

**WHITE PAPER**

# **Comparison of Three Portable Oxygen Concentrators on Exercising Patients**

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## ABSTRACT

Portable oxygen concentrators (POCs) are becoming more widely available for ambulation and travel. New POC systems have recently been introduced with features and benefits that are of interest to many patients, including a lightweight package and extended battery operation. There has been little research on the clinical capabilities of these new POCs related to their ability to maintain adequate oxygen saturations with exercise. Each POC on the market has a different performance capability related to minute production of oxygen and oxygen conserving dose methodology. We hypothesized that a POC with greater oxygen delivery capacity would allow patients greater exercise capacity.

Twelve patients were selected to compare three commercially available portable oxygen concentrators while exercising to determine if the patients could maintain oxygen saturations above 88% for a 10-minute walk. Eleven patients were able to complete the walk on the EverGo™ POC, nine patients were able to complete the walk on the Inogen One POC and seven patients were able to complete the walk on the FreeStyle POC. Conclusion: Each POC tested had a different performance capability that had an impact on the patient's ability to complete a 10-minute walk.

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## INTRODUCTION

Portable oxygen concentrators (POCs) are an intriguing addition to the options available for long-term oxygen therapy. The idea of a POC was promoted at early oxygen consensus conferences as an encouragement to the industry to produce smaller, more user-friendly ambulatory oxygen systems. The third oxygen consensus conference<sup>1</sup> identified specifications for a portable oxygen system as a guideline for new products to be developed. The challenge of providing an oxygen system that is small enough to be routinely used by an ambulatory patient, yet capable of meeting oxygenation needs of a patient during activity, has been the focus of product development and research for years. Information on the abilities of new oxygen systems to provide adequate oxygen saturation at all activity levels is very important, yet is lacking in the field. This study evaluated the ability of three new POCs to meet a patient's oxygenation needs with exercise.

## BACKGROUND

The Nocturnal Oxygen Therapy Trial<sup>2</sup> (NOTT) identified the survival benefits of continuous oxygen therapy (COT), and later analysis of the NOTT data<sup>3</sup> identified economic benefits of COT in reduced hospitalizations.

In recent years, there has been increasing economic pressure on the delivery of portable oxygen. Portable oxygen concentrators have the potential of reducing the service cost associated with providing ambulatory oxygen systems. Over the past six years, portable oxygen concentrator use among ambulating and traveling patients has increased significantly. There has been little

research on the capabilities of these systems for different patient groups at different activity levels and it is unknown what impact their increasing use might have on overall patient care. Oxygen conserving devices (OCDs), a key component in all existing POCs, vary in performance related to oxygen dose per setting and maximum oxygen dose delivery.<sup>4</sup> Additionally, POCs have limited oxygen production capabilities, meaning that under high demand conditions there may be a tradeoff between maintaining the specified oxygen concentration and maintaining a consistent pulse volume.

There are no standards for POCs related to maximum oxygen production per minute or the dose volume that corresponds to a dose setting. Bench testing of oxygen equipment provides an opportunity to see how products will perform under the same simulated lung conditions and allows for a consistent comparison of similar products under the same condition. Bench testing of POCs has shown variability in device performance related to dose volumes at various breath rates.<sup>7</sup>

Understanding this variability in OCD and POC performance, the Sixth Oxygen Consensus Conference<sup>5</sup> recommended that any oxygen system be titrated for adequate oxygen saturation at all achievable activity levels. The American Association for Respiratory Care's (AARC's) clinical practice guidelines<sup>6</sup> also indicate the need to adjust the oxygen system so that the delivered oxygen dose matches what the patient will need at the activity level for which the device will be applied. Even though these recommendations have been established, it is still not part of mainline practice for providers despite the modest additional cost and complexity.

## MATERIALS

<b>TREADMILL</b>	ProForm™ 380 I	ICON Health and Fitness, Logan, Utah
<b>OXIMETER</b>	PalmSAT®2500	Nonin Medical, Inc., Plymouth, Minnesota
<b>TEST UNIT 1</b>	EverGo™	Respironics, Inc., Murrysville, Pennsylvania
<b>TEST UNIT 2</b>	FreeStyle™	AirSep Corporation, Buffalo, New York
<b>TEST UNIT 3</b>	Inogen One™	Inogen Inc., Goleta, California

## METHOD

Prior to any testing, the study protocol was approved by an Investigational Review Board (IRB) and all patients were provided a thorough explanation of the test procedures before signing informed consent forms. Subjects arrived for testing and were rested with their primary oxygen device for no less than 30 minutes. Baseline resting saturation and heart rate data for each subject was then recorded.

Subjects were asked to step on the treadmill with their primary oxygen device. The treadmill was set at a speed of 1 mph and incline of 0% grade. Subjects were instructed not to talk during the exercise portion of the test and to breathe only through their nose. Saturation (SpO<sub>2</sub>) and heart rate data were collected every minute for 10 minutes, at which point the treadmill was turned off and the subject was asked to sit down until the baseline saturation level at rest was achieved. The resulting saturation and heart rate data was recorded as the baseline exercising saturation and heart rate.

