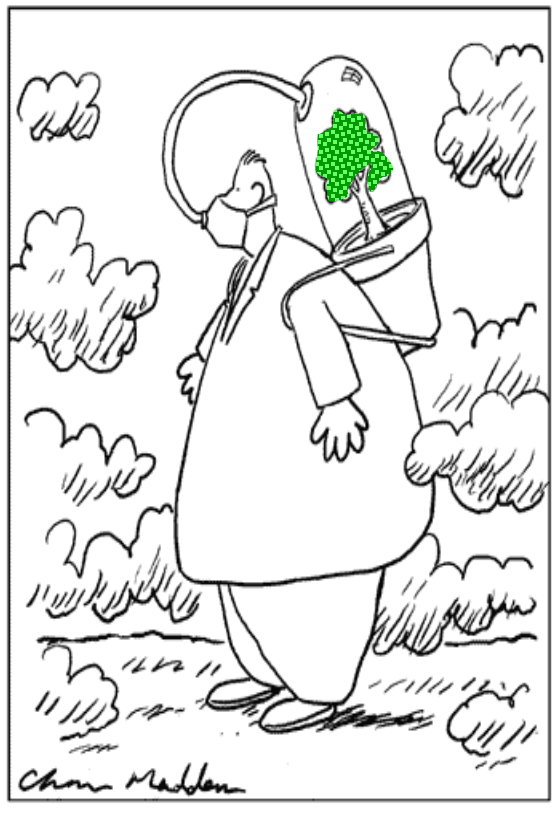
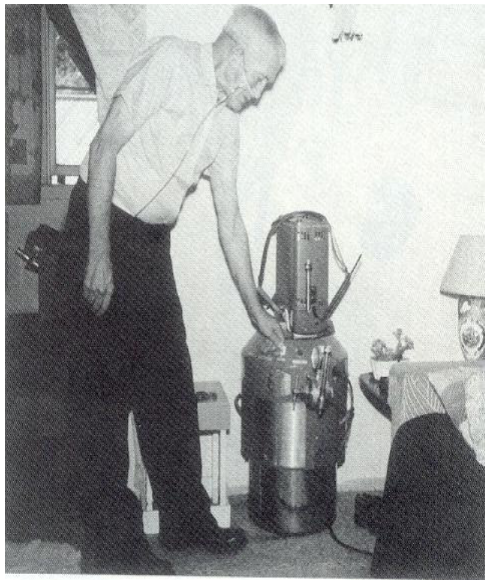


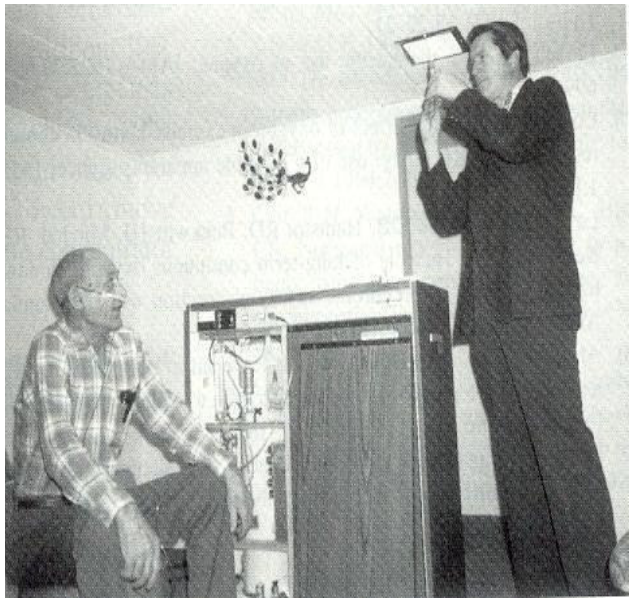
Portable Oxygen Concentrators (POC)

Performance Variables that Affect Therapy

Robert McCoy BS RRT FAARC

Old LTOT Patients and Products





New LTOT Patients and Products

You've come a long way baby

LTOT Market Trends

- Early diagnosis
- Early treatment
- Maintain active (normal) life
- More options and more choices
- Patients involved in therapy

New LTOT Products

- Can we see the forest for the trees?
  - Products are tools for clinicians to use. (trees)
  - Clinically effective therapy with positive patient outcomes is the objective (forest)

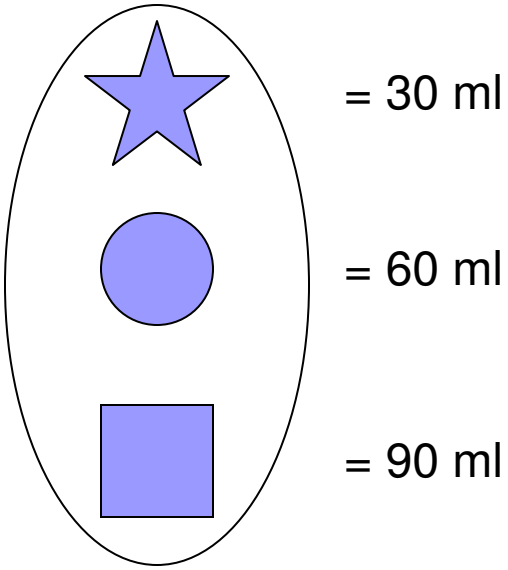
Variables Related to Oxygenation

- Activity / Environment
  - Rest
  - Exercise
  - Sleep
  - Altitude
- Oxygen %
- Patient / physiology / disease

Dose vs. Saturation

- The numbers on the dial are reference points
- Obtain the right saturation and then look at the dial

Example dose control



Oxygen Therapy Prescription

- 2 lpm continuous flow ?
- What is missing?
  - Titration with device the patient will be using at activity level
  - Understanding device operation
  - Respiratory rate and tidal volume
  - Follow up

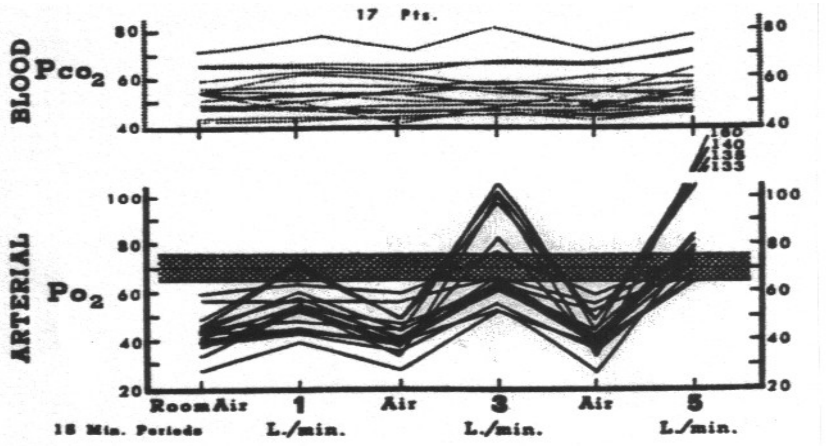


Figure 7. Arterial blood gas response in 17 patients with chronic airway obstruction in whom progressive P_{CO_2} rise did not develop while they were receiving low flow oxygen. (Cross-hatched area represents normal $P_{a_{O_2}}$ at Denver.)

