15es JOURNÉES FRANCOPHONES Alvéole

Le réentraînement à l'effort avec ventilation à haut débit nasal est(-il) plus efficace(?)

f.herengt@dieulefit-sante.org

alvéole
OSEZ UN SOUFFLE NOUVEAU
Groupe de travail de la SPLF pour Exercice et Réhabilitation Respiratoire

SPLF
Société de Pneumologie de Langue Française

- Lien d’intérêt: Fisher Paykel Healthcare, New Zealand

17 décembre 1903, 1er vol aérien de 12’’

Les types: mixeurs, turbines, Venturi

Générateur de flux (B)

Mixeurs avec débitmètre mécanique (A,D)

Mélangeur à effet Venturi (C,F)

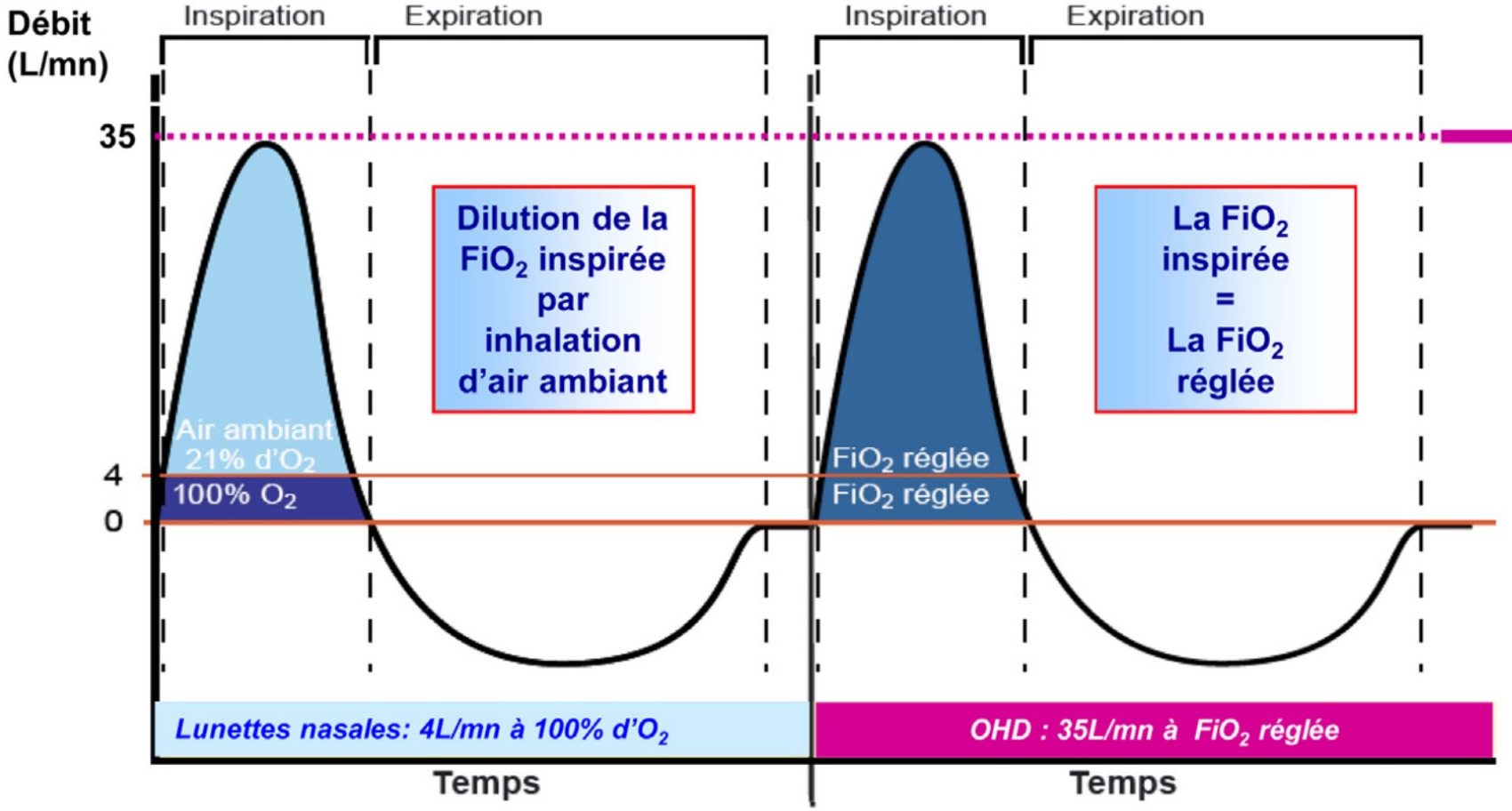
Mélangeur avec réglage de la FiO2 (E)

