Rol de la VMNI en Rehabilitación Respiratoria

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Servicio de Neumología, Hospital Clínic de Barcelona
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Definición RR

"Intervención multidisciplinaria e integral, basada en la evidencia, dirigida a los pacientes con enfermedades respiratorias crónicas, que son sintomáticos y con frecuencia han disminuido las actividades de la vida cotidiana"

NICI L, DONNER C, WOUTERS E, ZUWALLACK R, AMBROSINO N, BOURBEAU J, et al. American Thoracic Society/European Respiratory Society statement on pulmonary rehabilitation. Am J Respir Crit Care Med 2006; 173: 1390-413.

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Objetivos

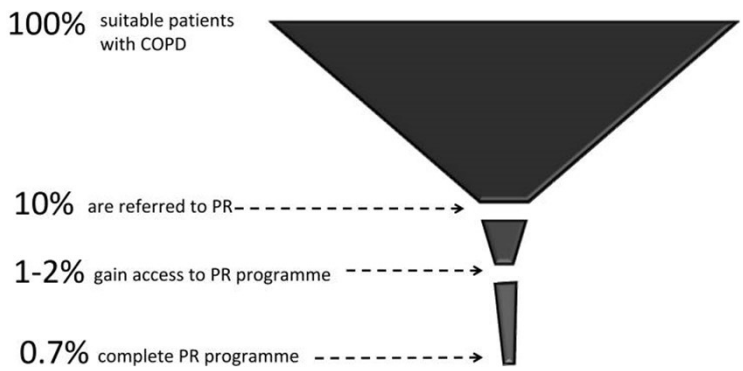
1. Reducir los síntomas

2. Mejorar la calidad de vida

3. Incrementar la participación física y emocional en las AVD

NHLBI/WHO. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Workshop Report. Updated on March 10th 2007

Rehabilitación Respiratoria



Johnston K, Grimmer-Somers K. Pulmonary rehabilitation: overwhelming evidence but lost in translation? Physiother Can. 2010;62(4):368–373

Rol de los profesionales

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Médico/neumólogo
- Lidera y coordina al equipo
- Indica el ingreso del paciente al programa
- Solicita evaluaciones o exámenes
- Deriva a subespecialistas
- Promueve la formación del equipo
- Fomenta la Investigación

Enfermera
- Colabora en la supervisión del programa Educación-autocuidado - adherencia
- Evalúa aspectos de calidad de vida

Trabajador Social
- Evalúa aspectos del funcionamiento – social
- Facilita acceso a la red social

Kinesiólogo
- Realiza y supervisa planes de acondicionamiento físico general y específico
- Realiza distintas pruebas de función respiratoria y test submáximos
- Educa a pacientes y/o familiares sobre distintas técnicas de entrenamiento
- Colabora en la supervisión de las indicaciones

Fonoaudiólogo
- Evalúa y maneja trastornos de la masticación, deglución y la capacidad de comunicación. ENM, alteraciones morfológicas de VA y/oTQT

SEPAR. Arch Bronconeumol 2000; 36: 257-74
Puppo. Neumologia Pediatrica 2007; 2: 21-28
Griffiths et al. Lancet 2000; 355: 362-8
Zach et al.Eur Respir J 2002; 20: 1587–1593
Coll et al . Med Clin (Barc) 1996;106: 534-6
Avendaño et al. Arch Bronconeumol 2003;39: 559-65

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Evaluación

Buena Cuantificación de la potencia (Watts)	Dificultad para cuantificar potencia (Watts)
Menor masa muscular	Mayor masa muscular
Menor VO2pico	Mayor VO2pico

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Evaluación en situaciones Especiales

Soporte Ventilatorio No Invasivo

- Ventajas
  - Entrega Presión Positiva sin necesidad de intubación
  - Puede entregarse por una gran variedad de interfases

Modalidades

- CPAP
- Bilevel
- PSV
- PAV

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CPAP

- Reduce umbral de carga inspiratorio
- Reduce trabajo respiratorio
- Incrementa la tolerancia al ejercicio

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Tohoku J. Exp. Med., 1997, **183**, 45–53

Improvement of Exercise Performance with Short-Term Nasal Continuous Positive Airway Pressure in Patients with Obstructive Sleep Apnea

Osamu Taguchi, Wataru Hida, Shinichi Okabe, Satoru Ebihara, Hiromasa Ogawa, Yoshihiro Kikuchi and Kunio Shirato