Recommendations from LTOT Consensus Conferences

- Titration LTOT with activity has been specified or implied since the 2nd Consensus Conference.
- Recommendation 8 from 2nd LTOT Consensus Conference (1987) "Clinical evaluation should include regular assessments of patients compliance with prescribed therapy, potential complications, potential hazards and the need for continued education. Patients receiving LTOT share responsibility with the prescribing physicians for remaining in communication with their physician in order to assure continued appropriate care for their condition"

Calculated Oxygen Concentrations Delivered by a Demand Valve with Pure Oxygen at Rest, Less-than-pure Oxygen at Rest and Less-than-pure Oxygen with Reduced Volume during Exercise

	A 20 b/min, rest			**B** 20 b/min rest			**C** 30 b/min, exercise		
L/min flow	Vox ml	Cox %	Cf %	Vox ml	Cox %	Cf %	Vox ml	Cox %	Vox %
"1"	10	100	22.6	10	95	22.5	6	95	21.9
"2"	20	100	***24.2***	20	90	23.8	12	90	22.7
"3"	30	100	25.7	30	85	***24.8***	18	85	23.3
"4"	40	100	27.3	40	85	26.1	24	85	24.1
"5"	50	100	28.9	50	80	26.9	32	80	***24.8***

Editorial: Dr. Shigeoka & Linda Gallegos RRT Respir. Care Jan. 2006 Vol 51 No1

Does 93% vs. 99% Make a Difference?

- Bolton CE, Annandale JA, Ebden P. Comparison of an oxygen concentrator and wall oxygen in the assessment of patients undergoing long term oxygen therapy assessment. Chron Respir Dis. 2006;3(1):49-51.

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Normobaric Hypoxia Inhalation Test vs. Response to Airline Flight in Healthy Passengers

Aviation, Space, and Environmental Medicine. Vol. 77, No 11 Nov. 2006

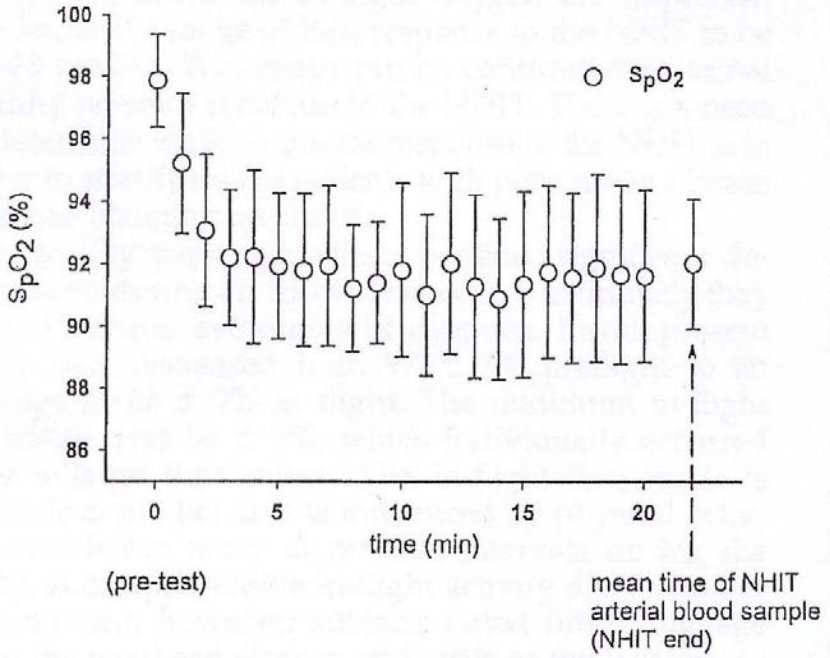


Fig. 1. Group S_{pO_2} response (mean ± SD) to the NHIT.

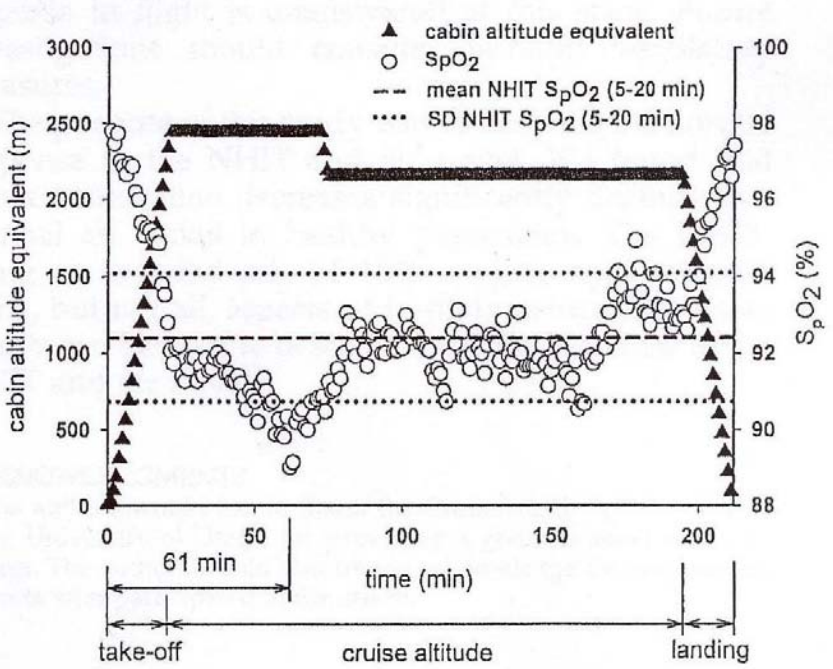


Fig. 2. Actual cabin altitude and in-flight S_{pO_2} (mean ± SD) on a study subject. NHIT S_{pO_2} (5–20 min) plotted on the y_2 axis for this subject.

Altitude Adventure

- 13 LTOT patients and 5 clinicians
- Bus trip to 10,500 ft
- Continuous oxygen monitoring
- 12 patients maintained > 90% sat during the trip
- My sat @ 84% at >10,000 ft with exercise