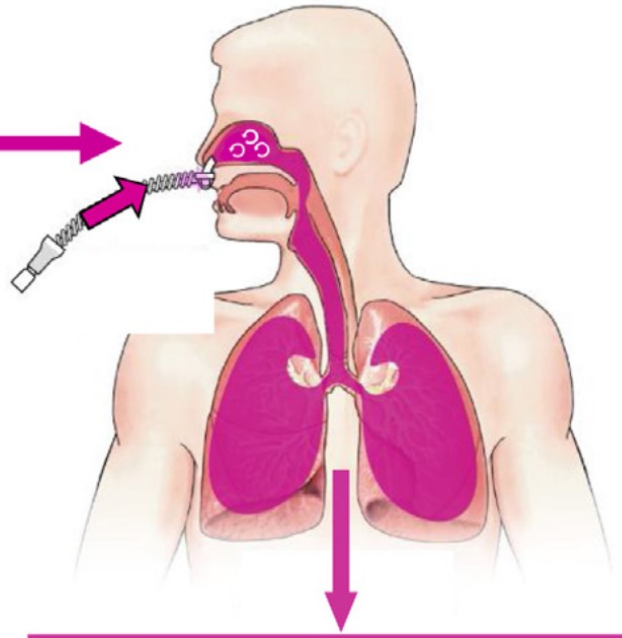
OHD permet la maîtrise de l'oxygénation (FiO2, SpO2) ↗

Oxygénothérapie standard

Oxygénothérapie à haut débit (OHD)

Détresse respiratoire aiguë : débit inspiratoire de pointe (35L/mn)





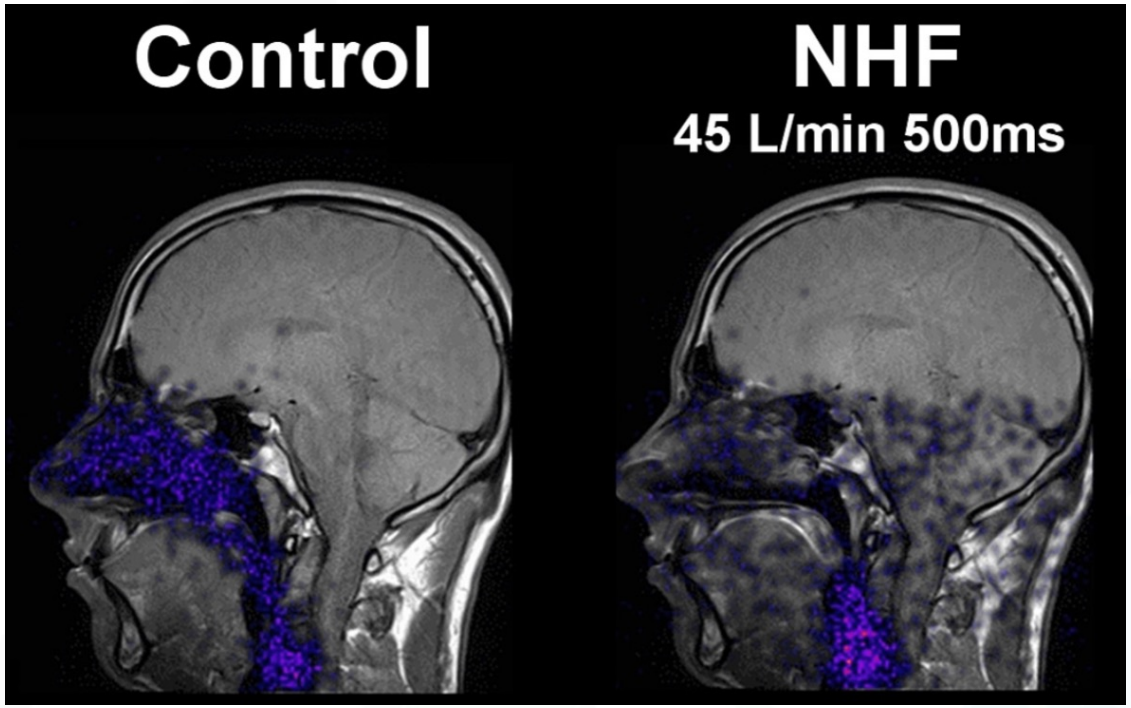
OHD :

