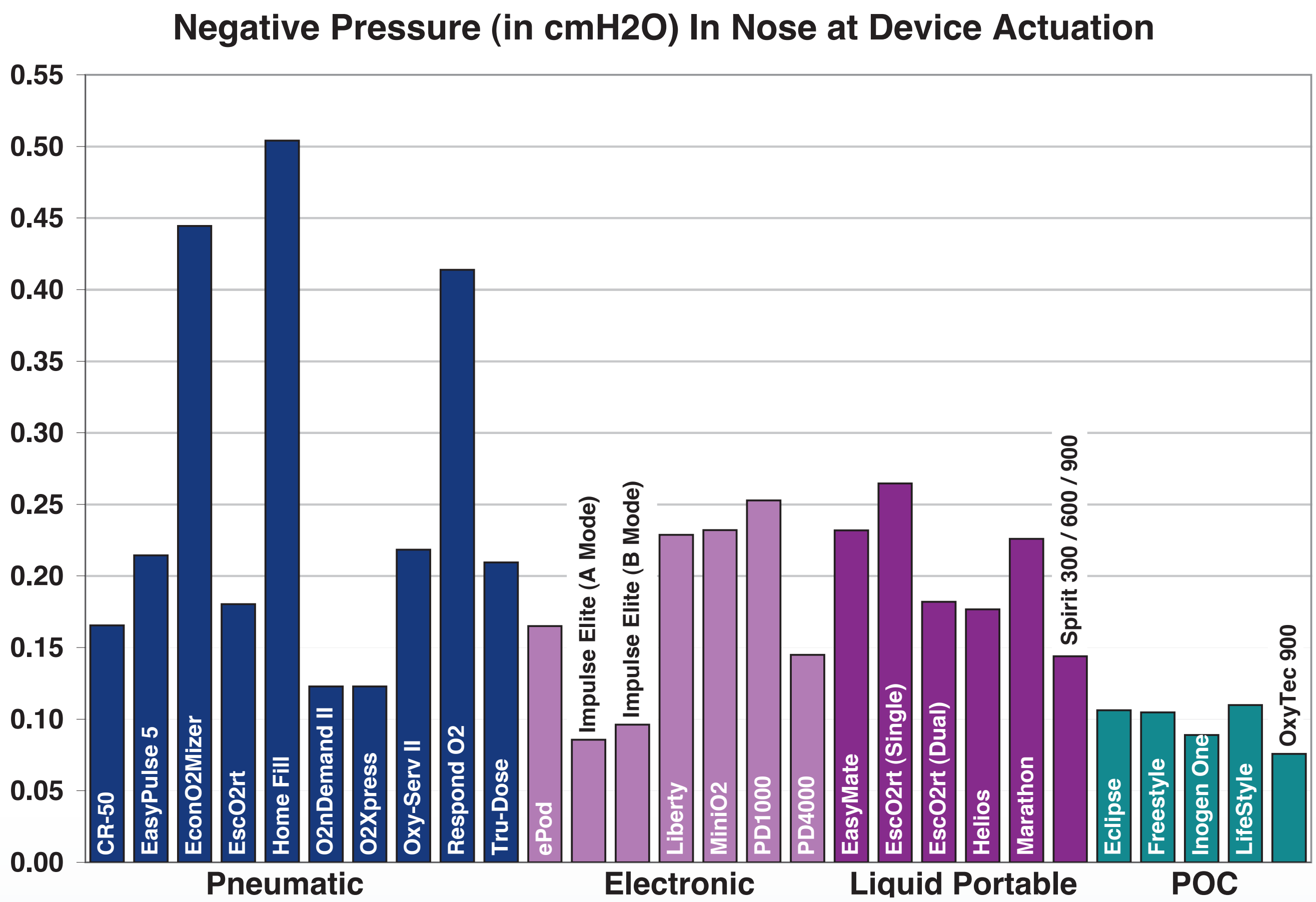


Sensitivity

All of the devices evaluated will generally trigger oxygen delivery under normal conditions with the user inhaling through their nose. Under these conditions, a relatively strong signal is present, and devices will respond reasonably quickly. However, when challenged with mouth or shallow breathing, including while talking, differences will begin to appear.