6 sujetos con SAHOS

7 días con CPAP

	Before	After
Body weight (kg)	83.2±6.6	82.0±6.9
Blood gas analysis		
pH	7.365±0.024	7.377±0.016
$PaCO_2$ (torr)	47.1±3.4	43.6±2.6**
PaO_2 (torr)	77.3±2.7	82.2±6.3*
Hemoglobin (g/100 ml)	16.8±1.1	16.5±0.9
Respiratory parameters		
$\dot{V}E$ (liter/min)	10.0±2.1	9.6±1.9
RR (min^{-1})	16.4±4.4	17.0±3.1
$\dot{V}O_2$ (ml/min)	279±45	268±21
$\dot{V}CO_2$ (ml/min)	243±40	235±22
Borg score	0.4±0.8	0.4±0.8
Circulation parameters		
HR (min^{-1})	87.3±12.8	73.5±9.1
SBP (mmHg)	124±20	114±5
DPB (mmHg)	90±18	73±4
Sleep study		
AHI (hr^{-1})	62.5±8.6	1.3±2.3**
Longest apnea (s)	71.5±19.4	5.3±8.6**
Lowest SpO_2 (%)	43.2±4.0	93.2±1.3**
MSLT (min)	4.1±2.7	7.4±2.4*

TABLE 2. *Cardiopulmonary variables at maximum exercise level and anaerobic threshold before and after seven-days nasal CPAP treatment*

	Before	After
Respiratory parameters		
$\dot{V}E$ (liter/min)	68.3 ± 16.7	73.8 ± 19.9
RR (min^{-1})	35.1 ± 10.0	34.8 ± 6.4
$\dot{V}O_2$ (ml/min)	1841 ± 350	2125 ± 351*
$\dot{V}CO_2$ (ml/min)	2162 ± 359	2413 ± 549
Borg score	7.5 ± 1.9	7.1 ± 1.1
Circulation parameters		
HR (min^{-1})	134.0 ± 28.1	131.0 ± 30.2
SBP (mmHg)	186 ± 35	196 ± 31
DPB (mmHg)	109 ± 32	105 ± 14
TET[a] (min)	19.5 ± 4.1	20.0 ± 4.1
Anaerobic threshold		
AT (ml/min)	985 ± 161	1050 ± 139

[a] TET, total exercise time.
Values are means ± S.D.
*$p < 0.05$

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Nocturnal Continuous Positive Airway Pressure Improves Ventilatory Efficiency During Exercise in Patients With Chronic Heart Failure*

Michael Arzt, MD; Martina Schulz, MD; Roland Wensel, MD; Sylvia Montalvàn, MD; Friedrich C. Blumberg, MD; Günter A. J. Riegger, MD; and Michael Pfeifer, MD

CHEST / 127 / 3 / MARCH, 2005

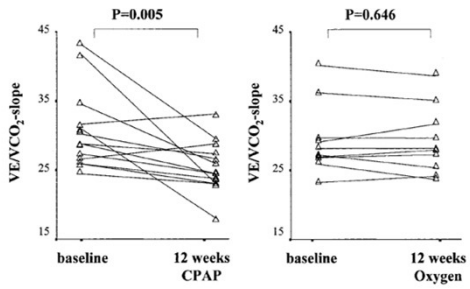

FIGURE 1. The individual values of ventilatory efficiency ($\dot{V}E/\dot{V}CO_2$-slope) of patients with chronic heart failure and CSA before (baseline) and after 12 weeks of CPAP (n = 14) and oxygen therapy (n = 10).

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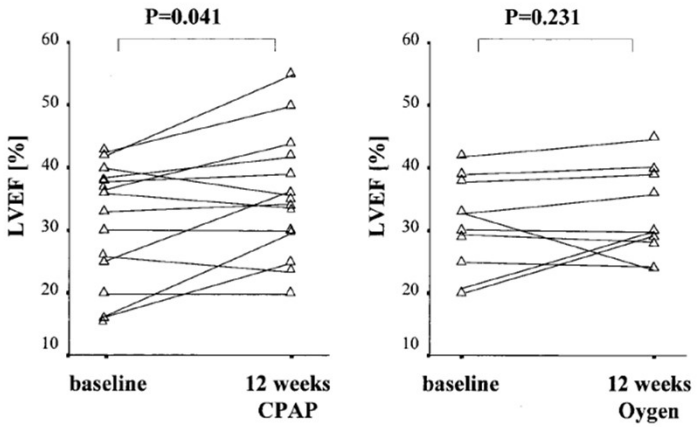

FIGURE 2. The individual values of LVEF in patients with chronic heart failure and CSA before (baseline) and after 12 weeks of CPAP (n = 14) and oxygen therapy (n = 10).