- **Couverture de la demande ventilatoire (35L/mn)**
- **FiO_2 inspirée = FiO_2 réglée**

Girault C, et al. Principes de fonctionnement, effets physiologiques et aspects pratiques de l'oxygénothérapie à haut débit. Rev Mal Respir. 2022 May;39(5):455-468. French. doi: 10.1016/j.rmr.2022.03.012. Epub 2022 May 16. PMID: 35589480.

OHD augmente le rinçage de l'espace mort anatomique

- Apnée après inhalation de Krypton marqué sans et avec NHF



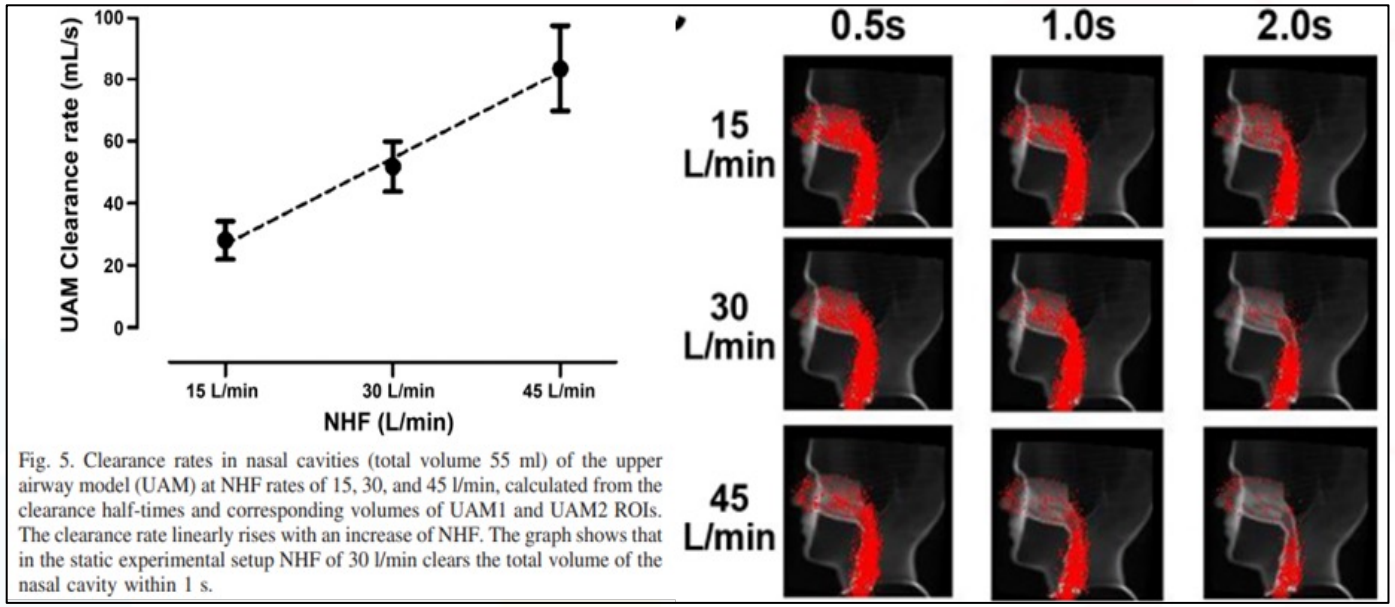


Fig. 5. Clearance rates in nasal cavities (total volume 55 ml) of the upper airway model (UAM) at NHF rates of 15, 30, and 45 l/min, calculated from the clearance half-times and corresponding volumes of UAM1 and UAM2 ROIs. The clearance rate linearly rises with an increase of NHF. The graph shows that in the static experimental setup NHF of 30 l/min clears the total volume of the nasal cavity within 1 s.

Möller W, Celik G, Feng S, Bartenstein P, Meyer G, Oliver E, Schmid O, Tatkov S. Nasal high flow clears anatomical dead space in upper airway models. J Appl Physiol (1985). 2015 Jun 15;118(12):1525-32. doi: 10.1152/japplphysiol.00934.2014. PMID: 25882385; PMCID: PMC4482836.

OHD produit une pression positive (effet PEP)