The three POCs were then similarly tested, in a randomized order. Prior to stepping on the treadmill, each trial POC device

was titrated at rest to a level consistent with the subject's current oxygen prescription (or 90%, whichever was greater). As the subject exercised, if the subject's oxygen saturations fell below 88%, the dose setting on the trial POC was increased until oxygen saturations of >88% were maintained or the device could not be set to a higher dose setting. If the subject was unable to maintain >88% oxygen saturations and the device was set to its highest dose setting, then the study was ended and the subject was immediately placed on his or her existing oxygen system.

There was a thirty-minute rest period between exercise sessions. Two devices were tested per session to reduce fatigue. Return visits were scheduled as quickly as possible with a target of less than 3 days and no longer than 2 weeks. Day 1 of the study included the exercise test of the subject's existing system and random POC 1. Day 2 of the study included the exercise test of random POC 2 and random POC 3. The subject's primary oxygen equipment was available to the subject at all times during the study to be used if a problem or concern occurred during the test.

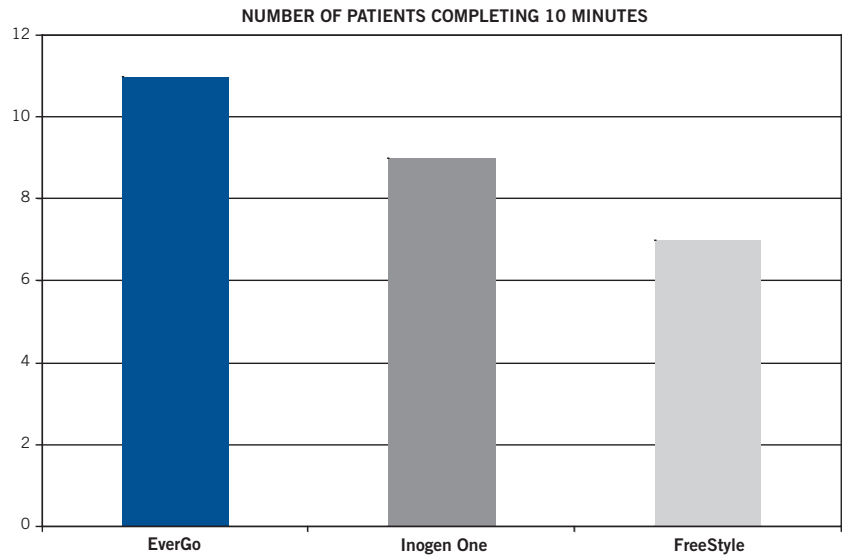
## PATIENT DEMOGRAPHICS

PATIENT	GENDER	AGE	FEV1%	REST O <sub>2</sub>	REST SpO <sub>2</sub>	REST HR	PRIMARY SYSTEM
1	Female	64	41	2	95	77	PD4000
2	Male	63	30	3	94	81	Spirit 300
3	Female	69	66	3	94	87	Spirit 300
4	Male	66	55	2	95	91	Marathon
5	Female	72	57	2	98	88	Invacare Homefill
6	Female	72	82	2.5	97	60	Invacare Homefill
7	Female	70	28	2	96	78	Helios
8	Female	72	50	2	98	77	Marathon
9	Male	70	18	2	97	69	Marathon
10	Male	78	59	2.5	95	68	Helios
11	Female	62	43	2	93	90	Helios
12	Male	71	54	2	97	72	Helios
<b>AVERAGE</b>		69.1	48.6	2.3	95.8	78.2	<b>MALE</b> 5
<b>STD DEV</b>		4.6	17.7	0.4	1.7	9.7	<b>FEMALE</b> 7

## RESULTS

Eleven patients were able to complete the 10-minute exercise period on the EverGo, nine on the Inogen One, and seven on the FreeStyle. Inability to complete the 10-minute walk was due to the inability to maintain 88% SpO<sub>2</sub> in all cases.

The Treadmill Study Summary data revealed variability in average dose setting, final oxygen saturation levels, average minutes walked, and average distance walked for all 12 patients. Data is displayed by patient number.



## FINAL SETTING NUMBER

	1	2	3	4	5	6	7	8	9	10	11	12	Avg
EverGo	3	3	4.5	3	2	2.5	2	5	5	3.5	2	2	3.1
Inogen One	4	3	5	5	4	3	3	5	5	4	3	2	3.8
Freestyle	3	3	3	3	2	3	3	3	3	3	2	3	2.8

## FINAL WALKING SPO<sub>2</sub>

	1	2	3	4	5	6	7	8	9	10	11	12	Avg
EverGo	92	95	91	93	98	96	91	87	90	92	95	93	92.8
Inogen One	92	91	88	88	94	95	92	86	90	90	93	90	90.8
Freestyle	90	92	88	88	96	94	91	85	87	87	92	92	90.2

