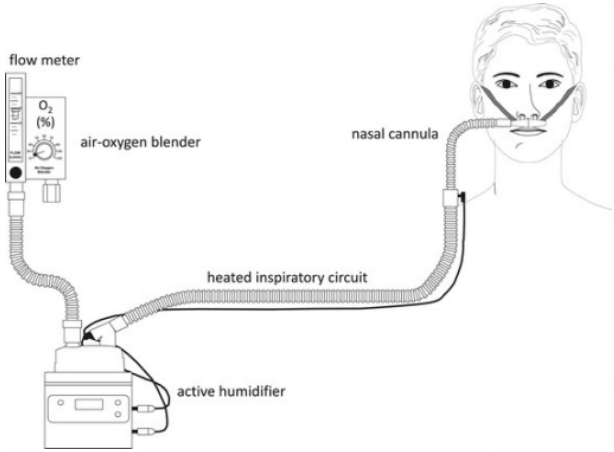


HFNO e NIV a casa (ostruiti)

Michele Vitacca MD FERS

UO Pnemolologia Riabilitativa

Istituti Clinici Scientifici Maugeri IRCCS

Lumezzane (Bs)

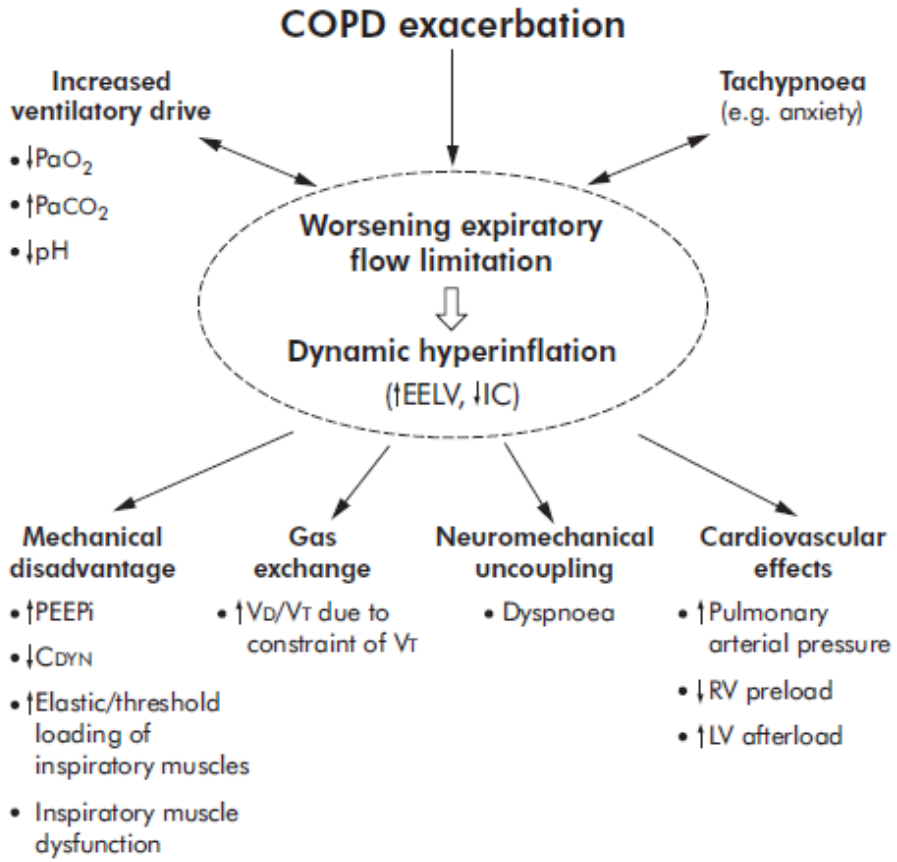
REVIEW SERIES

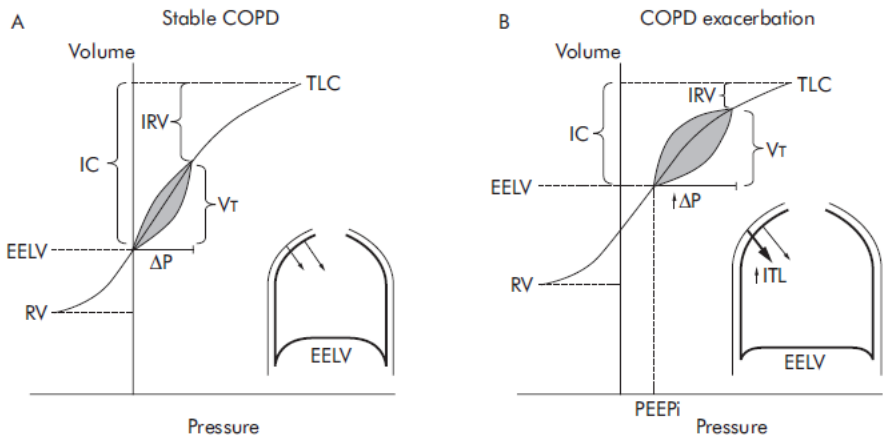
COPD exacerbations · 3: Pathophysiology

D E O'Donnell, C M Parker

Thorax 2006;**61**:354–361. doi: 10.1136/thx.2005.041830

Both





NIV O2/HFO Both

Short-term Effects of Supplemental Oxygen on 6-Min Walk Test Outcomes in Patients With COPD

A Randomized, Placebo-Controlled, Single-blind, Crossover Trial

CHEST 2017; 151(4):795-803

Inga Jarosch, MSc; Rainer Gloeckl, PhD; Eva Damm, MD; Anna-Lena Schwedhelm, MD; David Buhrow, MD; Andreas Jerrentrup, MD; Martijn A. Spruit, PhD; and Klaus Kenn, MD

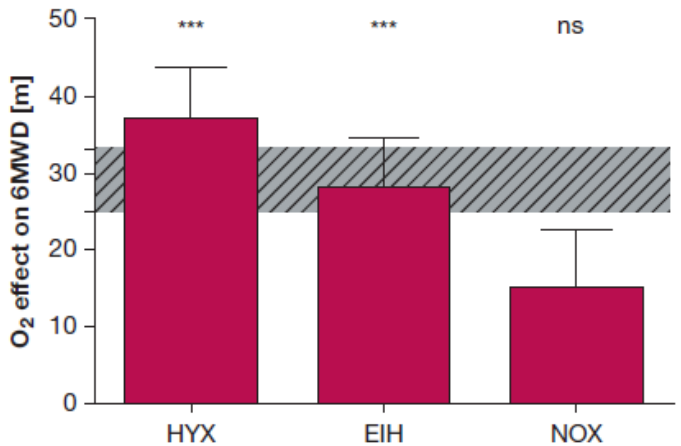


Figure 2 – *Direct effect of supplemental O_2 compared with compressed room air on the 6MWD in patients with HYX, patients with EIH, and patients with NOX. The band marks the minimal important difference for the 6MWD (range, 25-33 meters).*[20] ****P < .001. 6MWD = 6-min walk distance; EIH = exercise-induced hypoxemia; HYX = resting hypoxemia; NOX = normoxemia; NS = not significant. See Figure 1 legend for expansion of other abbreviation.*

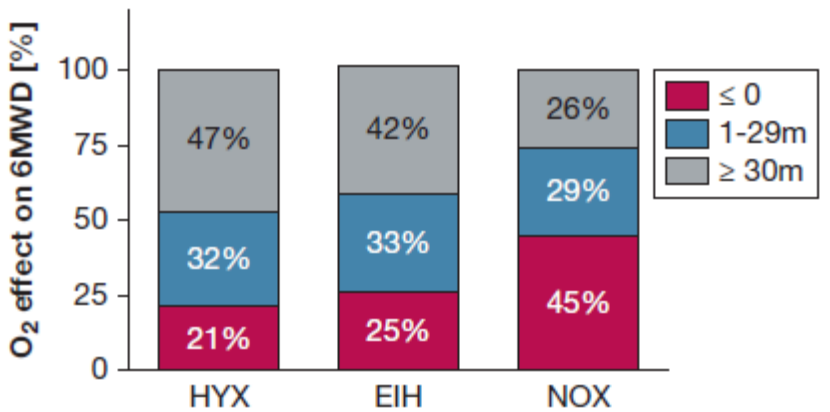
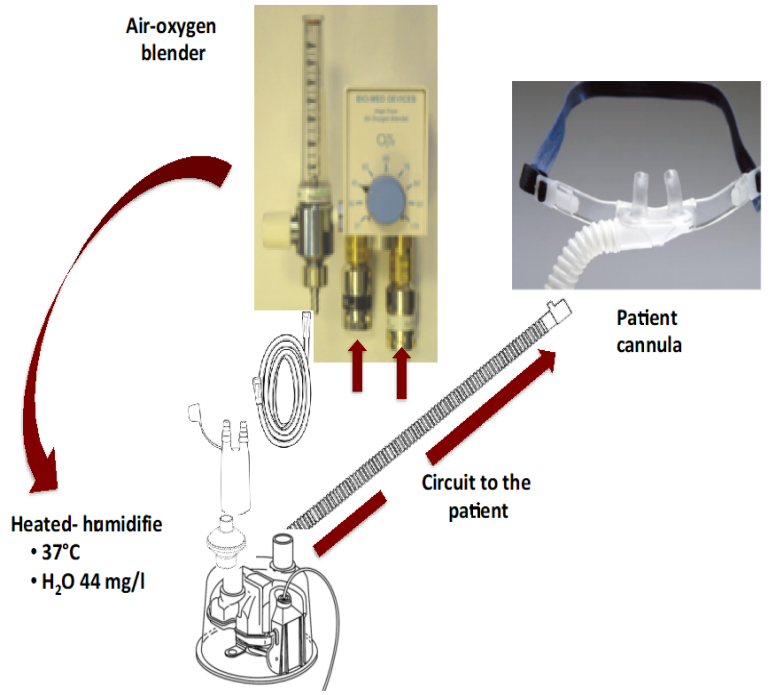