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Non-invasive ventilation improves peripheral oxygen saturation and reduces fatigability of quadriceps in patients with COPD

AUDREY BORGHI-SILVA,[1] LUCIANA DI THOMMAZO,[1] CAMILA B.F. PANTONI,[1] RENATA G. MENDES,[1] TANIA DE FÁTIMA SALVINI[2] AND DIRCEU COSTA[3]

Respirology (2009) **14**, 537–544

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n	18 control , 24 COPD
Intervención	Sham Bilevel S (IPAP 14, EPAP 6)
Outcome	SpO2 FC PAS PAD

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Respirology (2009) **14**, 537–544

Table 3 Physiologic data for SV and BV interventions during isokinetic endurance test, in the COPD group and control group

	COPD group ($n = 24$)			Control group ($n = 18$)			Inter-group P value†	
	SV	BV	Intra-group P value*	SV	BV	Intra-group P value*	SV	BV
SpO_2 (%)	84 ± 5	89 ± 4*	<0.0001	96 ± 1†	97 ± 1†*	0.007	<0.0001	<0.0001
HR (b.p.m.)	103 ± 15	110 ± 15*	0.05	126 ± 14†	123 ± 11†	0.24	<0.0001	0.005
SBP (mm Hg)	158 ± 19	149 ± 18*	0.0003	161 ± 13	152 ± 15*	0.01	0.61	0.54
DBP (mm Hg)	88 ± 9	81 ± 7*	0.0002	91 ± 9	87 ± 10†	0.16	0.39	0.02

Data are presented as mean ± SD.
* Significant intra-group differences.
† Significant inter-group differences.
BV, positive airway pressure ventilation; DBP, diastolic blood pressure; HR, heart beta; SBP, systolic blood pressure;

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Adjuncts to Physical Training of Patients With Severe COPD: Oxygen or Noninvasive Ventilation?

Audrey Borghi-Silva PT PhD, Renata Gonçalves Mendes MSc, Andreza Cristina Toledo MSc, Luciana Maria Malosá Sampaio PhD, Tatiane Patrocínio da Silva MSc, Luciana Noemi Kunikushita PT, Hugo Celso Dutra de Souza PhD, Tânia F Salvini PhD, and Dirceu Costa PhD

RESPIRATORY CARE • JULY 2010 VOL 55 NO 7

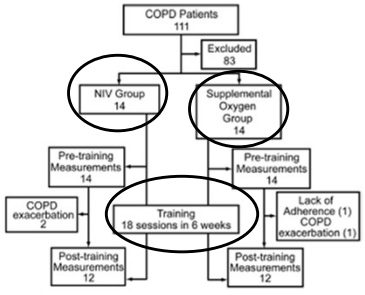

Fig. 1. Flowchart of patient participation and study protocol.

Entrenamiento
BiPAP S
6 (+2) – 3 (+1)
Sat > 90%

Oxígeno
1 a 3 L
Sat > 90%

Protocolo
70% vel max

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	Noninvasive Ventilation (n = 12)		Supplemental Oxygen (n = 12)	
	Before Training (mean ± SD)	After Training (mean ± SD)	Before Training (mean ± SD)	After Training (mean ± SD)
Maximum inspiratory pressure (cm H_2O)	41 ± 29	74 ± 28*	43 ± 21	50 ± 23†
Maximum expiratory pressure (H_2O)	67 ± 25	88 ± 40*	67 ± 38	69 ± 40
6-min walk distance (m)	372 ± 115	494 ± 103*	373 ± 103	420 ± 104*†

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	Noninvasive Ventilation (n = 12)		Supplemental Oxygen (n = 12)	
	Before Training (mean ± SD)	After Training (mean ± SD)	Before Training (mean ± SD)	After Training (mean ± SD)
SGRQ Scores				
Symptoms	54 ± 16	40 ± 19*	59 ± 21	41 ± 20*
Activity	51 ± 13	25 ± 19*	47 ± 19	34 ± 23
Impacts	52 ± 25	32 ± 21*	52 ± 17	41 ± 17*
Total	50 ± 20	29 ± 19*	52 ± 17	37 ± 15