Check Saturation Levels

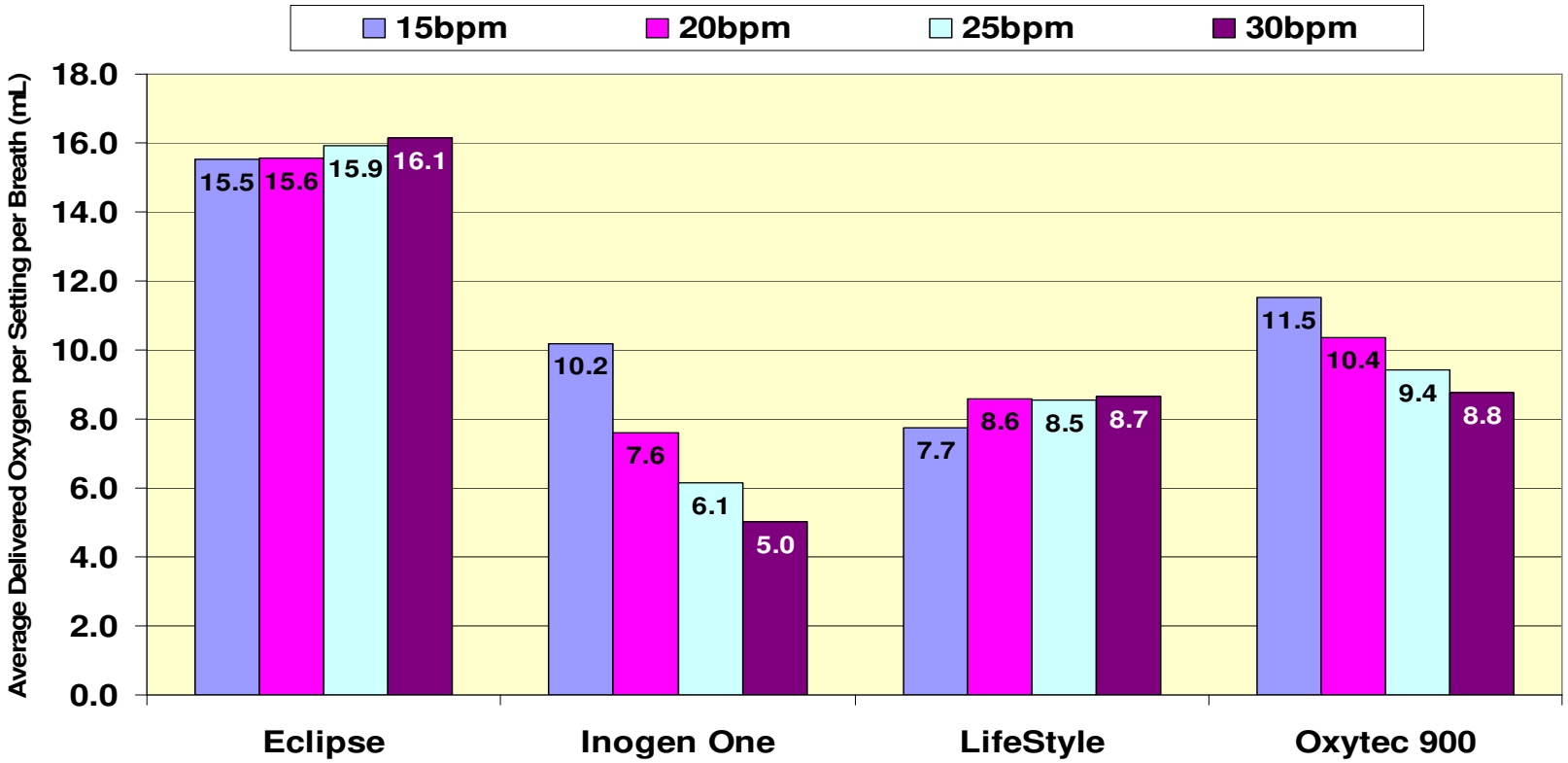
Portable Concentrator

- Improved operational range with access to ac or battery
- FAA approved
- Issues
  - Max. oxygen generation
  - Max. oxygen dose
  - Sleeping
  - 24 hour use

Specifications

Oxygen Dose Per Setting

15, 20, 25, 30 Breath per Minute



Breathing Patterns in COPD

Mean and (Standard Deviation)

Investigator	Severity	n	Rest F, min^{-1}	Rest Vt, cc	Sub Max Work F	Sub Max Work Vt	Max Work F	Max Work Vt	Ti/Tt
Bliss/NOTT '99 ('80)	FEV1 32%	99	**24** (6.8)		**26.7** (8.1)	**825** (411)	**32.1** (8.3)		
Schanning '76 *	FEV1 45%	14	**17** (4)	**650** (170)	**28** (5)	**1250** (270)	**32** (6)	**1480** (290)	
Schanning '78 *	FEV1 66%	18	**16.7** (3.4)	**920** (180)	**25.2** (5.4)	**1460** (320)	**33.7** (6.0)	**1910** (530)	0.44
Tobin '84									
PCO2<44	FEV1 35%	16	**20.4** (4.1)	**447** (139)					0.35
PCO2>44	FEV1 32%	12	**23.3** (3.3)	**476** (158)					
Sorlie '78 Supine									
PCO2 38 mean	FEV1 38%	8	**16.9** (3.9)	**930** (120)					0.39
PCO2 50 mean	FEV1 22%	7	**24.1** (9.1)	**640** (180)					0.41
Seated									
PCO2 38 mean	FEV1 38%	8		**710** (90)					
PCO2 50 mean	FEV1 22%	7		**560** (70)					
Bradley '79		20	**21.6** (1.6)	**580** (40)					0.34
Hagarty '97	FEV1 1.0L	15			**27** (6)	**1000** (400)	**30** (5)	**1300** (700)	

* Note that in the two studies by Schanning, the subjects were not as severely obstructed than in other studies.
In these trials, the diseased patients maintained tidal volumes almost as large as the normal, control group at rest and at sub-maximal exercise.

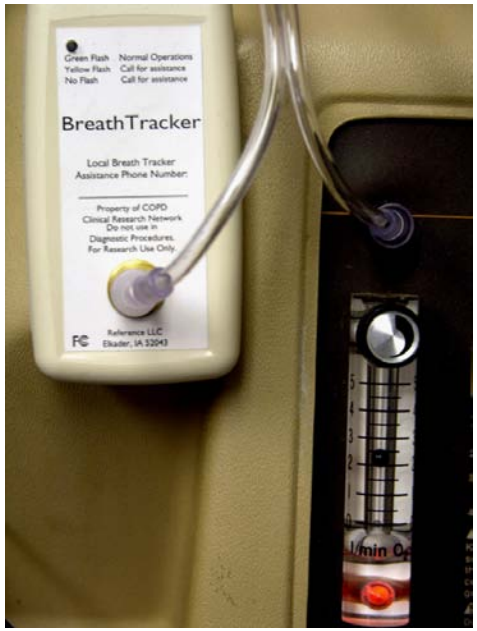
References

- Bradley GW, Fleetam, Anthonisen N. Ventilatory Control in Hypoxic COPD. *Am Review Resp Dis 1979*; 120:21-30
- Sorli J, Grassino A, Lorange G, Milic-Emili J. Control of Breathing in Patients with Chronic Obstructive Lung Disease. *Clinical Science and Molecular Medicine 1978*; 54: 295-304
- Hagarty EM, Skrodin MS, Langbein WE, Hultman CI, Jessen JA, Maki KC. Comparison of Three Oxygen Delivery Systems during Exercise in Hypoxemic Patients with Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med 1997*;155: 893-898
- Tobin MG, Tejvir SC, Jenouri G, Birch ST, Gazeroglu HB, Sackner MA. Breathing Patterns 2. Diseased Subjects. *Chest 1983*; 84:286-294
- Schanning J. Respiratory Cycle Time Duration during Exercise in Patients with Chronic Obstructive Lung Disease. *Scand J Resp Dis. 1978*;59:313-318
- Schanning J. Ventilatory and Heart Rate Adjustments during Submaximal and Maximal Exercise in Patients with Chronic Obstructive Lung Disease. *Scand J Resp Dis. 1976*;57:63-72
- Bliss P. Analysis of Nocturnal Oxygen Therapy Trial Data Set. *Unpublished. Valley Inspired Products 1999*

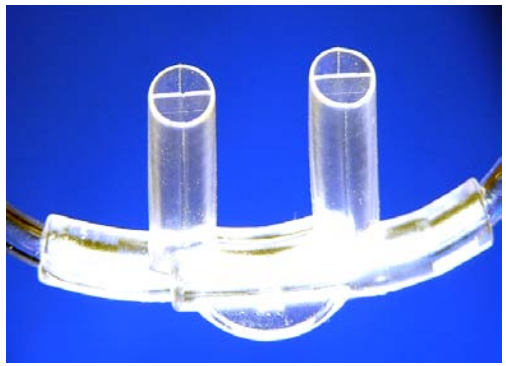
Breath Rate Tracking

Visual counting of breath rate: count for 15 seconds and multiply by 4, most recorded breath rates = 16 (4x4)