Figure 3 – *Three groups were created according to the O_2-related effect on the 6MWD: (1) no benefit (≤ 0 meters); (2) increase < 30 meters; and (3) a clinically relevant benefit of ≥30 meters.*[20] *Data are presented in patients with HYX, patients with EIH, and patients with NOX. See Figure 1 and 2 legends for expansion of abbreviations.*

High Flow Nasal Cannula Oxygen therapy

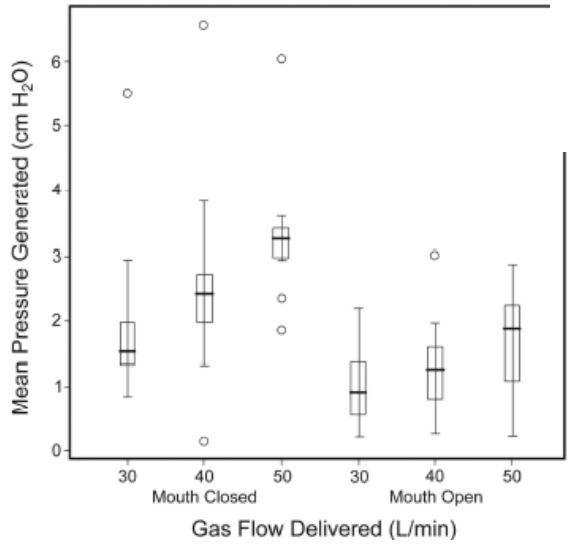
- **Characteristics** of HFNC:
  - high flow of gas: up to 70 L/min
  - heating-humidification
  - Stabilisation of flow and FiO2



	NIV	HFNT
Heat	Variable	31-34°C
Humidity	Variable	Saturated
Circuit	Single	Single-heated
Pressure	Pre-set insp and Exp	Variable
Flow	Variable	Continuous (20-60 Lmin)
Oxygen	Bled-in or blender	Blender (0.21-1)

Parke. BJA 2009; 103: 886-90
Roca. Resp Care 2010; 55: 408-13
Vargas. Resp Care 2015; 60:1369-76
Sztrymf. Intensive Care Med 2011; 37:1780-86
Frat. Resp Care 2015; 60:170-78

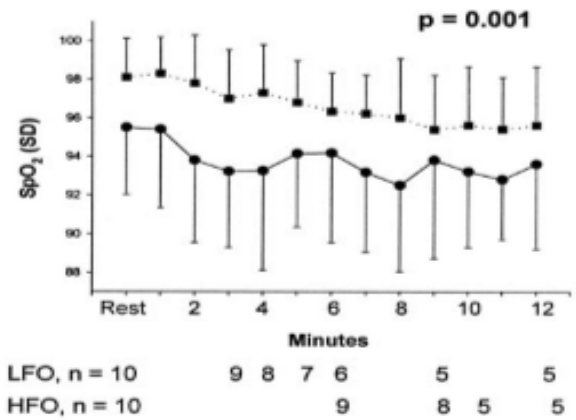
1. HFNO genera pressione



The Effects of Flow on Airway Pressure
During Nasal High-Flow Oxygen Therapy

Rachael L Parke RN MHSc, Michelle L Eccleston RN, and Shay P McGuinness MB ChB

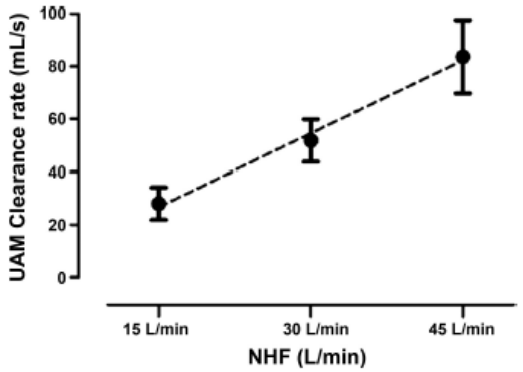
2. ↑ PaO2 a parità FiO2



J Appl Physiol 118: 1525–1532, 2015.
First published April 16, 2015; doi:10.1152/japplphysiol.00934.2014.

Nasal high flow clears anatomical dead space in upper airway models

Winfried Möller,[1,2] Gülnaz Celik,[1,2] Sheng Feng,[3] Peter Bartenstein,[4] Gabriele Meyer,[5]



3. Riduce CO2 rebreating

4. Miglior confort

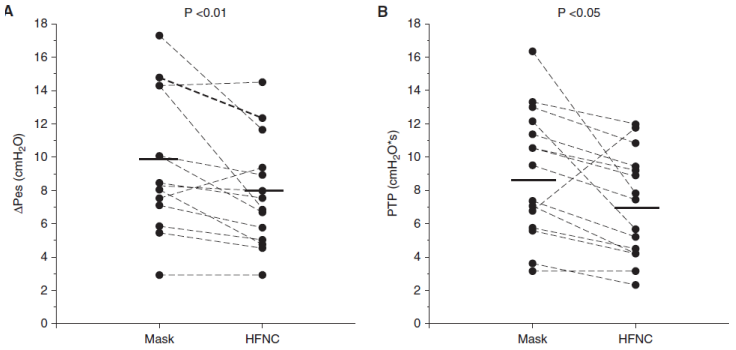
	Face Mask	HFNT
Dyspnea	6.8	3.8*
Mouth dryness	9.5	5.0*
Overall Comfort	5.0	9.0*

Roca O et al, Respir Care 2010

5. Migliore meccanica

Delta Pes

PTP



Physiologic Effects of High-Flow Nasal Cannula in Acute Hypoxemic Respiratory Failure

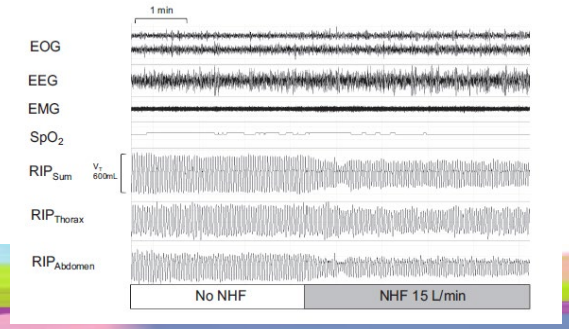
Tommaso Mauri[1,2], Cecilia Turrini[1,3], Nilde Eronia[4], Giacomo Grasselli[1], Carlo Alberto Volta[3], Giacomo Bellani[4,5], and Antonio Pesenti[1,2]

Change in pulmonary mechanics and the effect on breathing pattern of high flow oxygen therapy in stable hypercapnic COPD

Pisani L. thoraxjnl-2016-209673

John F Fraser. Thorax August 2016 Vol 71 No 8

6. Migliore indice di tobin (e CO2) in veglia



7. Riduce VE e VT di notte

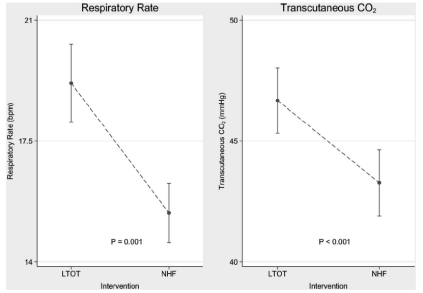
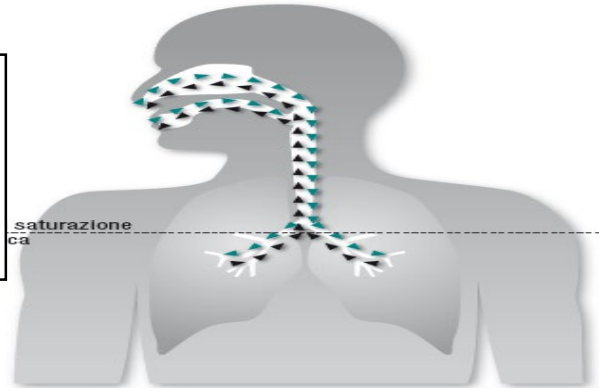
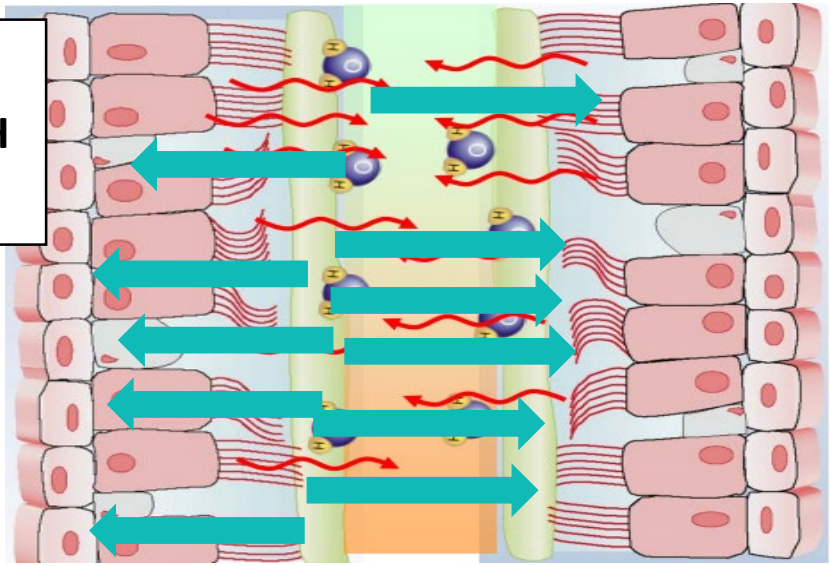


Figure 1 Observed decreases in respiratory rate and transcutaneous carbon dioxide level between the long-term oxygen therapy (LTOT) group and the nasal high flow (NHF) group. Data are presented as mean and vertical 95% CI bars.