## MINUTES WALKED

	1	2	3	4	5	6	7	8	9	10	11	12	Avg
EverGo	10	10	10	10	10	10	10	7	10	10	10	10	9.8
Inogen One	10	10	6	7	10	10	10	4	10	10	10	10	8.9
Freestyle	10	10	5	5	10	10	10	3	4	4	10	10	7.6

## FEET WALKED

	1	2	3	4	5	6	7	8	9	10	11	12	Avg
EverGo	880	880	880	880	880	880	880	616	880	880	880	880	858
Inogen One	880	880	528	616	880	880	880	352	880	880	880	880	785
Freestyle	880	880	440	440	880	880	880	264	352	352	880	880	667

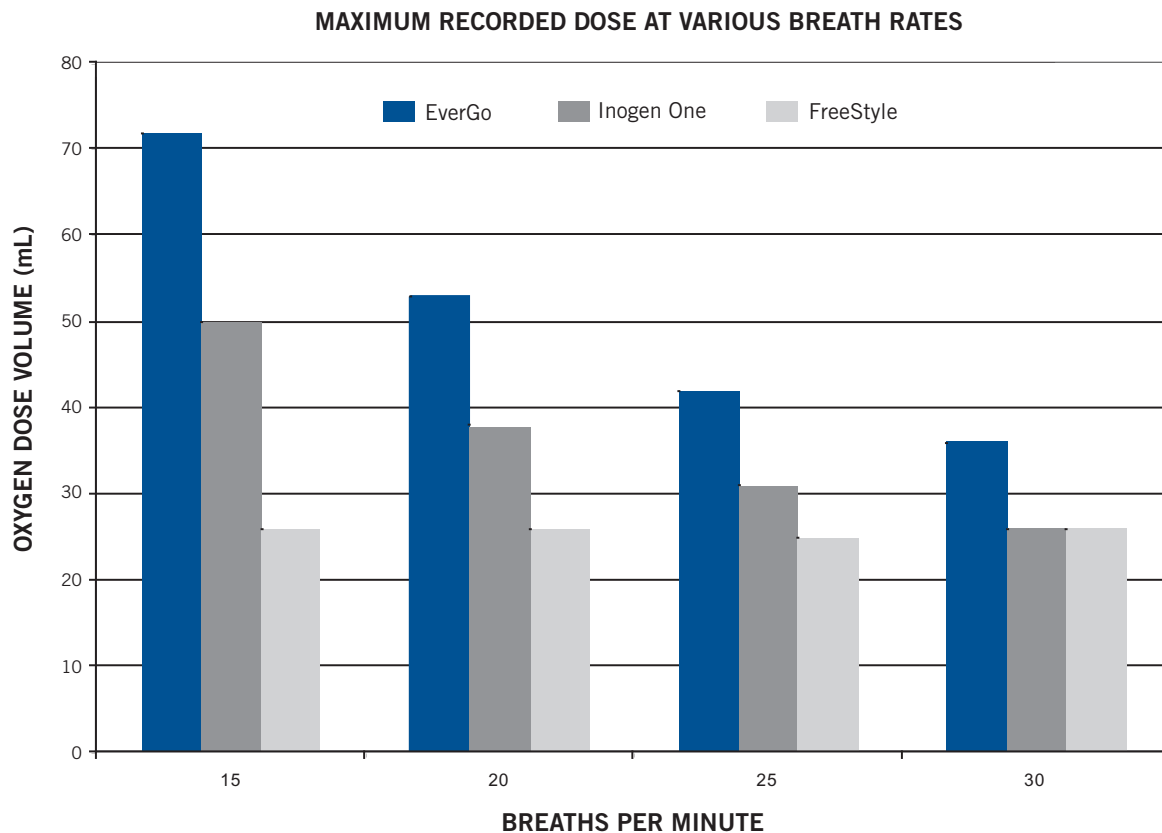
## DATA AVERAGES FOR THE ABOVE FOUR PARAMETERS FOR EACH DEVICE

	SETTING	SpO <sub>2</sub>	MINUTES	FEET
EverGo	3.1	92.8	9.8	858
Inogen One	3.8	90.8	8.9	785
Freestyle	2.8	90.2	7.6	667

## DISCUSSION

Bench testing data has shown that each POC in this study produces a different volume of oxygen per minute, a different dose volume per setting and that each unit responds differently to an increase in respiratory rate<sup>7</sup> (see below).

There was a direct correlation between the oxygen production capacity of the POC and the total distances walked by the subjects in this study. The ability of a POC to produce higher amounts of oxygen as compared to another POC appeared to provide oxygen levels that allowed patients to exercise longer at an average lower dose setting and an average higher oxygen saturation level.



## CONCLUSION

POCs with greater oxygen delivery capacity gave patients in this study greater exercise capacity, allowing them to walk further at higher SpO<sub>2</sub> level. Oxygen production and dose capabilities of POCs do vary and the needs of each patient must be assessed before placing the patient on a POC. Proper titration is needed to determine the optimal dose setting per device and whether the device selected has the capabilities to oxygenate the patient adequately for activity.

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