Units that have relatively low sensitivity may deliver late in inhalation, losing the effect of some of the gas delivery. Additionally, the longer the delay in delivery, the more likely the following breath may be missed. Both situations have the potential to result in reduced oxygenation.

Also affecting sensitivity is the choice of cannula, especially within the dual lumen variety used on many pneumatic devices. This is because of different nasal prong configurations. We have found that cannula with smaller prongs, while they may be more comfortable to the patient, may also result in a lower pressure signal being communicated to the conserving device. This is because the smaller prongs do not occlude the nostril as much as wider pronged cannula, resulting in less resistance to air flow. With a smaller cannula, a greater inspiratory flow may be necessary to create a threshold triggering pressure.

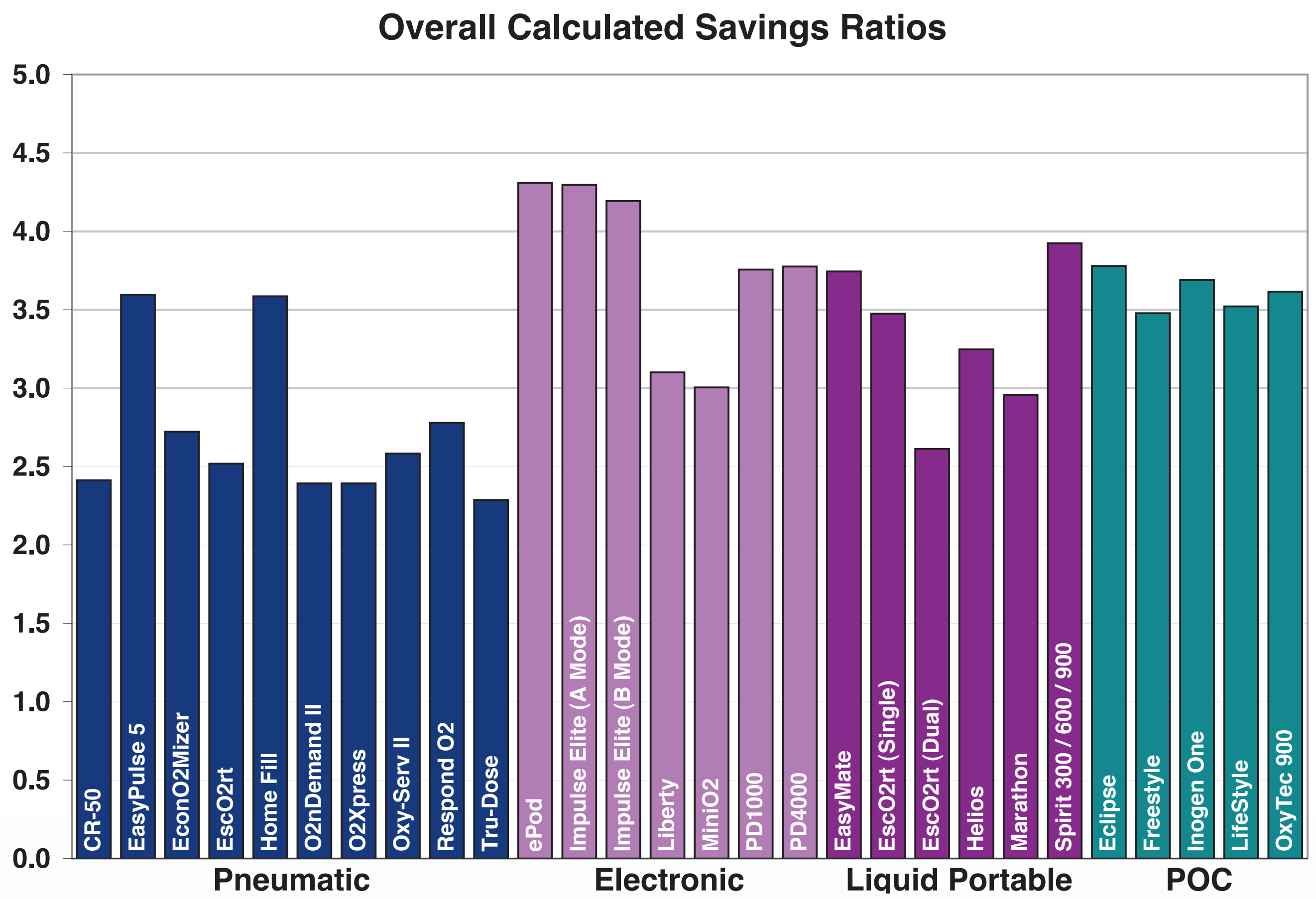


Calculated Savings Ratio

Much attention has been paid by marketing personnel regarding "savings ratio". This can be a very misleading quantity because it only considers the reduced oxygen consumption at the same numerical setting as continuous flow, not necessarily at the same oxygenation level. Hence, a device that delivers very little oxygen per breath will save a great deal, but it may not adequately oxygenate the patient.

Each manufacturer has their own justification, and often clinical studies, supporting these claims. Unfortunately, there are few side by side comparisons of devices, and little long term research. Patient studies are often complicated by the myriad of patient variables. As a result, there are devices that operate in very similar manners that report anywhere from 3:1 to 7:1 claimed savings ratios.

Here we report a "calculated savings ratio" (CSR), a qualitative measure of relative efficiency, based on similar oxygenation to continuous flow. See the Test Methods & Material section for information on how these values are calculated. While CSR values are not as critical in the use of portable oxygen concentrators (since those devices continually "manufacture" their own oxygen), they are nonetheless reported here.



Summary

The use of oxygen conserving devices with long term oxygen therapy continues to grow. New products with both patient and economic benefits in mind are continually entering the market, with oxygen conservation being the key component in accomplishing both of these objectives. Clinicians, providers, and patients need to know and understand the capabilities, limitations and applications of this type of equipment to ensure that the patient is maintaining proper oxygenation at all activity levels.