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	Noninvasive Ventilation (n = 12)		Supplemental Oxygen (n = 12)	
	Before Training (mean ± SD)	After Training (mean ± SD)	Before Training (mean ± SD)	After Training (mean ± SD)
Incremental Exercise Testing				
Walk speed (km/h)	2.9 ± 1.0	4.4 ± 1.0*	3.2 ± 0.9	3.7 ± 1.3
Heart rate (beats/min)	107 ± 12	116 ± 11*	110 ± 13	110 ± 12
$\dot{V}_{O_2}$/heart rate (mL · beats/min)	8.3 ± 1.6	9.4 ± 1.7	8.4 ± 1.6	8.6 ± 2.1
Minute ventilation (L/min)	29.9 ± 6.9	33.8 ± 7.6*	29.5 ± 4.3	30.7 ± 7.3
Respiratory rate (breaths/min)	31 ± 4	29 ± 3*	30 ± 5	31 ± 4
Tidal volume (L)	0.96 ± 0.17	1.17 ± 0.21*	1.0 ± 0.20	1.0 ± 0.18
$\dot{V}_{CO_2}$ (mL/min)	0.89 ± 0.17	1.03 ± 0.25*	0.93 ± 0.24	0.96 ± 0.17
$\dot{V}_{O_2}$ (mL/min)	0.88 ± 0.16	1.07 ± 0.22*	0.92 ± 0.17	0.95 ± 0.18
Lactate (mmol/L)	1.8 ± 0.7	1.8 ± 0.5	1.9 ± 0.8	2.2 ± 0.7*
Lactate/speed (mmol/L/km/h)	0.7 ± 0.3	0.4 ± 0.2*	0.6 ± 0.2	0.6 ± 0.3†
S_{pO_2} (%)	88 ± 2	88 ± 3	87 ± 2	87 ± 2
Systolic blood pressure (mm Hg)	178 ± 13	181 ± 17	180 ± 20	177 ± 21
Dyspnea (Borg score [0–10 scale])	5.5 ± 2.1	3.5 ± 1.8*	4.6 ± 1.7	4.2 ± 2.2

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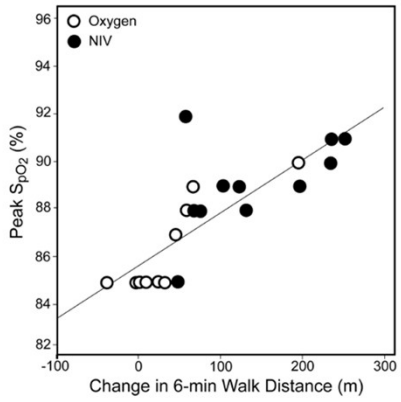

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Eur Respir J 1998; 11: 422–427
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European Respiratory Journal
ISSN 0903 - 1936

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Effects of proportional assist ventilation on exercise tolerance in COPD patients with chronic hypercapnia

L. Bianchi*, K. Foglio*, M. Pagani*, M. Vitacca*, A. Rossi**, N. Ambrosino*

Control	Sham	CPAP	PSV	PAV
Sin Presión Positiva	1 cmH2O	6 cmH2O	12-16/1	8,3/1

15 EPOC hipercápnicos estables

Test de resistencia al 80% de Wmax

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Effects of proportional assist ventilation on exercise tolerance in COPD patients with chronic hypercapnia

L. Bianchi*, K. Foglio*, M. Pagani*, M. Vitacca*, A. Rossi**, N. Ambrosino*

Table 2. – Effects of different modes of mechanical ventilation on exercise tolerance, dyspnoea, leg discomfort and need of oxygen supply

Parameter	Control	Sham	CPAP	PSV	PAV
Endurance time min	7.1±4.6	7.2±4.4	9.6±4.6*	10.5±2*	12.5±6*§#
Borg dyspnoea isotime	6.3±1.4	6.5±1.5	5.3±1.9*	4.4±1.4*§	4.2±1.9*§
Borg leg discomfort isotime	5.0±2.6	5.4±1.9	4.9±2.3	4.1±2.2*	4.2±2.3*
O_2 supply isotime L·min^{-1}	3.8±1.8	3.9±1.9	3.7±2.0	3.1±1.8*§	3.4±1.9*

*: p<0.05 *versus* sham; #: p<0.05 *versus* pressure support ventilation (PSV); §: p<0.05 *versus* continuous positive airway pressure (CPAP). PAV: proportional assist ventilation.