AIRVO
100% RH
37°C

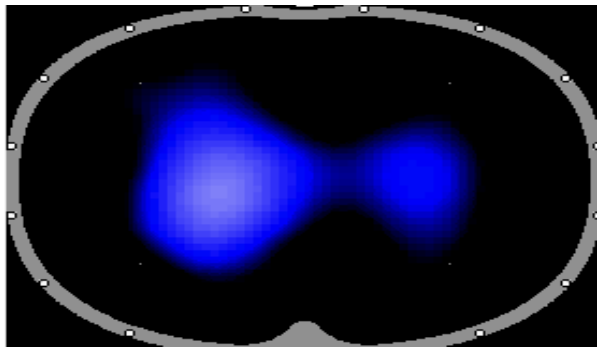


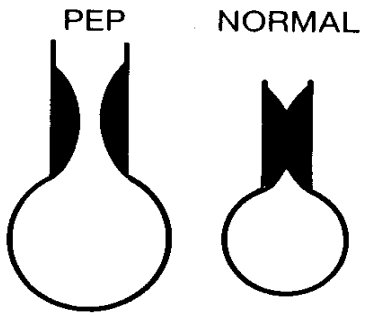
AIRVO
100% RH
37°C



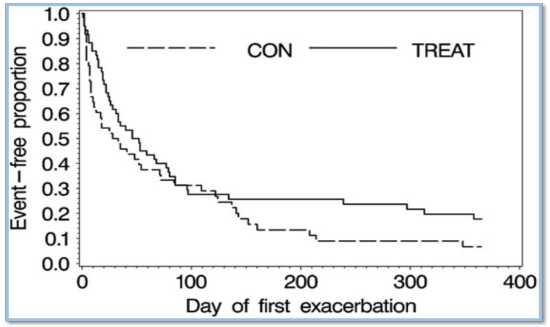
8. Ripristino funzione ciliare (pazienti O2 terapia alti flussi) + Fluidificazione del muco

9. Aumento reclutamento polmonare periferico + Incremento dei flussi espiratori (BPCO)



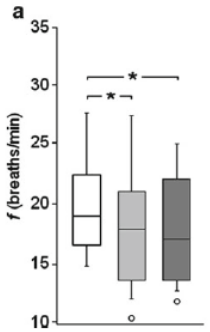


10. **reduced exhacerbation days, increased time to first exhacerbation nei bronchiectasici**



Rea H. et al., Respir Med 2010

11. Riduce la FR nei COPD



Nilius G., Adv ExpMed Biol. 2013

12. decreases MinVent due to an overall reduction in dead space

Reductions in dead space ventilation with nasal high flow depend on physiological dead space volume: metabolic hood measurements during sleep in patients with COPD and controls

Paolo Biselli[1,2], Kathrin Fricke[1], Ludger Grote[3], Andrew T. Braun[1], Jason Kirkness[1], Philip Smith[1], Alan Schwartz[1] and Hartmut Schneider[1]

Eur Respir J 2018; 51: 1702251

13. Migliora Indice di Tobin nella FC

High-flow nasal oxygen versus noninvasive ventilation in adult patients with cystic fibrosis: a randomized crossover physiological study

Michael C. Sklar[1,2], Martin Dres[3,4], Nuttapol Rittayamai[3,5], Brent West[6], Domenico Luca Grieco[3,7], Irene Telias[2,3], Detajin Junhasavasdikul[3,8], Michela Rauseo[2,9], Tai Pham[2], Fabiana Madotto[10], Carolyn Campbell[3], Elizabeth Tullis[6] and Laurent Brochard[2,3*]

Ann. Intensive Care (2018) 8:85

14. In COPD (postextubation) decreased the neuroventilatory drive and work of breathing

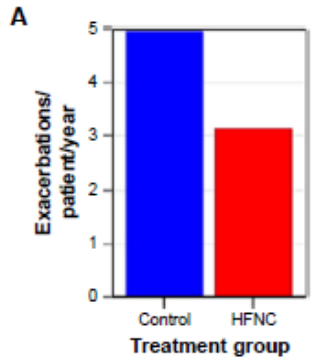
Di musi et al. Critical Care (2018) 22:180
https://doi.org/10.1186/s13054-018-2107-9

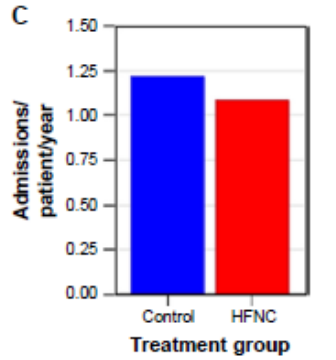
Critical Care

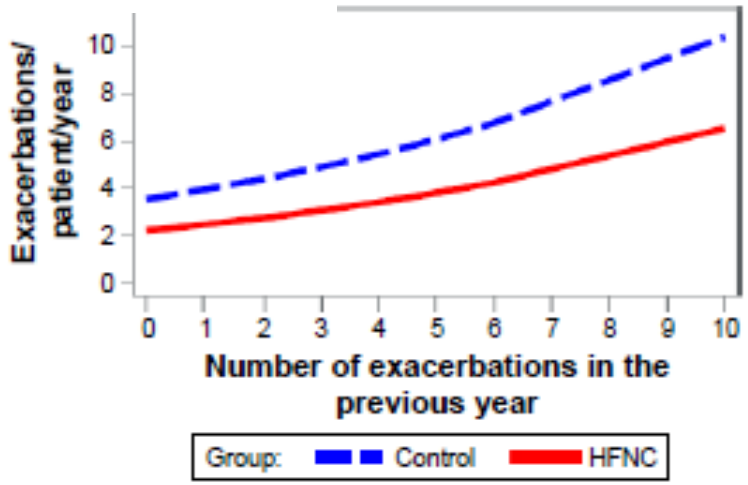
RESEARCH Open Access

High-flow nasal cannula oxygen therapy decreases postextubation neuroventilatory drive and work of breathing in patients with chronic obstructive pulmonary disease

Rosa Di mussi[1], Savino Spadaro[2], Tania Stripoli[1], Carlo Alberto Volta[2], Paolo Trerotoli[3], Paola Pierucci[4], Francesco Staffieri[5], Francesco Bruno[1], Luigi Camporota[6] and Salvatore Grasso[1*]