There has been confusion in the past due to the variability of the available equipment and the limited research and education related to the use of OCDs. This guide intended to illustrate what one should know about using an OCD, the key issues related to OCDs, and how several devices on the market operate.

There is no one right product for all applications of oxygen therapy. The patient's needs are the driving factor that should be considered when setting a given patient up with an OCD, and it is important to understand that every person's needs will be very different.

Understanding the capabilities of each OCD on the market will give users, clinicians, marketers, and manufacturers knowledge that can be used to ask the right questions, evaluate the user's needs, and the ability to make an informed decision when buying and using oxygen conserving devices.

Glossary of Terms Associated with the Use of Conserving Devices

Apnea: The cessation of breathing for an extended period of time. When the patient is on an OCD, the device will not have sensed a breath and oxygen will not have been delivered. Some OCDs feature a fail open mechanism that, when a breath is not detected for a certain amount of time, will switch to a continuous flow mode automatically.

Back-Up Flow: A continuous flow delivery option that may be selected if the OCD is not working properly, or if quiet operation is desired. Note that not all OCDs are equipped with this back-up flow option. Some devices have a fail open mechanism that will automatically switch to continuous flow when a patient breath is not detected for an extended period of time.

Bolus Volume: The amount of oxygen (in cc or mL) delivered in the initial delivery pulse from an OCD.

BPM: An abbreviation for breaths per minute.

Calculated Savings Ratio: A term coined by Valley Inspired Products when comparing equal amounts of oxygen delivered using conserving technology to that of continuous flow. See the Protocol section for the description of how this value is calculated.

Continuous Flow Oxygen Delivery: A style of oxygen delivery where oxygen is delivered throughout the entire breath cycle, usually at a set flow rate (e.g. 2 LPM Continuous Flow). Today, this method of oxygen delivery is considered inefficient, though it is still prescribed in most hospitals and for emergency medical services.