Dr. Tiep prototype



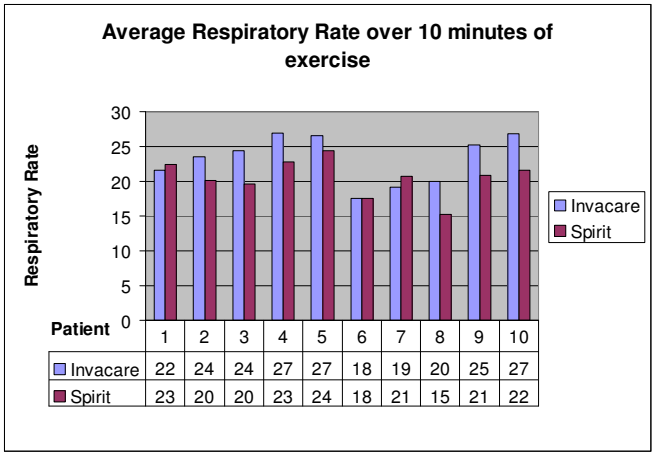
VIP Prototype



Duel Lumen Cannula

Average Respiratory Rate from Two Locations, using a Breath Rate Counter

Milwaukee WI

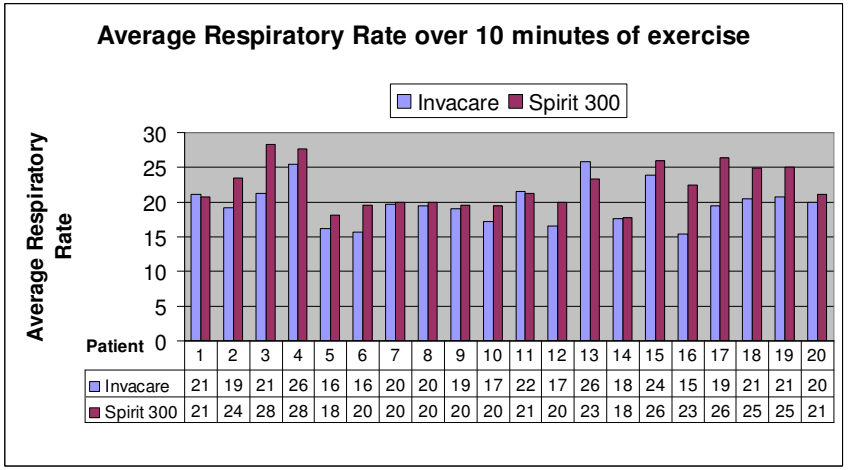


Average Invacare 23.18

Average Spirit 20.54