International Journal of COPD

Dovepress
open access to scientific and medical research

Open Access Full Text Article

CLINICAL TRIAL REPORT

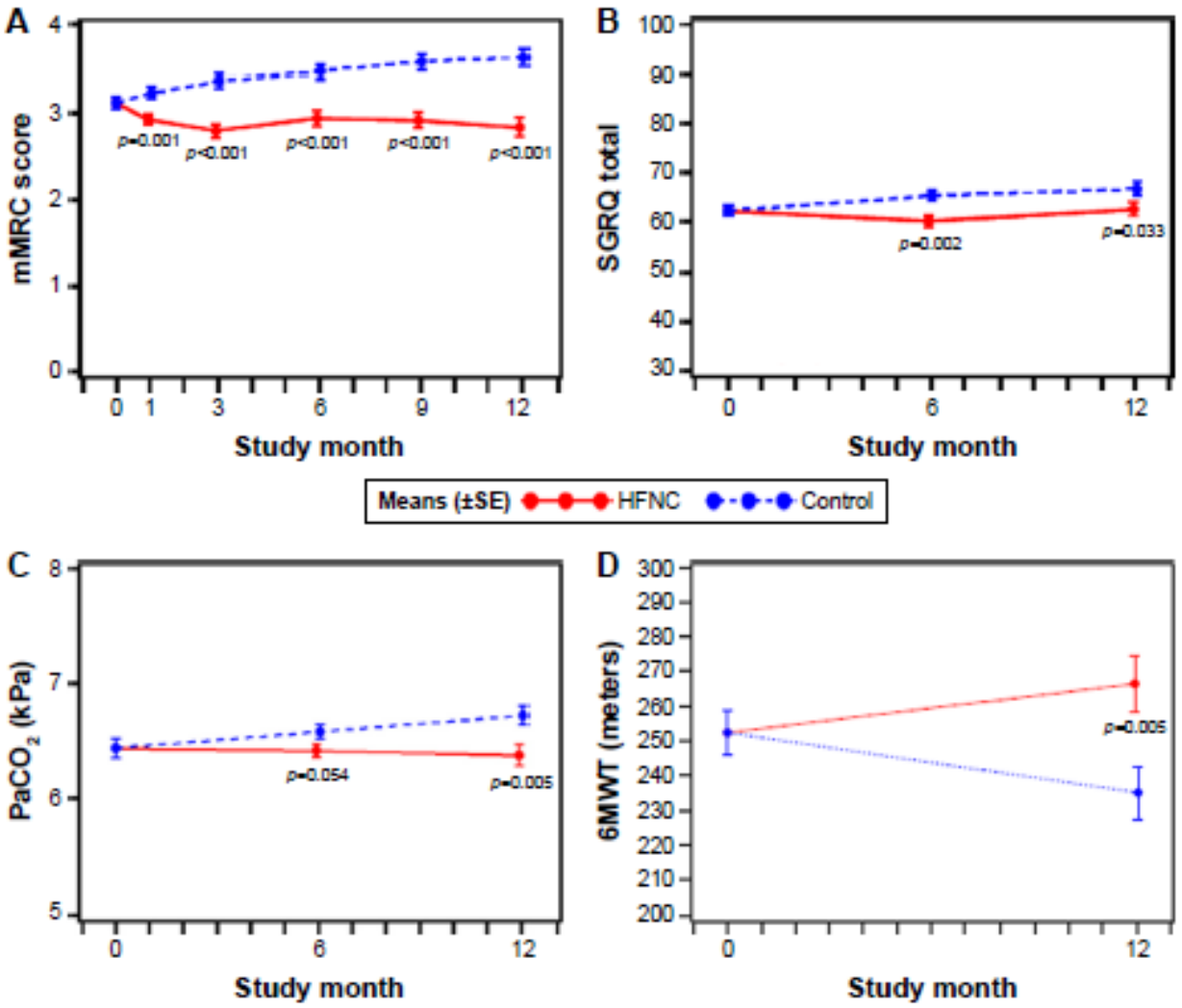
Long-term effects of oxygen-enriched high-flow nasal cannula treatment in COPD patients with chronic hypoxemic respiratory failure

This article was published in the following Dove Press journal:
International Journal of COPD

A total of 200 COPD with chronic hypoxemic respiratory failure patients were randomized into usual care ± HFNC

20 L/min flow rate. Starting at 15 L, flow was titrated over 30 minutes at the baseline visit.
to use HFNC for **8 hours/day, preferably at night**;
however, there were no restrictions in the duration of use nor time of day.

The average daily use of HFNC was 6 hours/day.
There was no difference in all-cause mortality



International Journal of COPD

Dovepress
open access to scientific and medical research

Open Access Full Text Article

CLINICAL TRIAL REPORT

Long-term effects of oxygen-enriched high-flow nasal cannula treatment in COPD patients with chronic hypoxemic respiratory failure

This article was published in the following Dove Press journal:
International Journal of COPD

Domiciliary High-Flow Nasal Cannula Oxygen Therapy for Patients with Stable Hypercapnic Chronic Obstructive Pulmonary Disease

A Multicenter Randomized Crossover Trial

Kazuma Nagata[1], Takashi Kikuchi[2], Takeo Horie[3], Akira Shiraki[4], Takamasa Kitajima[5], Toru Kadowaki[6], Fumiaki Tokioka[7], Naohiko Chohnabayashi[8], Akira Watanabe[9], Susumu Sato[10], and Keisuke Tomii[1]

Ann Am Thorac Soc Vol 15, No 4, pp 432–439, Apr 2018

Randomized crossover trial for stable hypercapnic chronic obstructive pulmonary disease.

6 weeks of high-flow nasal cannula oxygen therapy/long-term oxygen therapy using the myAIRVO 2 device followed by another 6 weeks of long-term oxygen therapy only

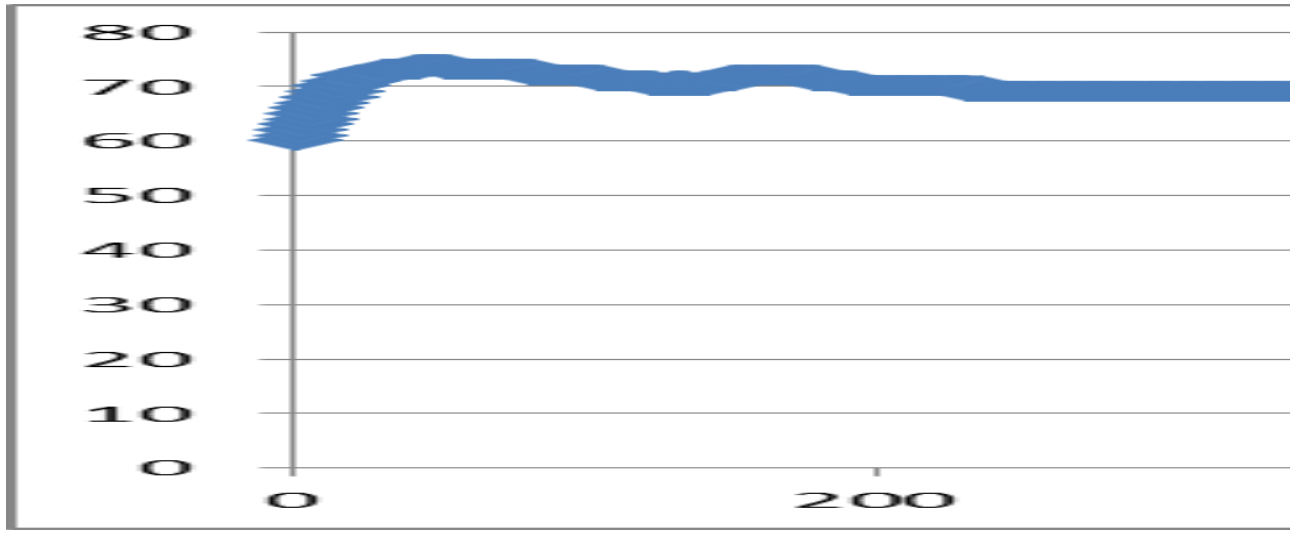
29 completed the study.

HFO improved :
- total St. George's Respiratory Questionnaire
- arterial partial pressure of carbon dioxide
- pH
- median nocturnal transcutaneous carbon dioxide pressure

No effects on :
- arterial partial pressure of oxygen,
- dyspnea,
- spirometry,
- lung volume,
- 6-minute walk test,
- or physical activity.

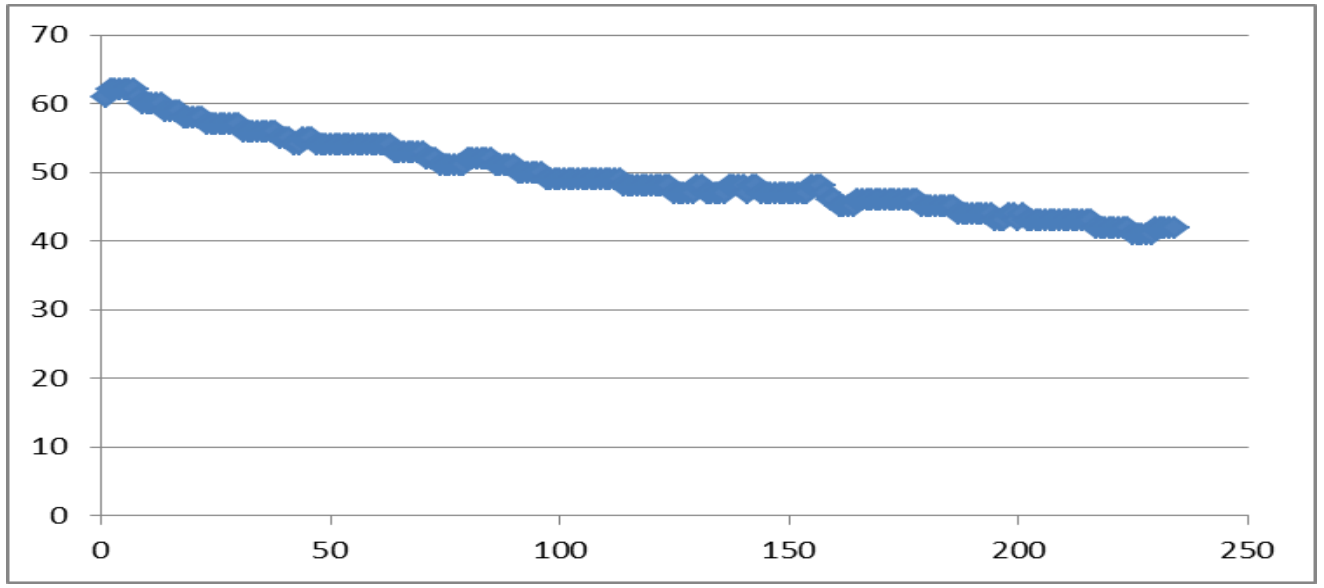
Applicazione notturna in BPCO + IRC (1 case report)