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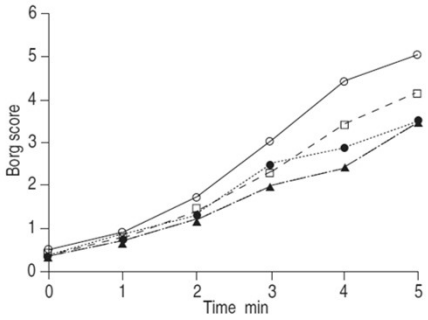

Fig. 2. – Mean values of breathlessness (Borg scale) at each minute of exercise until the fifth. —○—: Sham; - -□- - : continuous positive airway pressure; - -▲- - : proportional assist ventilation;- -●- - : pressure support ventilation.

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L. Bianchi*, K. Foglio*, M. Pagani*, M. Vitacca*, A. Rossi**, N. Ambrosino*

Table 3. – Effects of different modes of mechanical ventilation on cardiac function, end-tidal carbon dioxide tension (P_{et,CO_2}) and breathing pattern at isotime

	Sham	CPAP	PSV	PAV
f_C beats·min^{-1}	116±17	111±15	112±10	112±15
P_{et,CO_2} kPa	9.3±1.4	8.0±1.2	7.5±1.2*	7.4±1.0*§
f_R breaths·min^{-1}	34±8	32±8	31±7	30±7
t_I s	0.81±0.23	0.84±0.29	0.81±0.21	0.83±0.21
t_I/t_{tot}	0.44±0.06	0.45±0.09	0.39±0.05*§	0.39±0.07*§
V_T L	1.00±0.39	1.07±0.39	1.15±0.43*	1.14±0.47*
V'_E L·min^{-1}	32.3±10.2	32.6±11.3	34.4±13	33.8±13.1
V_T/t_I L·s^{-1}	1.27±0.43	1.31±0.56	1.50±0.62*§	1.42±0.50*

*: p<0.05 *versus* sham; §: p<0.05 *versus* CPAP. f_C: cardiac frequency; f_R: respiratory frequency; t_I: inspiratory time; t_{tot}: total respiratory time; V_T: tidal volume; V'_E: minute ventilation. For further definition refer to table 2.

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CHEST
Volume 160, Issue 6, December 2021, Pages 2066-2079

COPD: Original Research

Bilevel Noninvasive Ventilation During Exercise Reduces Dynamic Hyperinflation and Improves Cycle Endurance Time in Severe to Very Severe COPD

Clancy J. Dennis BEng [a], Collette Menadue PhD [a], Tessa Schneeberger MSc [c, g], Daniela Leitl MSc [c, g], Ursula Schoenheit-Kenn MD [f], Camilla M. Hoyos PhD [b, d], Alison R. Harmer PhD [a], David J. Barnes MBBS [a, f], Andreas R. Koczulla MD [c, g, h], Klaus Kenn MD [c, g], Jennifer A. Alison PhD [a, e]

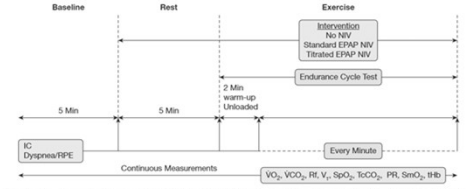

Figure 2 – *Flow diagram of endurance exercise tests. Participants rested for 5 min without intervention at baseline, followed by 5 min of rest with (or without) intervention and a 2-min warm up before performing an endurance cycle test at 75% peak work rate. EPAP = expiratory positive airway pressure; IC = inspiratory capacity; NIV = noninvasive ventilation; PR = pulse rate; Rf = respiratory frequency; RPE = rate of perceived exertion; SmO_2 = muscle oxygen saturation; SpO_2 = oxygen saturation as measured by pulse oximetry; $TcCO_2$ = transcutaneous CO_2 tHb = total hemoglobin; $\dot{V}O_2$ = oxygen consumption; $\dot{V}CO_2$ = CO_2 production; V_T = tidal volume.*

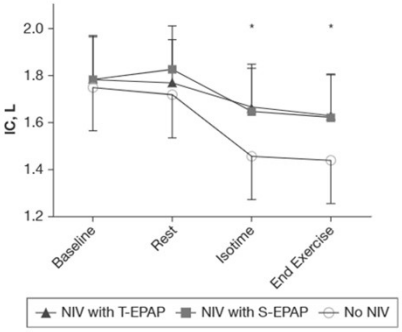

Figure 3 – *Graph shows IC at each time point: baseline, rest, isotime, end exercise. IC = inspiratory capacity; NIV = noninvasive ventilation; S-EPAP = standardized expiratory positive airway pressure; T-EPAP = titrated expiratory positive airway pressure. Error bars represent SD. *P < .05 for no NIV vs NIV with S-EPAP and for no NIV vs NIV with T-EPAP.*