Combined 22 Breath per minute

Albuquerque NM

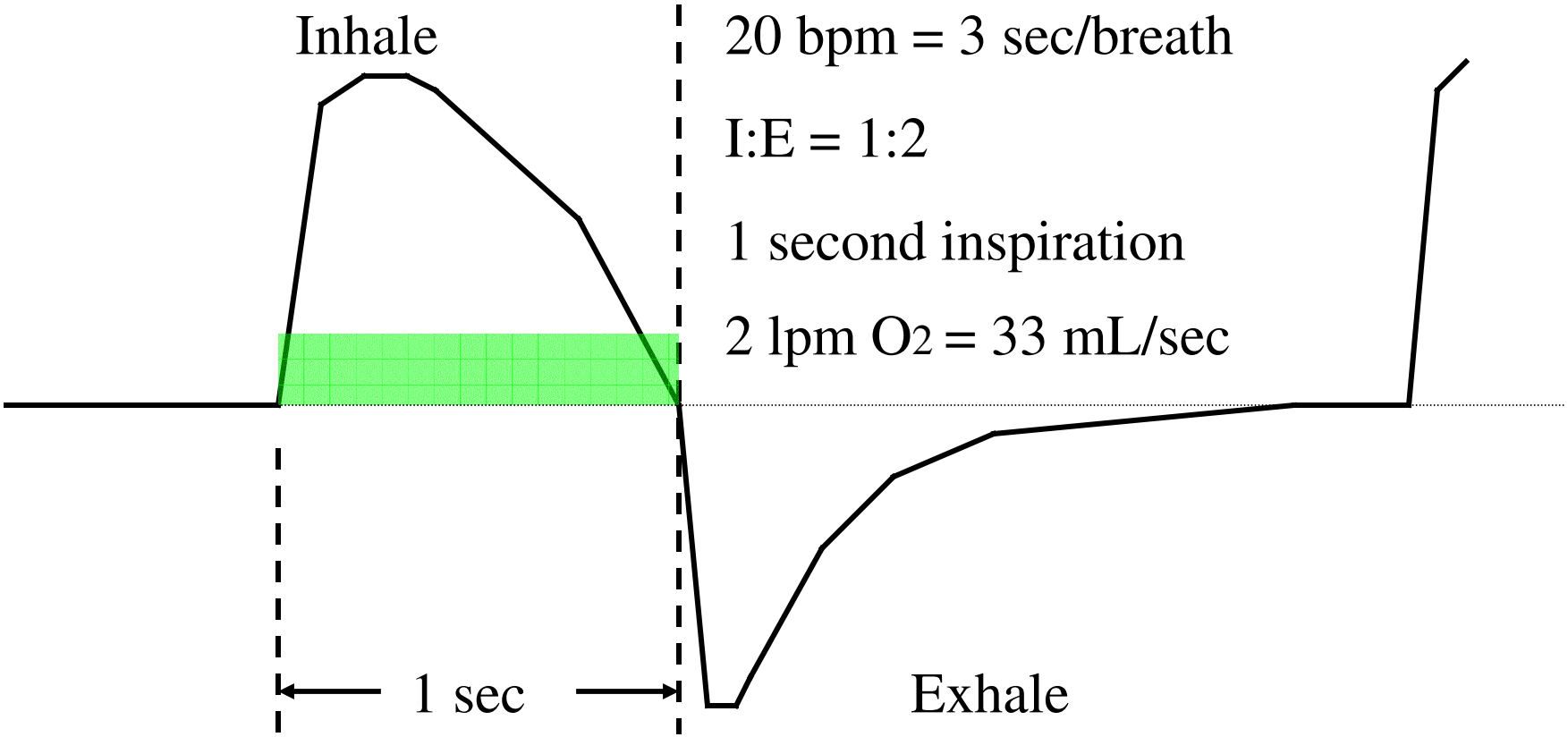


Average Invacare 19.79

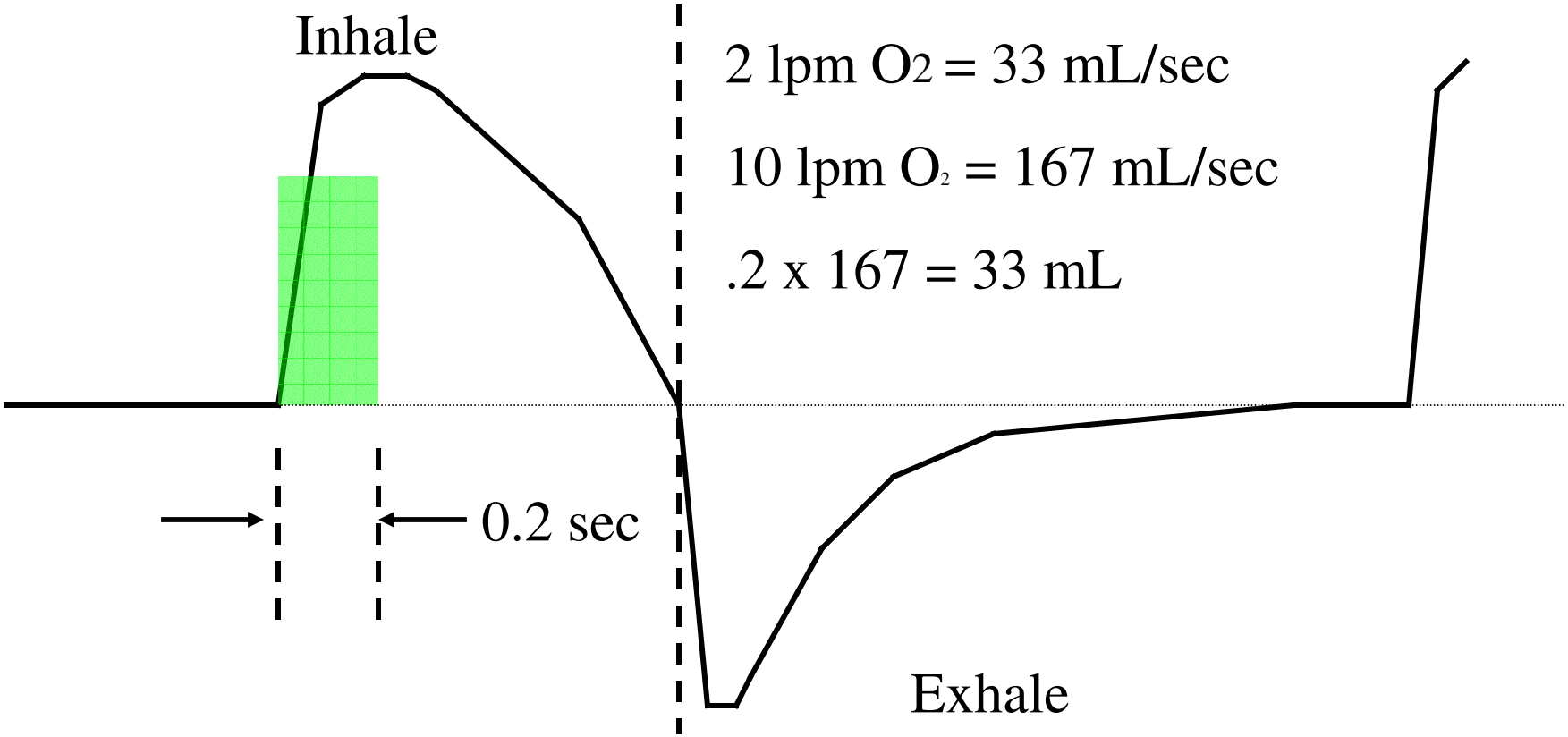
Average Spirit 22.25

Combined 21 Breath per minute

Oxygen Delivered in 1 breath



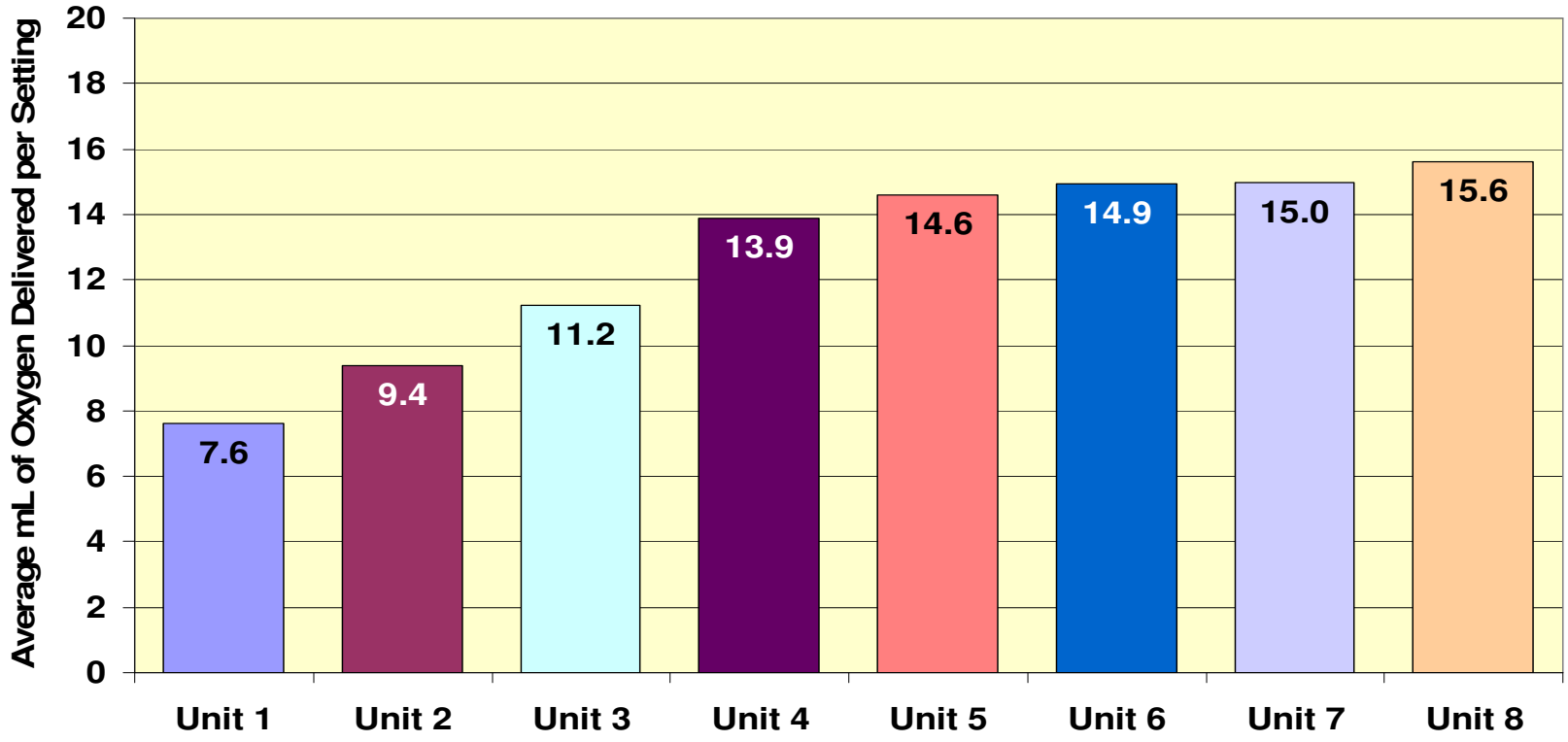