TC CO2 (mmhg)



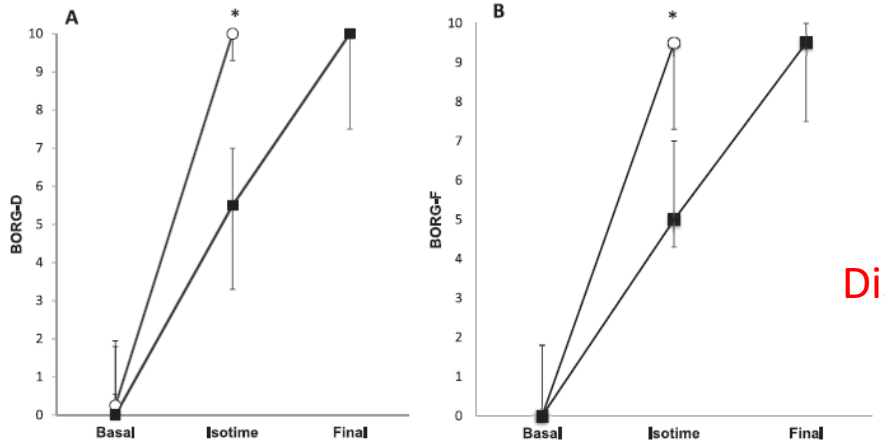
Con O2 2 litri

TC CO2 (mmhg)



Con HF 2 litri

Vitacca 2018 unpublished



Dispnea

Fig. 2. Borg ratings of dyspnea (A) and leg discomfort (B) during the HFNC test (*solid squares*) and Control-test (*open circles*). Significant difference at isotime was found betwe two tests (*p = 0.002). Values are represented as median and range.

Contents lists available at ScienceDirect

Respiratory Medicine

journal homepage: www.elsevier.com/locate/rmed

Effects of heated and humidified high flow gases during high-intensity constant-load exercise on severe COPD patients with ventilatory limitation

Serena Cirio [a], Manuela Piran [a], Michele Vitacca [b], Giancarlo Piaggi [a], Piero Ceriana [a], Matteo Prazzoli [a], Mara Paneroni [b], Annalisa Carlucci [a, *]

Tolleranza sforzo

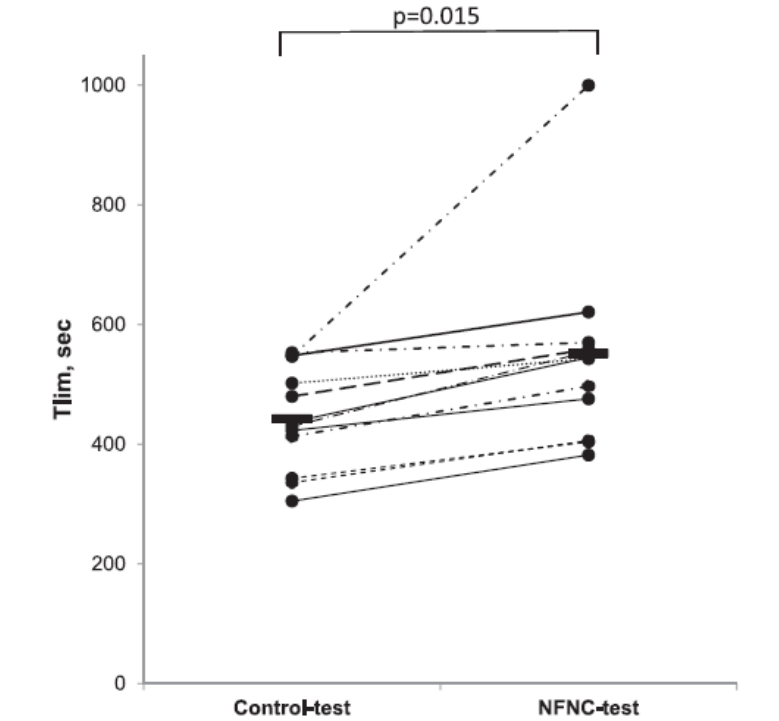
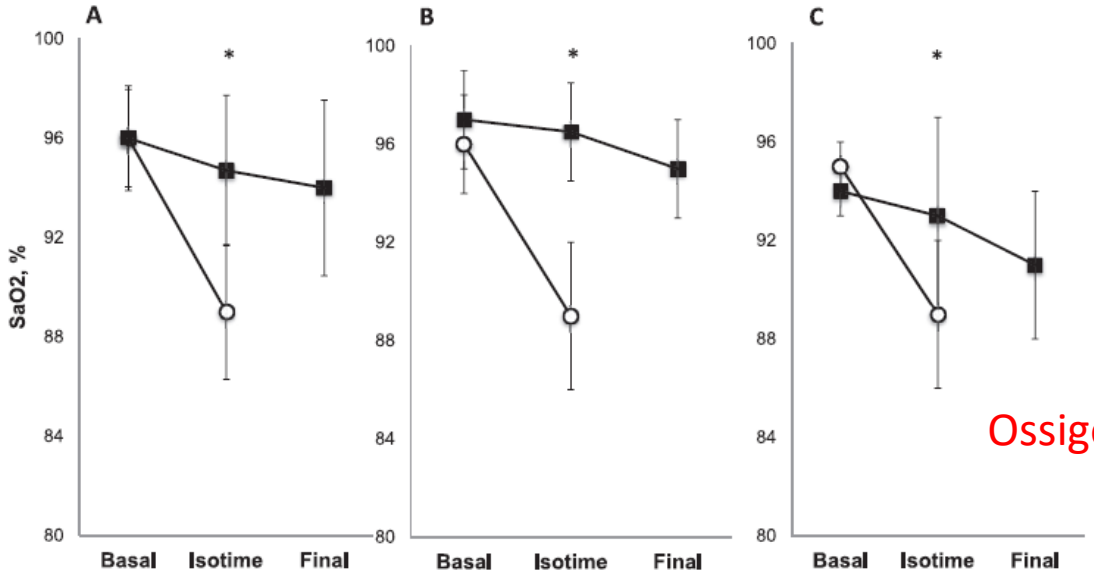


Fig. 1. Effect of the HFNC on exercise capacity during a constant-load test compared to a control condition in which the test was performed at the same FiO_2. In all patient HFNC significantly increased the exercise performance. Tlim = exercise duration. *Solid line* = mean value.



Ossigenazione

Fig. 3. Oxyhemoglobin saturation (SaO_2) during HFNC-test (*solid squares*) and Control-test (*open circles*) in the whole group (A), in the 8 patients who performed exe additional oxygen (B) and in the 4 patients who performed it at FiO_2 of 0.21 (C). In all groups meanSaO_2 at isotime was significantly higher during HFNC-test (*p = 0.000 are represented as mean and standard deviation.

HFO USE DURING EXERCISE TRAINING IN PATIENTS WITH RESPIRATORY FAILURE SECONDARY TO COPD

Michele Vitacca + 5 ICS Maugeri + Auxilium Vitae + 2 Don Gnocchi

Criteri di inclusione:

- BPCO+IRC in OTLT
- Stabilità clinica

Criteri di esclusione:

- Malattia ortopedica/neurologica
- Cardiopatia ischemica/insuff.cardiaca
- OSAS
- Fibrosi polmonare

Randomizzati (n=156)

Gruppo intervento HFO (n=78)

Gruppo controllo "Venturi mask" (n=78)

Obiettivi primari:

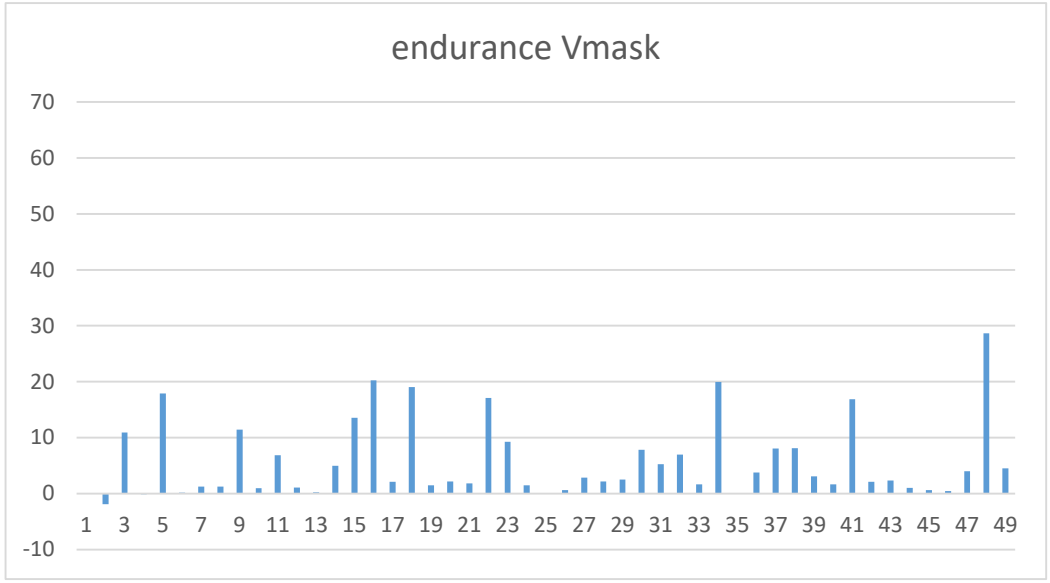
- Miglioramento della tolleranza allo sforzo **(tempo di endurance)** prodotto da un programma di allenamento ad alta intensità con HFO rispetto allo stesso effettuato con «Venturi mask»