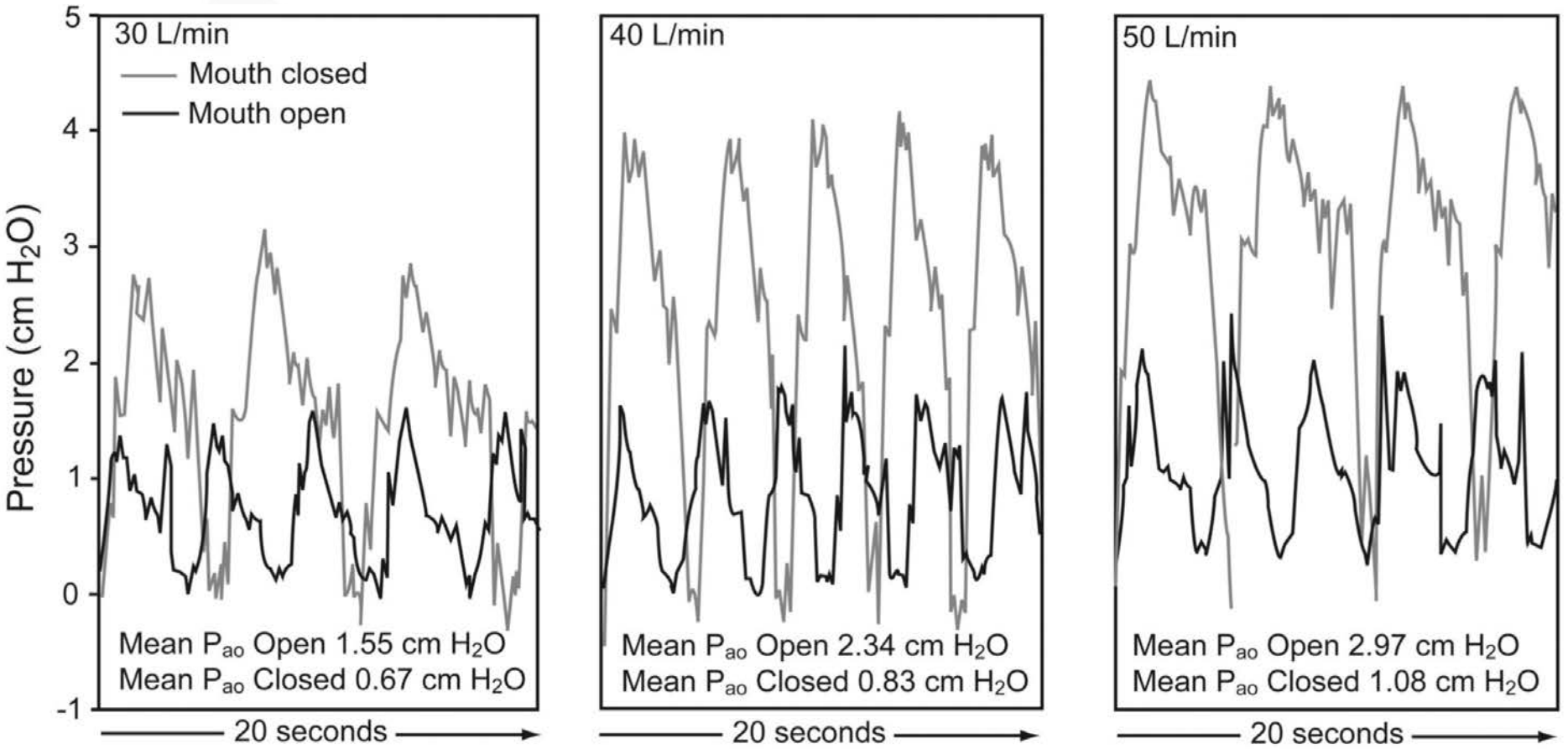


Fig. 4. Example airway pressure profiles from one patient, with mouth open or mouth closed, at flows of 30, 40, and 50 L/min.

- ↗ **le volume pulmonaire de fin d'expiration (CRF).**
- ↗ **le volume courant (VT)**
- ↗ **le recrutement alvéolaire.**
- **Limite le risque d'atélectasie.**

Parke RL, Eccleston ML, McGuinness SP. The effects of flow on airway pressure during nasal high-flow oxygen therapy. Respir Care. 2011 Aug;56(8):1151-5. doi: 10.4187/respcare.01106. Epub 2011 Apr 15. PMID: 21496369.

Les effets physiologiques de l'OHD

Haut débit

- Oxygénation
- Rinçage espace mort anatomique
- Effet PEP
- ↘ Raw
- ↘ W ventilatoire
- ↗ Recrutement alvéolaire

Humidification

- ↗ escalator mucociliaire
- ↗ température & humidité
- ↗ confort
- ↗ défenses tissulaires locales
- ↘ sécrétions
- ↘ W conditionnement des gaz

OHD et exercice chez les patients BPCO

Cirio 2016: OHD vs O2

- N=12 BPCO, VEMS#40 %; Randomisé crossover 2 tests d'endurance Pcst à 75 % de Pmax cycloergometref