Oxygen Delivered in 1 breath



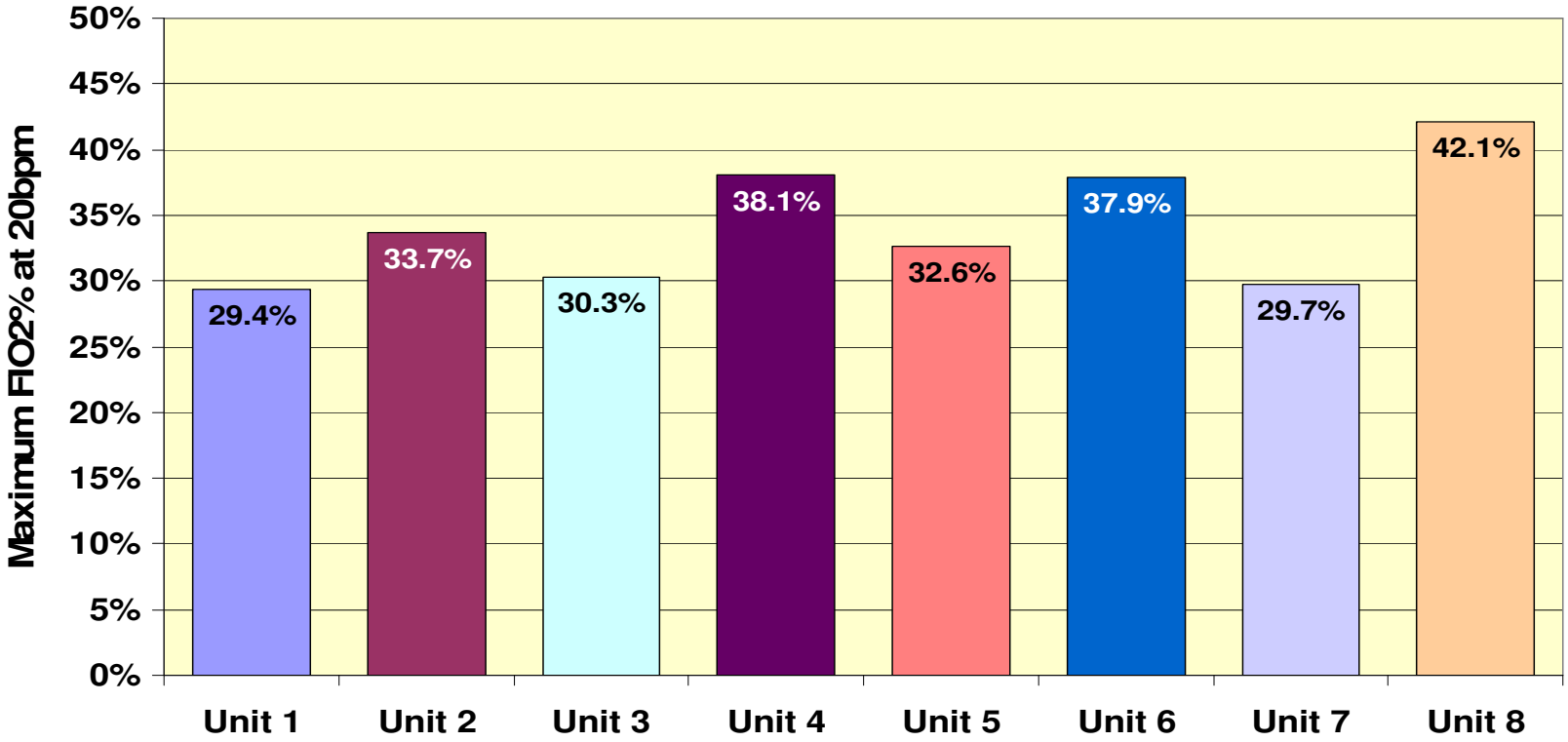
Issues Differentiating OCDs

- Dose per Setting
- Maximum O2 Delivery
- Oxygen Purity
- Response to Rate Increases
- Sensitivity

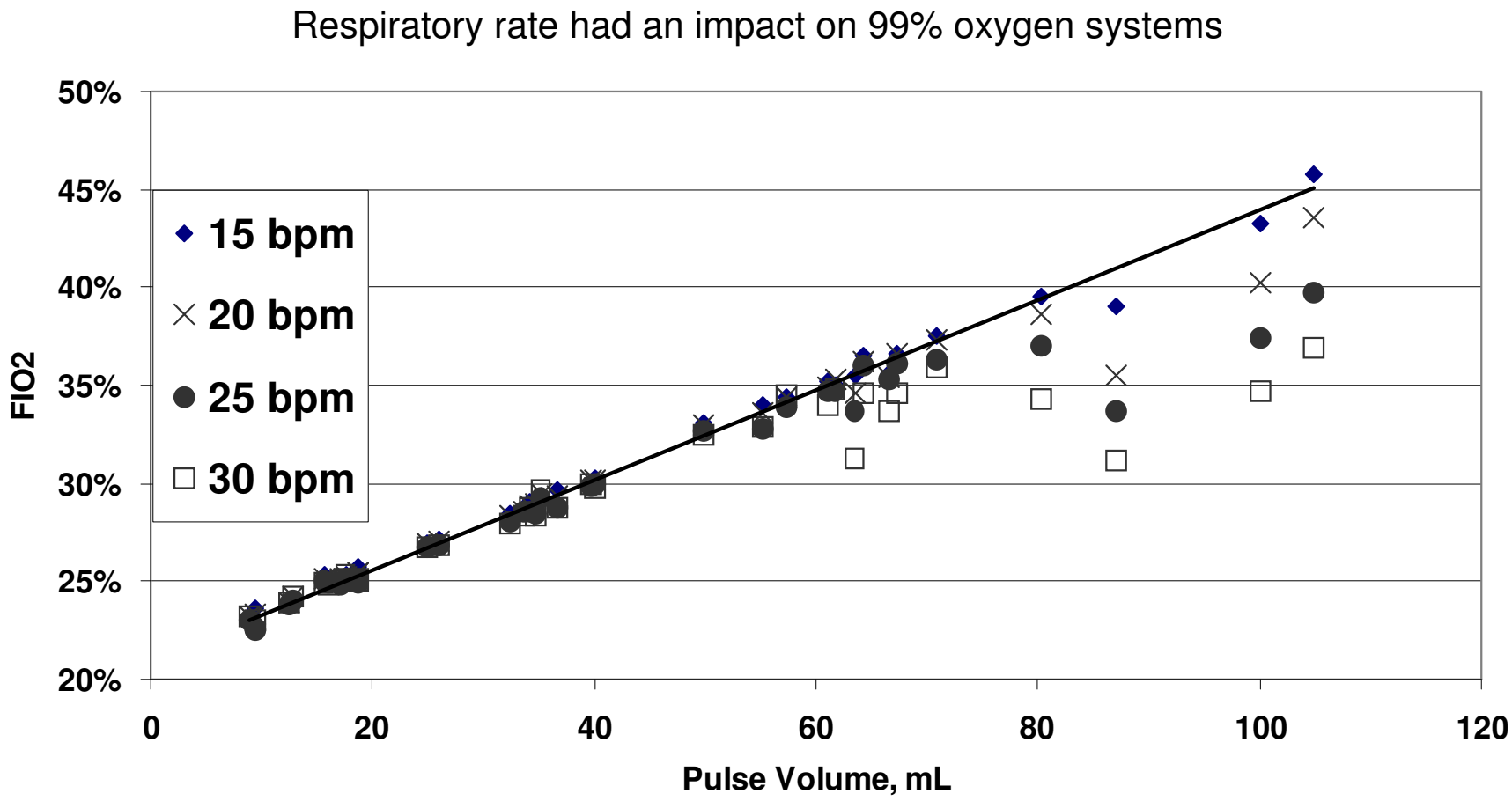
Pulse Volume per 1 lpm Setting



Maximum FIO2 (20 bpm)