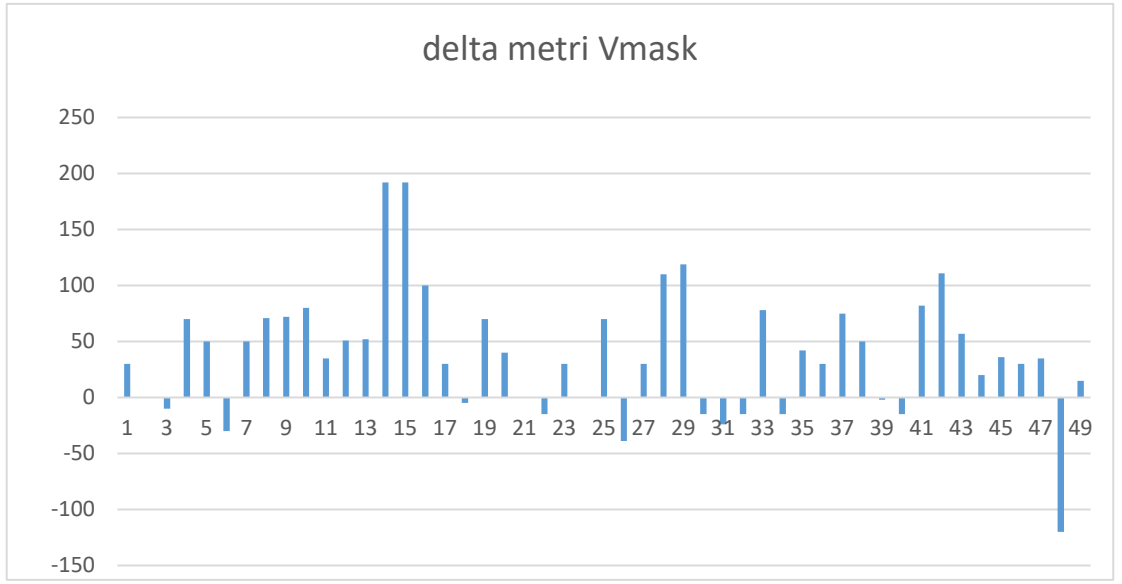
Obiettivi secondari:

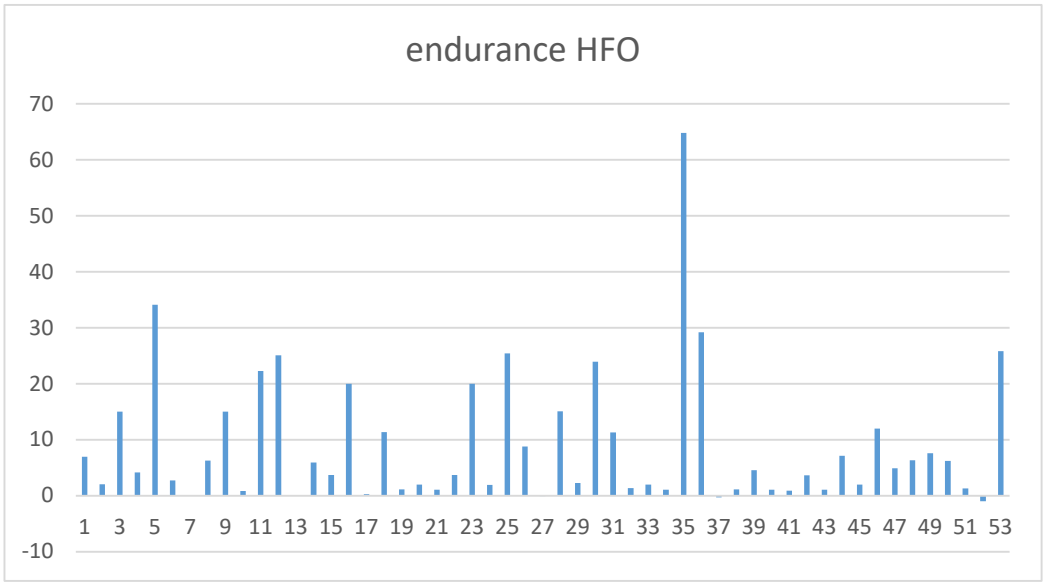
Miglioramento

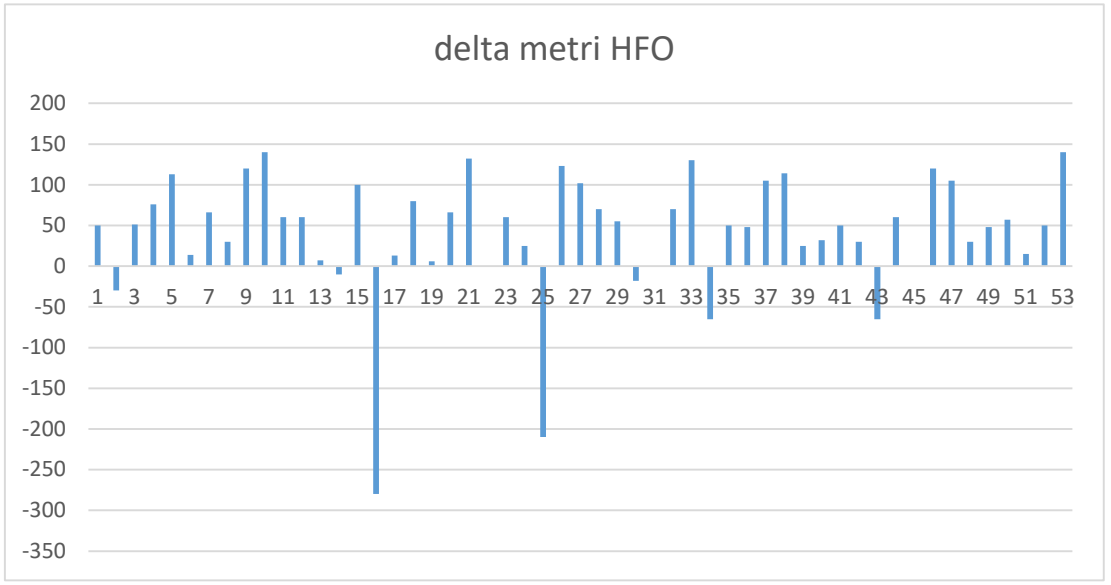
- 6MWT (m)
- Dispnea
- forza periferica e dei muscoli respiratori
- qualità della vita e dell'impatto della malattia

Arruolati 170 pts









Vitacca et al in progress

CONCLUSIONI

- L'utilizzo degli alti flussi in riabilitazione ha grandi potenzialità.
  - Riduce dispnea
  - Facile da usare (rispetto alla NIV)
- L'esercizio fisico e la disostruzione bronchiale sembrano essere le aree che maggiormente possono beneficiare di questo trattamento.
- Attualmente vi è urgente necessità di studi fisiologici e clinici che supportino l'uso routinario di questa terapia in ambito riabilitativo e che definiscano il paziente ideale, anche ai fini prescrittivi.
  - Costi ??

Why does it work?

- Unloading of the respiratory muscles
- Improvement breathing patterns
- Changes in airways?
- Changes in airflow distribution
- Improvement of sleep quality

Duiverman et al. Int J Chron Obstruct Pulmon Dis. 2017 Jan 11;12:243-257
Windisch W et al. Respir Physiol Neurobiol. 2006 Feb 28;150(2-3):251-60.
De Backer L et al. Int J Chron Obstruct Pulmon Dis. 2011;6:615-24.
Schwarz SB et al. Curr Opin Pulm Med. 2017 Aug 5.