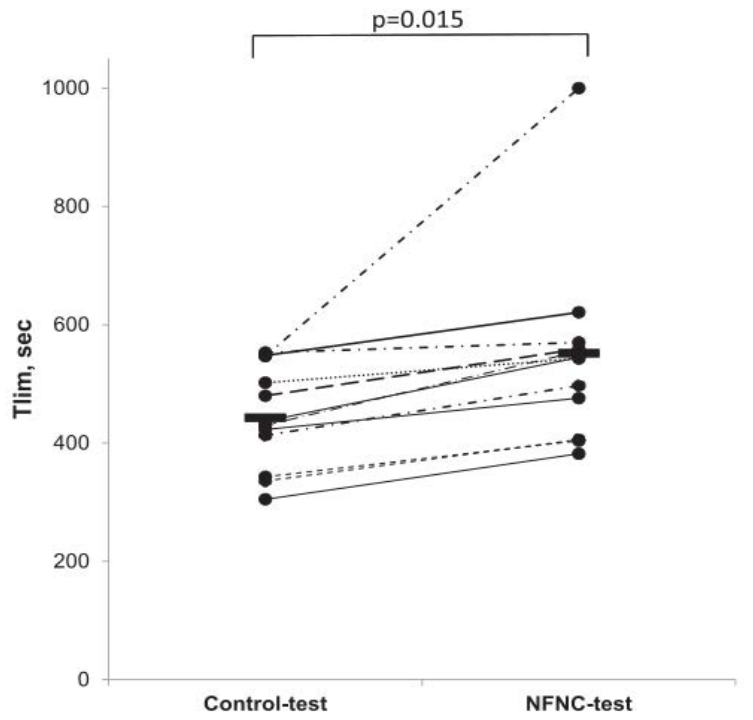