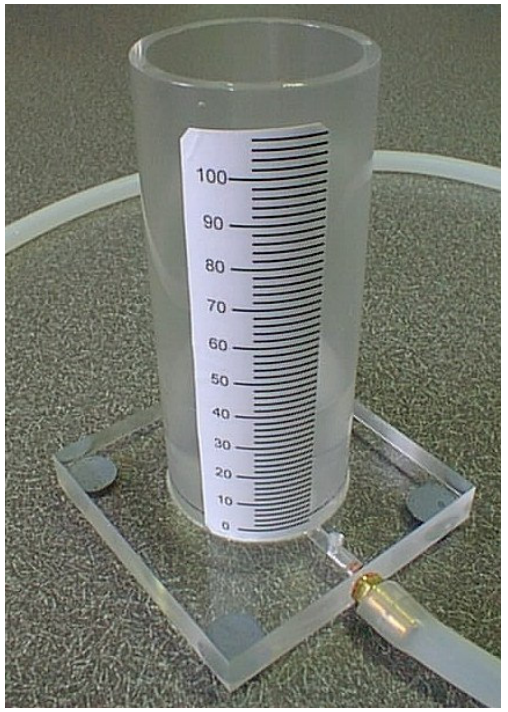
FIO2 vs. Pulse Volume



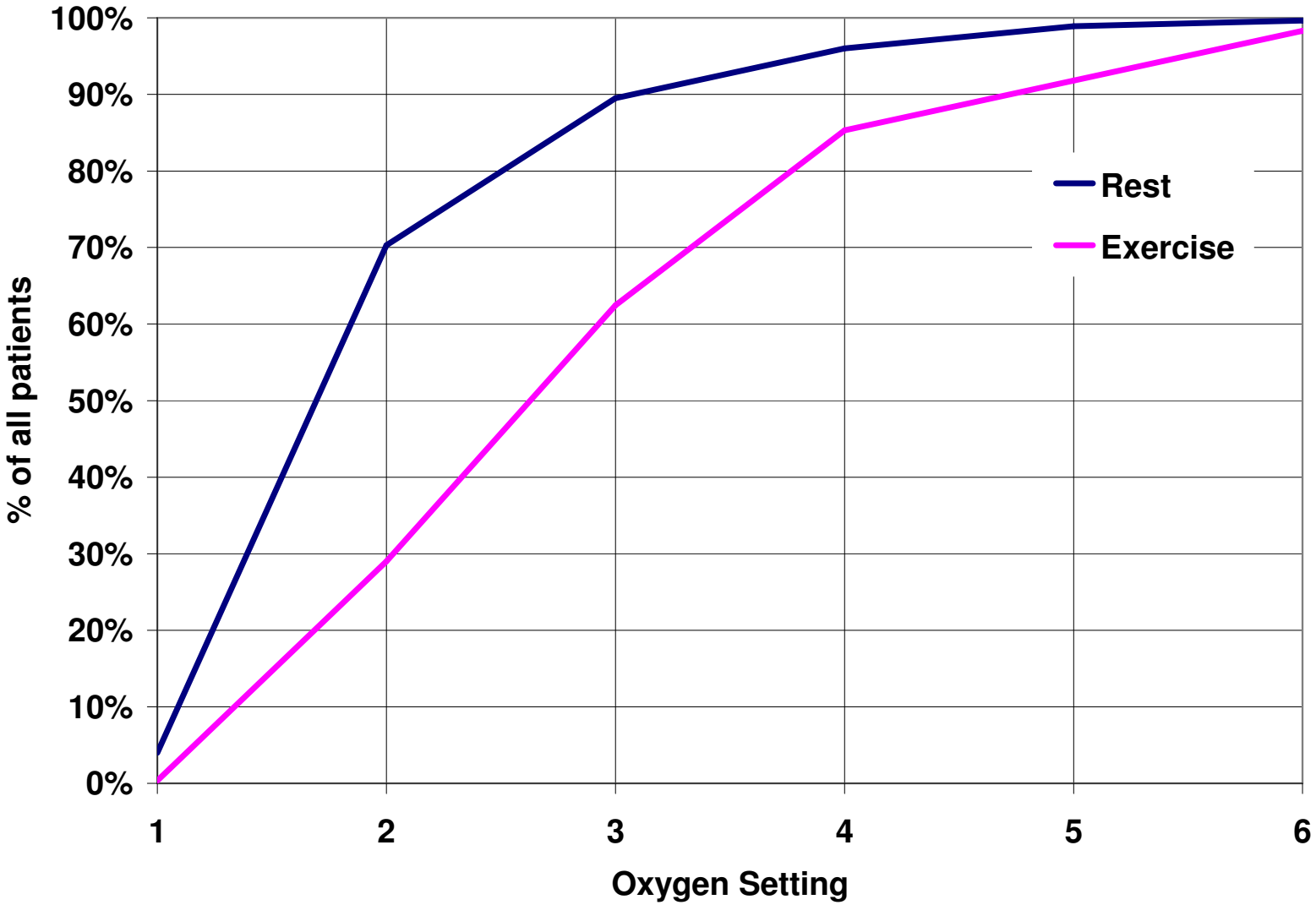
Testing Pulse Products

Device | Setting	1	2	3	4	5	6
Chad OM 301/2400	*	*	*	35	-	-
Chad OM 401/302	*	*	*	40	50	60
Chad OM 411/311	10	20	30	40	50	60
AirSep Impulse Select A Mode	*	*	*	35	44	52
AirSep Impulse Select B mode	17	33	50	66	83	99
Caire Spirit	15	30	45	60	75	-
Penox Escort	16	32	48	64	80	96

PulseMeter →



% of Patients Served



POC Sleep Study Demographics

Patient	Age	Gender	Diagnosis	AHI	Years on Oxygen
1	73	M	Emphysema	1.0	3
2	65	F	Emphysema	2.6	6
3	58	M	Pulmonary Fibrosis	0.8	3
4	73	M	Emphysema	9.0	3
5	77	M	Emphysema	4.4	.4
6	71	F	Emphysema	5.0	6
7	74	F	Emphysema	5.0	2.5
8	76	F	Emphysema	3.8	7
9	72	F	Emphysema	Not Available	1.5
10	64	F	Emphysema	1.6	5

Results

Patient	CF	PDOCD Sensitivity	PDOCD	Hours of data collection		Mean SpO_2 (%)			Mean HR (beats/min)		
				CF	PDOCD	CF	PDOCD	Δ	CF	PDOCD	Δ
1	0.75	S	1	7.4	9.2	94.0	93.2	-0.8	75	73.4	-1.6
2	2	S	3	7.1	6.6	96.0	95.8	-0.2	89.6	89.8	0.2
3	2	D	5	8.1	9.0	90.1	90.3	0.2	74.1	82.7	8.6
4	3	S	3	9.5	9.0	97.5	96.1	-1.4	79.7	69.6	-10.1
5	2	S	2	7.2	8.6	96.9	94.6	-2.3	64.3	63.9	-0.4
6	2	S	3	7.2	9.6	96.5	97.2	0.7	64.3	69.6	5.3
7	2	S	3	6.6	6.6	97.2	93.3	-3.9	69.3	69.6	0.3
8	2	D	2.5	7.2	9.0	96.9	86.3	-10.6	79.9	84.3	4.4
9	2	S	3.5	5.1	7.2	96.5	94.0	-2.5	80	80.5	0.5
10	2.5	D	3	5.6	6.5	95.0	91.6	-3.4	97	96.0	-1.0
			Mean	**7.1**	**8.1**	**95.7**	**93.2**	**-2.4**	**77.3**	**77.9**	**0.6**
			SD	**1.2**	**1.2**	**2.2**	**3.2**	**3.3**	**10.4**	**10.3**	**5.0**

Conserving Devices

- Multiple choices
- How do they work
  - Capabilities
  - Limitations
- Titrate for dose
- Understand the objective (patient oxygenation)