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Clancy J. Dennis BEng [a], Collette Menadue PhD [a], Tessa Schneeberger MSc [c, g], Daniela Leitl MSc [c, g], Ursula Schoenheit-Kenn MD [f], Camilla M. Hoyos PhD [b, d], Alison R. Harmer PhD [a], David J. Barnes MBBS [a, f], Andreas R. Koczulla MD [c, g, h], Klaus Kenn MD [c, g], Jennifer A. Alison PhD [a, e]

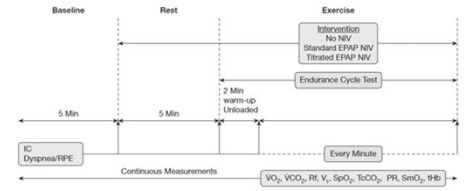

Figure 2 – *Flow diagram of endurance exercise tests. Participants rested for 5 min without intervention at baseline, followed by 5 min of rest with (or without) intervention and a 2-min warm up before performing an endurance cycle test at 75% peak work rate. EPAP = expiratory positive airway pressure; IC = inspiratory capacity; NIV = noninvasive ventilation; PR = pulse rate; Rf = respiratory frequency; RPE = rate of perceived exertion; SmO_2 = muscle oxygen saturation; SpO_2 = oxygen saturation as measured by pulse oximetry; $TcCO_2$ = transcutaneous CO_2 tHb = total hemoglobin; $\dot{V}O_2$ = oxygen consumption; $\dot{V}CO_2$ = CO_2 production; V_T = tidal volume.*

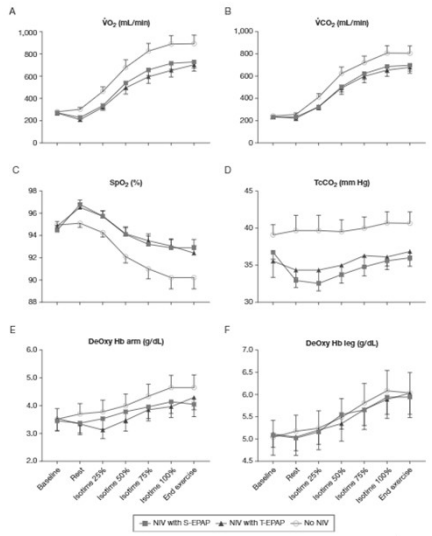

Figure 5 – *Graphs show secondary outcomes at each time point: baseline; rest; isotime 25%, 50%, 75%, and 100%; and end exercise. A, $\dot{V}O_2$ = oxygen consumption. B, $\dot{V}CO_2$ = CO_2 production. C, SpO_2 = oxygen saturation as measured by pulse oximetry. D, $TcCO_2$ = transcutaneous CO_2. E, DeOxy Hb arm = deoxygenated hemoglobin as measured in the triceps via near infrared spectroscopy. F, DeOxy Hb leg = deoxygenated hemoglobin as measured in the vastus lateralis via near infrared spectroscopy. Error bars represent the SEM. g/dL = grams per deciliter; NIV = noninvasive ventilation; S-EPAP = standardized expiratory positive airway pressure; T-EPAP = titrated expiratory positive airway pressure.*

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Annals of Physical and Rehabilitation Medicine

Volume 64, Issue 6, November 2021, 101460

Review

Non-invasive ventilation intervention during exercise training in individuals with chronic obstructive pulmonary disease: A systematic review and meta-analysis ☆