CFO: An abbreviation for Continuous Flow Oxygen Delivery.

Demand Flow Delivery: A style of oxygen delivery by a conserving device where oxygen delivery begins when the device senses patient inhalation and is stopped when the OCD senses an exhalation signal from the user.

DODS: An abbreviation for Demand Oxygen Delivery System. This term is often used in many research papers involving OCDs. A DODS device is the same as a Demand Flow Delivery device.

Dose Volume: The volume (in cc or mL) of oxygen delivered by an OCD at a given setting for one breath.

Dual Lumen Cannula: A two-channel nasal cannula style that is used primarily with pneumatic conservers. One channel senses patient inhalation and exhalation; the other channel serves as the conduit for oxygen delivery to the patient.

Electronic OCD: An OCD requiring the use of and electric power source either AC or batteries to functionally operate. The length of time an OCD operates from battery power will vary based on the user's respiratory rate and selected OCD setting. Number and type of batteries required for use varies by device. All electronic OCDs are Pulse Flow Delivery style devices.

Equivalency: A term used primarily with early conserving devices to indicate similar oxygenation at a given device setting to that of continuous flow (e.g. a setting of "3" on a particular OCD yields equivalent oxygenation of CFO therapy at 3 LPM). It is not appropriate to assume that any OCD device at a given numerical setting has equivalency to CFO at that same setting.

Fail Open: A mechanism in an OCD that will switch the device to continuous flow delivery if there is an apnea detected for a specific period of time.

FIO2: An abbreviation for Fraction of Inspired Oxygen. FIO2 is a measurement of the percentage of oxygen in the air inspired during a given breath. A person breathing room air will take in air with 20.9% oxygen. A patient on oxygen will take in air with a higher percentage of oxygen—this value can depend on several factors, including delivery setting, pooling, and anatomy.

Hybrid OCD: A demand flow OCD that features characteristics of pulse flow delivery devices, primarily in that there is an initial pulse delivery of oxygen before flattening into a static flow rate until exhalation is sensed by the device, at which delivery is shut off to conserve oxygen during exhalation. Many pneumatic conservers currently on the market are of this style.

I:E Ratio: The ratio between inspiratory time and expiratory time in a single breath. An I:E ratio of 1:2 means that the expiratory phase is twice as long as that of the inspiratory phase.

Liquid Oxygen System: An oxygen delivery device that uses liquid oxygen as its source for oxygen delivery.

Long Term Oxygen Therapy: The administration of therapeutic oxygen to a patient as a continuous and ongoing therapy.

LOX: An abbreviation for liquid oxygen.

LPM: An abbreviation for liters per minute.

LTOT: An abbreviation for Long Term Oxygen Therapy.

Maximum Dose: The maximum amount of oxygen delivered at the maximum setting by an OCD.

Minimum Dose: The minimum amount of oxygen delivered at the minimum setting by an OCD.

Minute Volume Delivery: A style of oxygen delivery where the amount of delivered oxygen is dependent on both a fixed amount of oxygen available and the patient's respiratory rate over the course of one minute. An OCD with minute volume delivery can deliver twice the oxygen dose at 15BPM than it will at 30BPM. Over the course of one minute, though the delivered dose volume at 15BPM is double that of the dose volume at 30BPM, the amount of oxygen used by the OCD in one minute is equal.

Nasal Cannula: A length of specially designed tubing—usually 5′ to 7′—used to administer oxygen to a patient. It is the most common interface style used by patients on oxygen.

Non-Delivery System: A home oxygen system that does not require the oxygen provider to regularly deliver compressed or liquid oxygen to the patient's home. This term encompasses portable oxygen concentrators and stationary concentrators that can transfill a portable oxygen system.

O_2 (or O2): An abbreviation for oxygen.

OCD: An abbreviation for Oxygen Conserving Device.

On-Time: The total time an OCD delivers oxygen during a single patient breath. The on-time is usually a set value and consistent with electronic OCDs; the on time with pneumatic systems is variable with changing breath rates and I:E ratios.