Oxygen Saturation and Heart Rate

Patient -	Spirit SpO2	Helios SpO2	Spirit HR	Helios HR
1	91.8	86.0	76.0	78.8
2	96.1	92.0	85.8	94.1
3	91.9	89.0	109.0	114.8
4	86.9	84.0	106.5	103.4
5	98.9	94.3	99.5	98.8
6	91.0	89.3	103.4	106.1
7	89.5	86.9	102.6	104.3
8	85.6	85.6	104.9	114.3
9	92.9	91.0	101.4	108.4
10	97.5	93.3	98.0	115.8
Average	92.2	89.1	98.7	103.9

Exercise and POCs

- Dose volume and maximum dose is an important factor
- Respiratory rate has an impact on oxygen dose and purity
- Patient should be titrated on the POC at the activity level they will be using the POC

NOTT Patients Matched for Ambulation

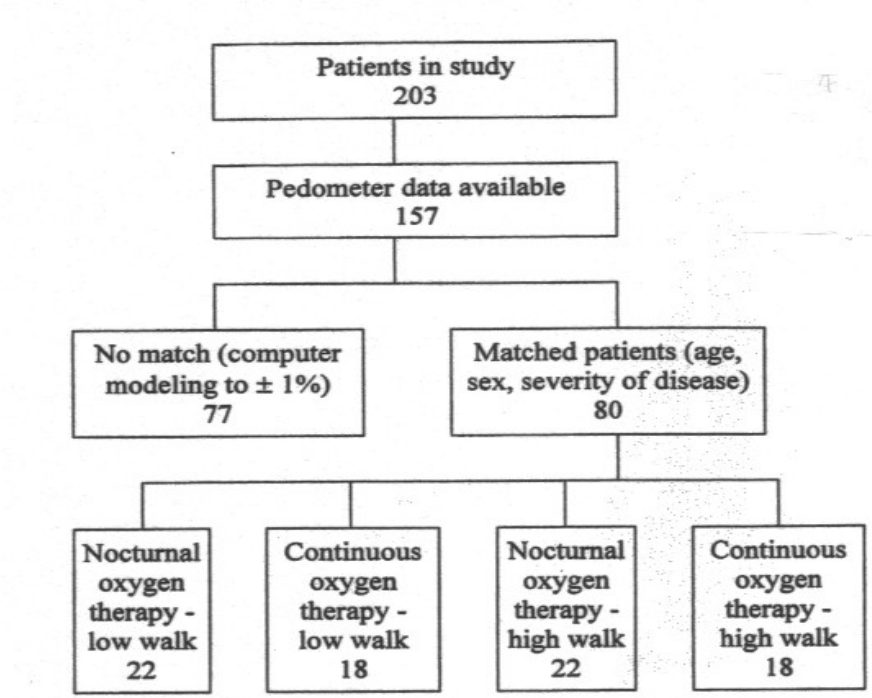
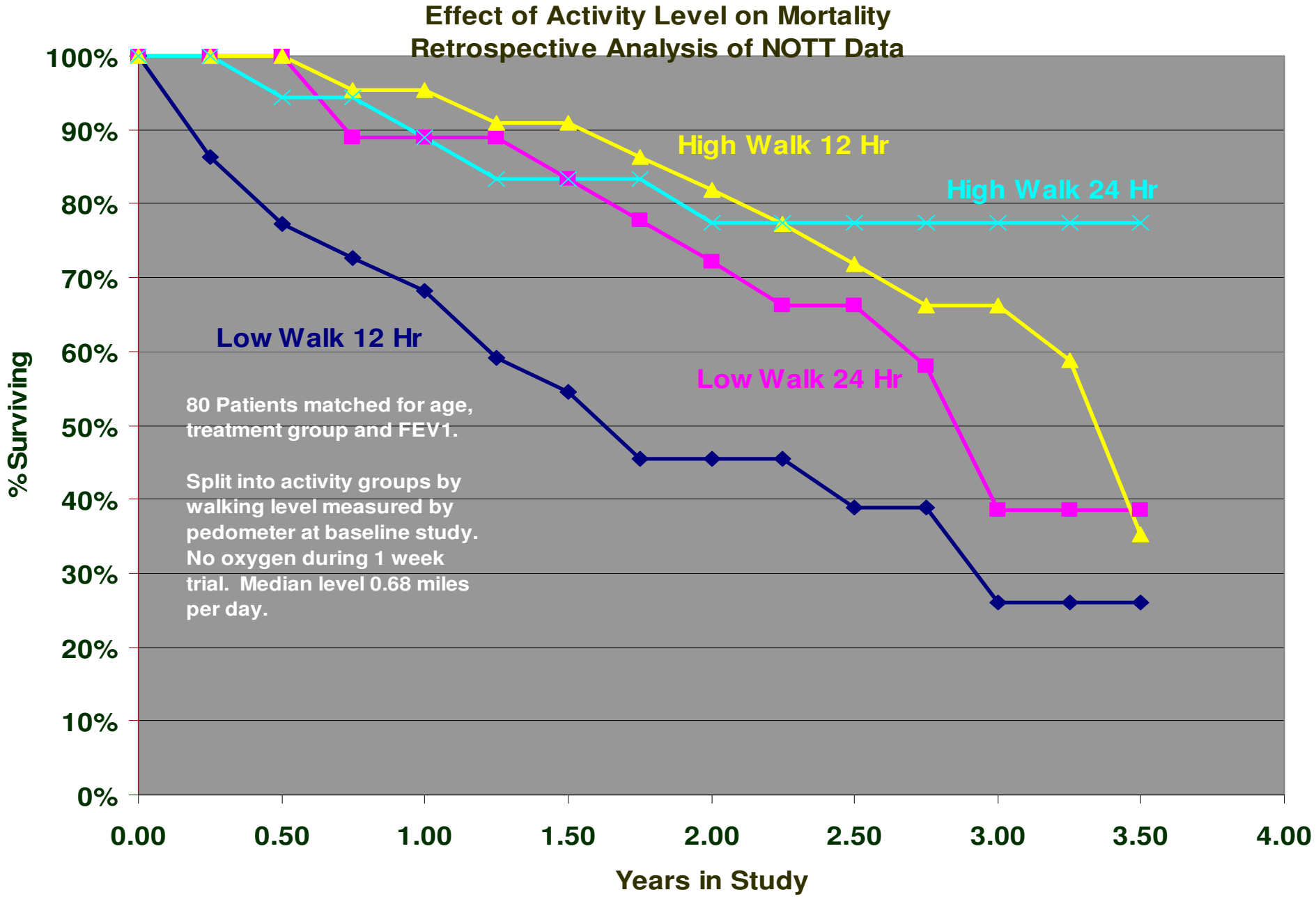


Figure 8. Re-examination of the Nocturnal Oxygen Therapy Trial by pretreatment ambulation status. Origins of the 80 matched patients.


Effect of Activity Level on Mortality
Retrospective Analysis of NOTT Data
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Surviving
High Walk 12 Hr
High Walk 24 Hr
Low Walk 12 Hr
Low Walk 24 Hr
80 Patients matched for age, treatment group and FEV1.
Split into activity groups by walking level measured by pedometer at baseline study. No oxygen during 1 week trial. Median level 0.68 miles per day.
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Years in Study

DEAL OR NO DEAL

- Evidence based research - when findings conflict
  - Accept what you see
    - Deal!
  - Repeat the study yourself
    - No Deal!

Thank You