Guiling Xiang, Qinhan Wu, Xu Wu, Shengyu Hao, Liang Xie, Shanqun Li

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Capacidad de ejercicio

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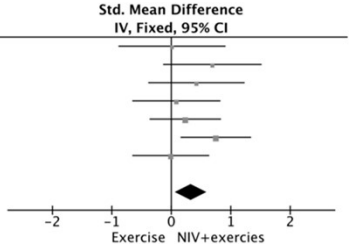
Study or Subgroup	NIV+exercise Mean	SD	Total	Exercise Mean	SD	Total	Weight	Std. Mean Difference IV, Fixed, 95% CI
Bianchi et al (2002)	504	83	9	503	83	10	8.8%	0.01 [−0.89, 0.91]
Borghi−Silva et al (2010)	494	103	12	420	104	12	10.4%	0.69 [−0.14, 1.52]
El Hoshy et al (2017)	392.2	110.6	12	345.2	104.2	12	10.8%	0.42 [−0.39, 1.23]
Marquez−Martı´n et al (2014)	412	105.4	14	403	100.2	14	13.0%	0.08 [−0.66, 0.83]
Marrara et al (2018)	451.5	158.2	21	419.2	108.1	22	19.8%	0.24 [−0.37, 0.84]
Peng etal (2019)	508.74	100.11	23	420.04	130.25	24	20.2%	0.75 [0.16, 1.34]
Shi et al (2020)	212.59	38.4	17	212.95	37.31	20	17.0%	−0.01 [−0.66, 0.64]
Total (95% CI)			**108**			**114**	**100.0%**	**0.33 [0.06, 0.59]**

Heterogeneity: $Chi^2 = 4.74$, df = 6 (P = 0.58); $I^2 = 0\%$
Test for overall effect: Z = 2.39 (P = 0.02)



Xiang G, et al. Non-invasive ventilation intervention during exercise training in individuals with chronic obstructive pulmonary disease: A systematic review and meta-analysis. Ann Phys Rehabil Med. 2021 Nov;64(6):101460.

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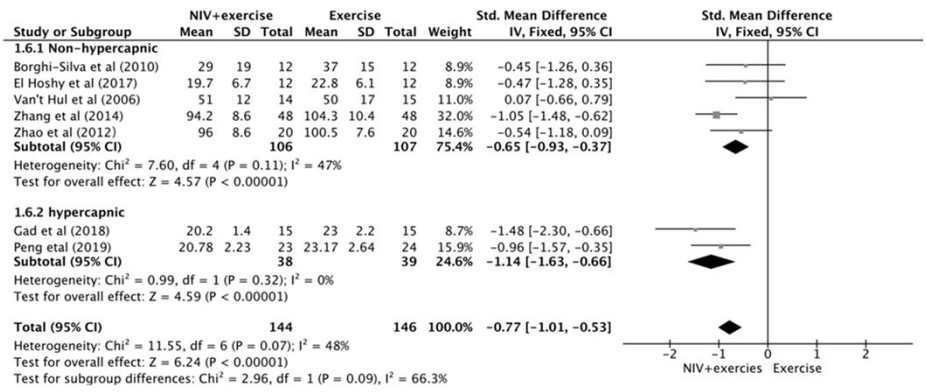
Calidad de vida



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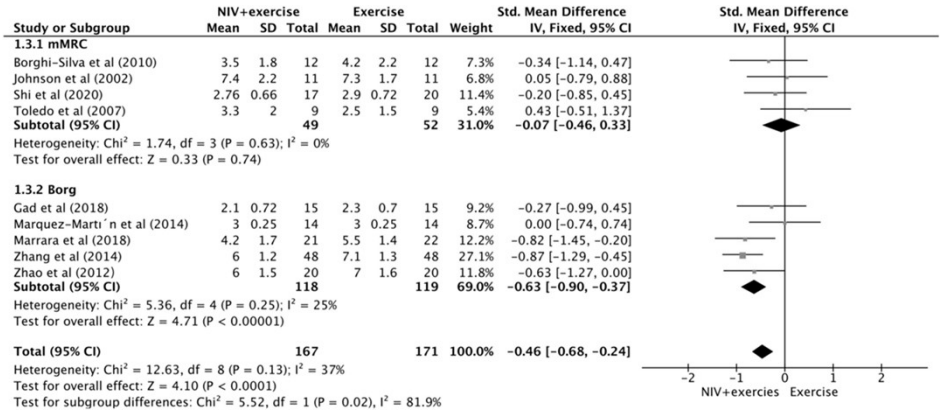
Disnea



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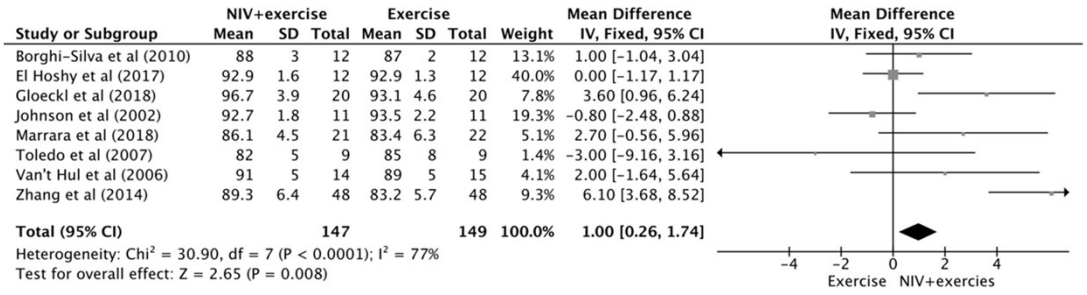
Saturación de oxígeno