Operating Pressure: The pressure the OCD is specified to operate at. Most OCDs operate at 20 or 50 psig. Portable oxygen concentrators generally operate at within 5 to 10 psig.

Oxygen Concentrator: An oxygen delivery system that separates oxygen from room air, allowing for high-concentration (usually 87 to 93%) oxygen to be delivered to the patient, usually via continuous flow delivery. As these devices continually "manufacture" oxygen, conservation is not an important factor with their use.

Oxygen Conserving Device: An oxygen delivery device that "conserves" oxygen by delivering oxygen during a patient's inspiratory phase only. Oxygen is not delivered during most, if not all, of the expiratory phase. For transtracheal oxygen delivery systems, oxygen conservation is accomplished by bypassing the dead space volume in the patient's upper airway.

Oxy-view Glasses: Eyeglasses that have an oxygen delivery lumen built into the frames. Both single and dual lumen cannula devices can be used by a patient wearing Oxy-view glasses. Cannula tubing is connected to the glasses behind the ears, and clear nasal prongs attach to the frame on both sides of the bridge of the nose.

Peak Flow: The maximum flow of oxygen during delivery on a conserving device.

Pneumatic OCD: An OCD where all parts and functions are mechanical in nature- there are no on-board electronics, and no batteries are needed for the device to operate.

Portable Oxygen Concentrator: A smaller, lighter-weight oxygen delivery system compared to standard oxygen concentrators. In order to conserve "manufactured" oxygen during use, which allows the devices to be constructed in smaller case housing, all portable oxygen concentrators utilize conserving technology.

POC: An abbreviation for Portable Oxygen Concentrator.

Pulse Flow Delivery: A style of oxygen delivery where the volume of oxygen delivered is timed. When a pulse flow OCD senses inhalation, it will deliver its entire dose within a specified time frame, at which point oxygen delivery ceases. All electronic OCDs use this method of delivery, as well as some pneumatic OCDs.

Pulse Indicator: A light that indicates when an inhalation has been sensed and the OCD has responded. The pulse indicator activating does not necessarily indicate that oxygen has been delivered, just that the breath was sensed and the OCD triggered its delivery mechanism.

RR: An abbreviation for respiratory rate.

Saving Ratio: The ratio of the amount of oxygen savings possible using a conserving device compared to continuous flow oxygen. An OCD with a true 3:1 savings ratio means that it will take the patient three times as long to empty an O2 cylinder on that OCD than it would if the patient was using the tank with continuous flow oxygen. See the section on Calculated Savings Ratio for further discussion on savings ratio.

Sensitivity: How fast the OCD responds to an inspiratory signal. Device sensitivity can be controlled by pressure or flow characteristics.

Single Lumen Cannula: A standard cannula used for low flow oxygen delivery. When used with an OCD, sensing and delivery are accomplished through a single channel.

Transfill: The process of filling one cylinder or liquid portable from the contents of a separate stationary oxygen system.

Transtracheal Oxygen Delivery: A method of oxygen therapy where an incision is made at the base of the patient's neck allowing a small catheter to pass through to the larynx, thus bypassing the oro-nasal cavity, and allowing oxygen to be delivered directly into the airway.

TTO: An abbreviation for Transtracheal Oxygen delivery.

Valley Inspired Products
15112 Galaxie Avenue
Apple Valley, MN 55124
Phone:952.891.2330
Fax: 952.891.4625

2007 Guide to Understanding Oxygen Conserving Devices

Robert McCoy BS RRT FAARC
Managing Director
Valley Inspired Products, Inc.
bmccoy@inspiredrc.com

Ryan Diesem
Research Associate
Valley Inspired Products, Inc.
rdiesem@inspiredrc.com

Design & Layout by Jonathan Johnston
jon@jonjohnston.com

Product Photography by Lynn Jonson
lynnjonson@comcast.net

VALLEY
INSPIRED
PRODUCTS