(CHEST 1999; 116:521–534)

consensus conference

Clinical Indications for Noninvasive Positive Pressure Ventilation in Chronic Respiratory Failure Due to Restrictive Lung Disease, COPD, and Nocturnal Hypoventilation—A Consensus Conference Report*

Muscle hypothesis

NPPV rests chronically fatigued respiratory muscles

Sleep hypothesis

NPPV prevents sleep-disordered breathing and improves sleep quality

Positive NIV effects on COPD

- **Nocturnal Gases (**Elliott *Thorax* 1992; Simonds Thorax 1998; Windisch W. *Respir Med* 2002)
- **Δ FEV_1 (**Kohnlein Lancet Resp Medicine 2014)
- **Resting the respiratory muscles** (Lukacsovits Eur Respir J 2012)
- **Delta paCO2 (**Köhnlein Lancet Respir Med 2014**)**

- **Sleep efficiency (**Elliott *Thorax* 1992; Meecham Jones 1995 Schönhofer B et al. *Thorax* 2000)
- **Changes in Quality of Life (**Windisch W. Eur Respir J 2008; Murphy et al JAMA 2016; *Kohnlein Struik)*
- **Readmissions (**Chu Thorax 2004; Cheung Int J Tuberc Lung Dis 2010; Clini 2002)
- ***Survival (*** *Simonds 1995;* Jäger Chest. 2008 Chu Thorax 2004 Köhnlein Lancet Respir Med 2014;Funck 2011 Murphy et al. JAMA. 2017)

Negative NIV effects on COPD

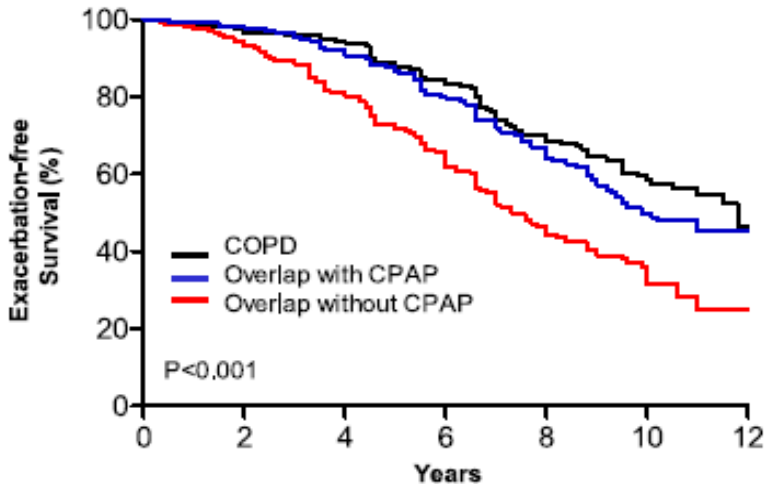
- Changes in Quality of Life (*McEvoy 2009)*
- Readmissions (*Casanova 2000; McEvoy 2009*
- Survival *(Casanova, Clini;* Struik Thorax 2014)

Am J Respir Crit Care Med Vol 182. pp 325–331, 2010

Jose M. Marin[1,2*], Joan B. Soriano[2,3*], Santiago J. Carrizo[1*], Ana Boldova[1*], and Bartolome R. Celli[4*]

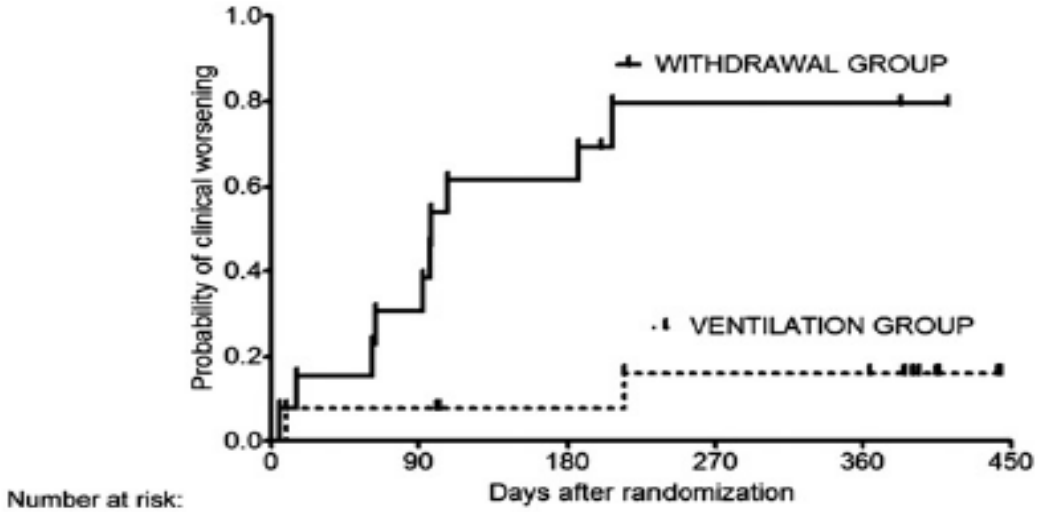
Outcomes in Patients with Chronic Obstructive Pulmonary Disease and Obstructive Sleep Apnea

The Overlap Syndrome



Long-term non-invasive ventilation in COPD after acute-on-chronic respiratory failure☆

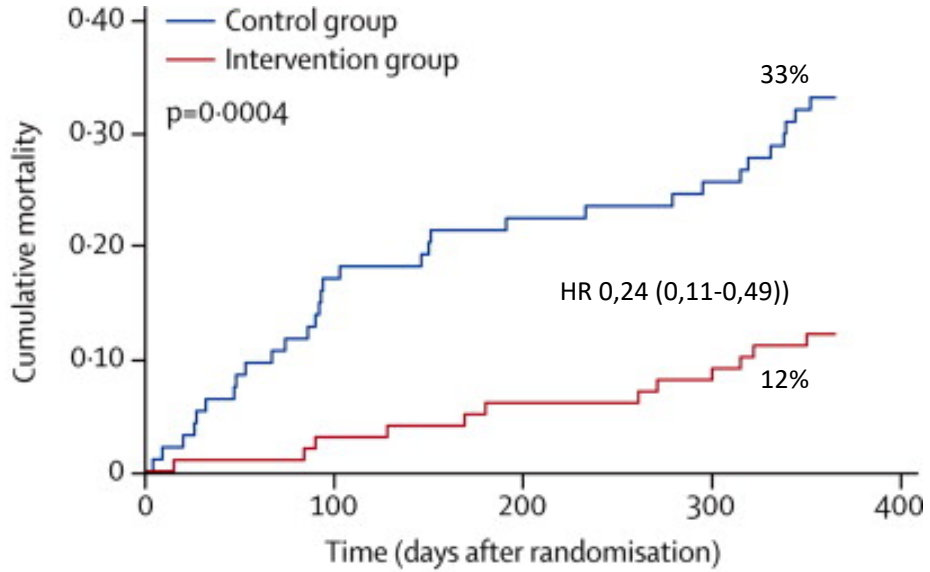
Funk GC. et al. Respir Med 2011;105(3):427-34



Conclusion: COPD patients who remain hypercapnic after acute respiratory failure requiring mechanical ventilation may benefit from long-term NIV.

Non-invasive positive pressure ventilation for the treatment of severe stable chronic obstructive pulmonary disease: a prospective, multicentre, randomised, controlled clinical trial

Thomas Köhnlein, Wolfram Windisch, Dieter Köhler, Anna Drabik, Jens Geiseler, Sylvia Hartl, Ortrud Karg, Gerhard Laier-Groeneveld, Stefano Nava, Bernd Schönhofer, Bernd Schucher, Karl Wegscheider, Carl P Criée, Tobias Welte



Number at risk

Control group	93	77	72	69
Intervention group	102	95	92	90

Köhnlein et al. Lancet Respir Med 2014;2:698-705.

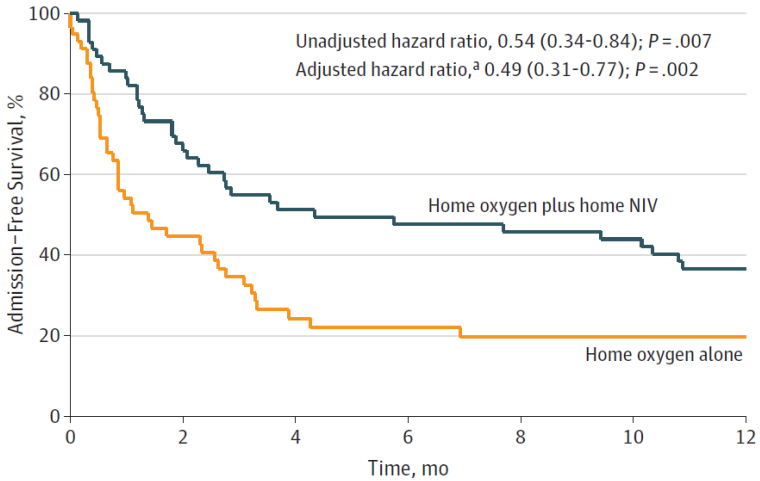
JAMA | Original Investigation

Effect of Home Noninvasive Ventilation With Oxygen Therapy vs Oxygen Therapy Alone on Hospital Readmission or Death After an Acute COPD Exacerbation

A Randomized Clinical Trial

randomization / prolonged hypercapnia:

14 -21 days post index event



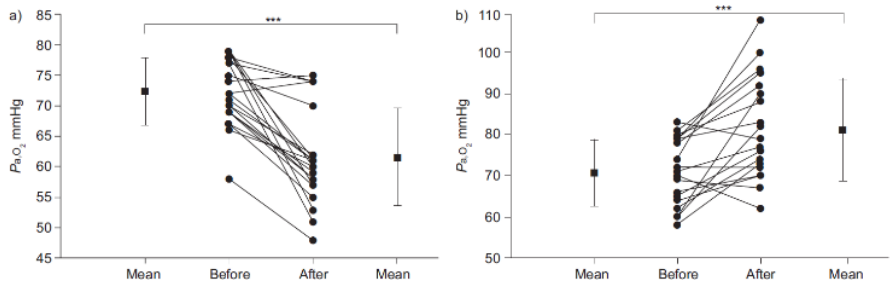
Murphy et al. JAMA. 2017 Jun 6;317(21):2177-2186