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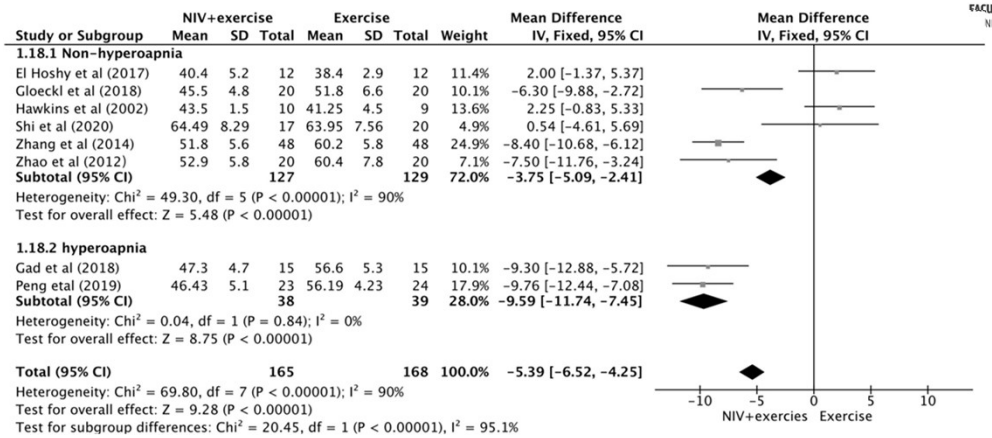
CO2



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Entrenamiento con VMNI

Complicaciones

- Interfaces
  - Incómodas
- Comorbilidades
  - Doping mecánica: riesgo de isquemia
- Costo
  - 1 paciente por un tratante

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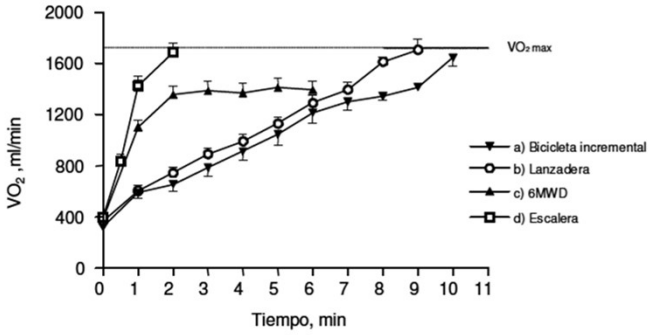

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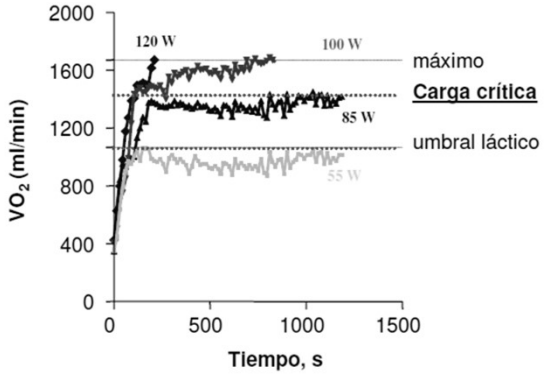

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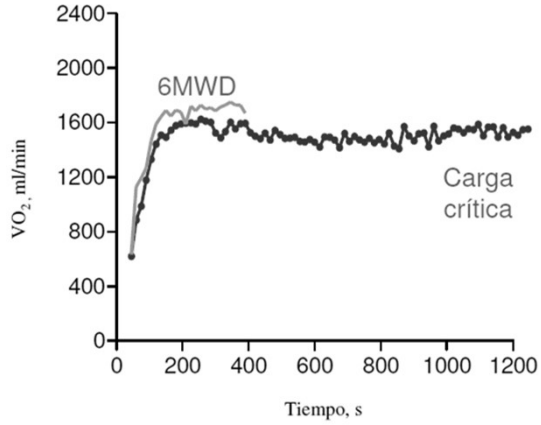

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Conclusiones

- Pocos estudios por lo que rol de VMNI en rehabilitación todavía no está definido
- Precaución con doping mecánico
- Herramienta fértil para la investigación

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¡Gracias!

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