NIV even “works” during exercise

Eur Respir J 2007; 29: 930–936
DOI: 10.1183/09031936.00075806

Noninvasive ventilation during walking in patients with severe COPD: a randomised cross-over trial

M. Dreher, J.H. Storre and W. Windisch



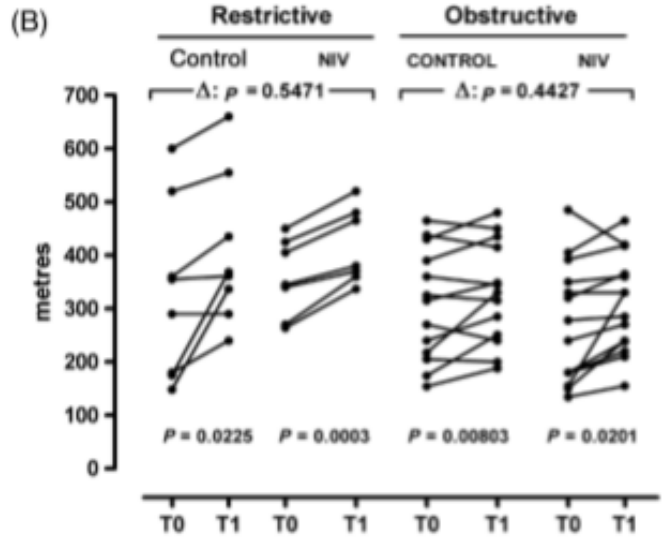
Dreher et al. Eur Respir J. 2007 May;29(5):930-6.

Official Journal of the Asian Pacific Society of Respirology
Respirology

ORIGINAL ARTICLE

Non-invasive ventilation during cycle exercise training in patients with chronic respiratory failure on long-term ventilatory support: A randomized controlled trial

MICHELE VITACCA,[1] DICLE KAYMAZ,[2] BARBARA LANINI,[3] GUIDO VAGHEGGINI,[4] PINAR ERGÜN,[2] FRANCESCO GIGLIOTTI,[3] NICOLINO AMBROSINO[5] AND MARA PANERONI[1]



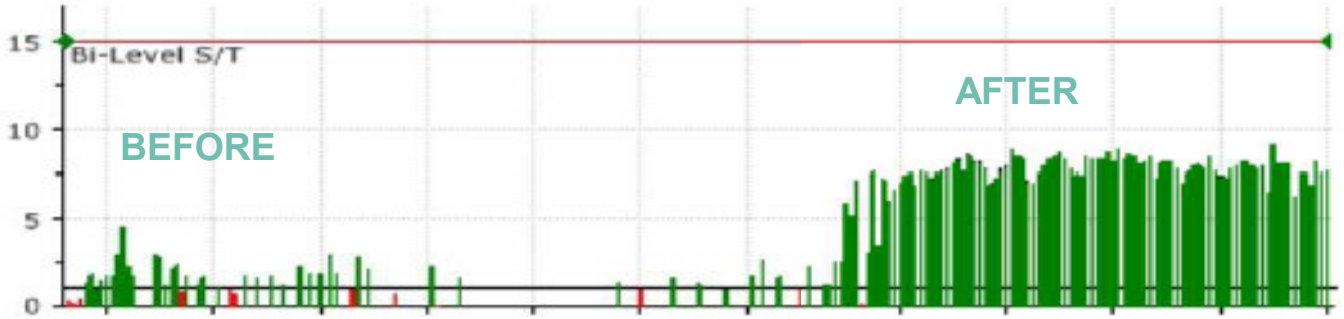
User experience vs. design

How important are comfort and lifestyle factors?

Rank	Priority	%
1	Being able to fall asleep easily and stay asleep whilst using my ventilator	96.6
2	Having smooth, ‘natural feeling’ breathing	93.8
3	How comfortable the mask is	86.0
4	Being able to travel with it (such as by car and by air)	81.0
5	Reducing dryness of mouth and eyes	80.4
6	How noisy the ventilator is	79.7
7	Being able to speak and be heard whilst using my ventilator	64.7
8	How big it is	63.1
9	Reducing nasal secretions	61.3
10	How heavy it is	56.6

NIV service

NIV setting and adherence control at distance



The service

- Outpatient and home visit appointments
- 12 appointments/week over 1.5 days

Patient cohort

- 138 patients:
  (8 unsuccessful)
- 138 using EncoreAnywhere database system
- Modem – 27 patients
  (1 removed)
- Range of disease conditions and complexity

The team

- Respiratory Consultant
- Chief Physiologist
- Nurse Specialist
- Senior Physiologist

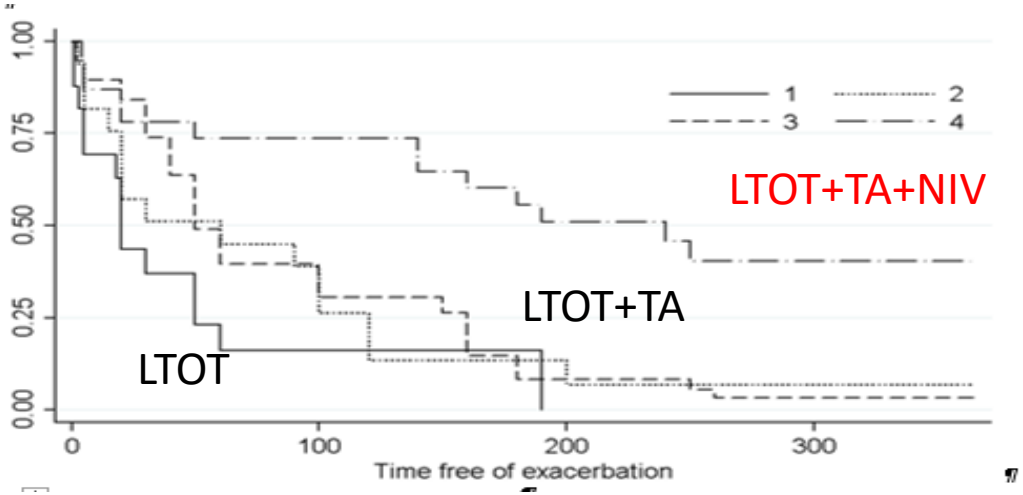
With courtesy of Sara Parsons St George University Hospital UK

IS THERE ANY ADDITIONAL EFFECT OF TELE-ASSISTANCE ON LONG-TERM CARE PROGRAMS IN HYPERCAPNIC COPD PATIENTS? A RETROSPECTIVE STUDY.

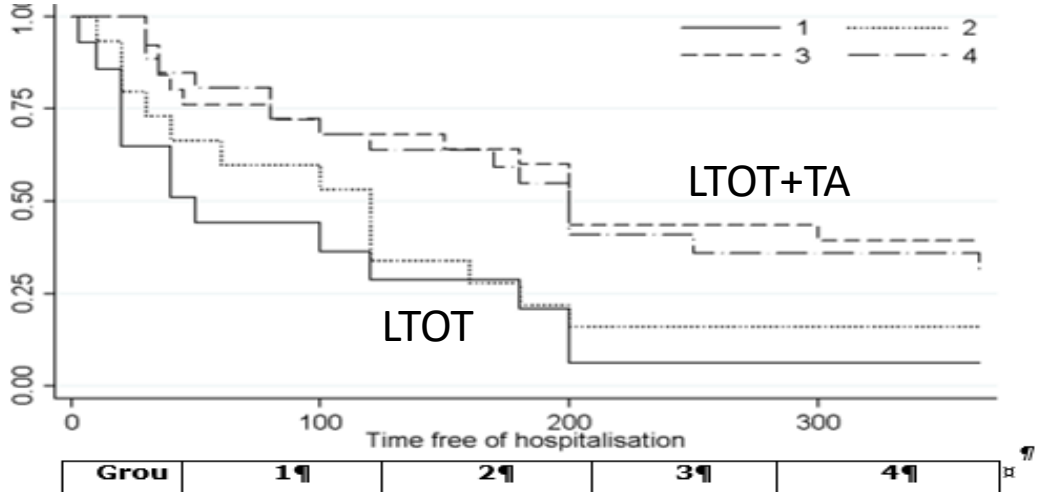
M.Vitacca, M.Paneroni, F.Grossetti, N. Ambrosino. **COPD 2016**

Post hoc analysis 76 COPD under LTOT out 240 pts: Haz Ratio for relapse, H and death were calculated

Exacerbations



Hospitalisations



1. **Tele-assistance alone and with greater efficacy when combined with NIV may reduce the frequency of exacerbations.**
2. **Tele-assistance, added to LTOT but not to NIV may reduce the frequency of hospitalizations.**

Take home on COPD

- Long-term NIV has the potential to improve the outcome
- Overuse of NIV must be avoided *(not all patients requiring acute NIV in hospital need subsequent long-term NIV)*
- Indication criteria are:
  - Severe symptoms
  - Clinical hystory of revolving doors (exacerbations, hospitalisations, at least three hospital admissions with acute hypercapnic respiratory failure ?)
  - Hypercapnia >54 mmhg post acute NIV (at least 15 days !)
- Control visits are necessary (side effects, adherence to therapy, QoL, and co-morbidities must be considered)
- integrate NIV into a multidisciplinary programme
- time, experience and a dedicated infrastructure.