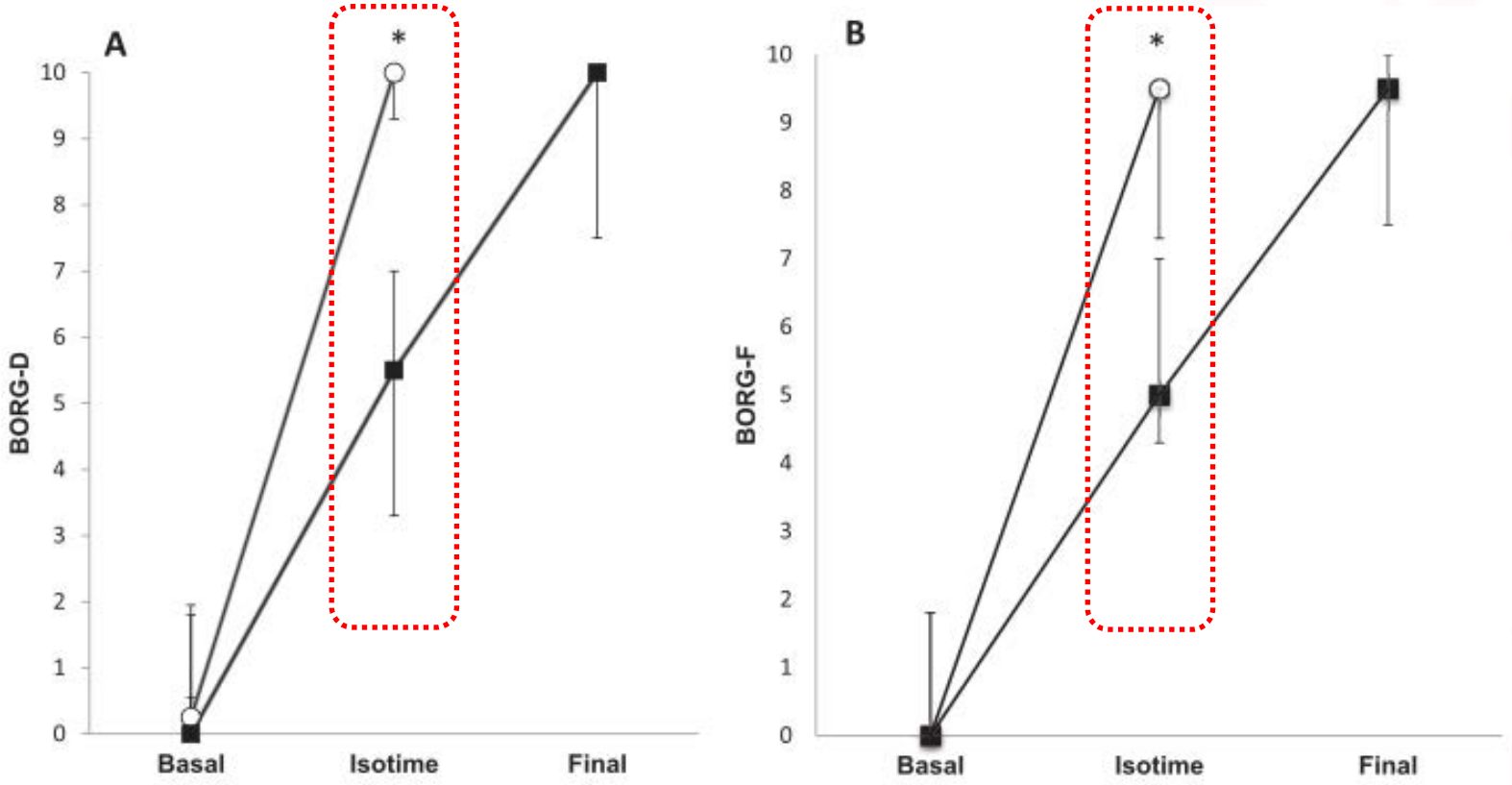


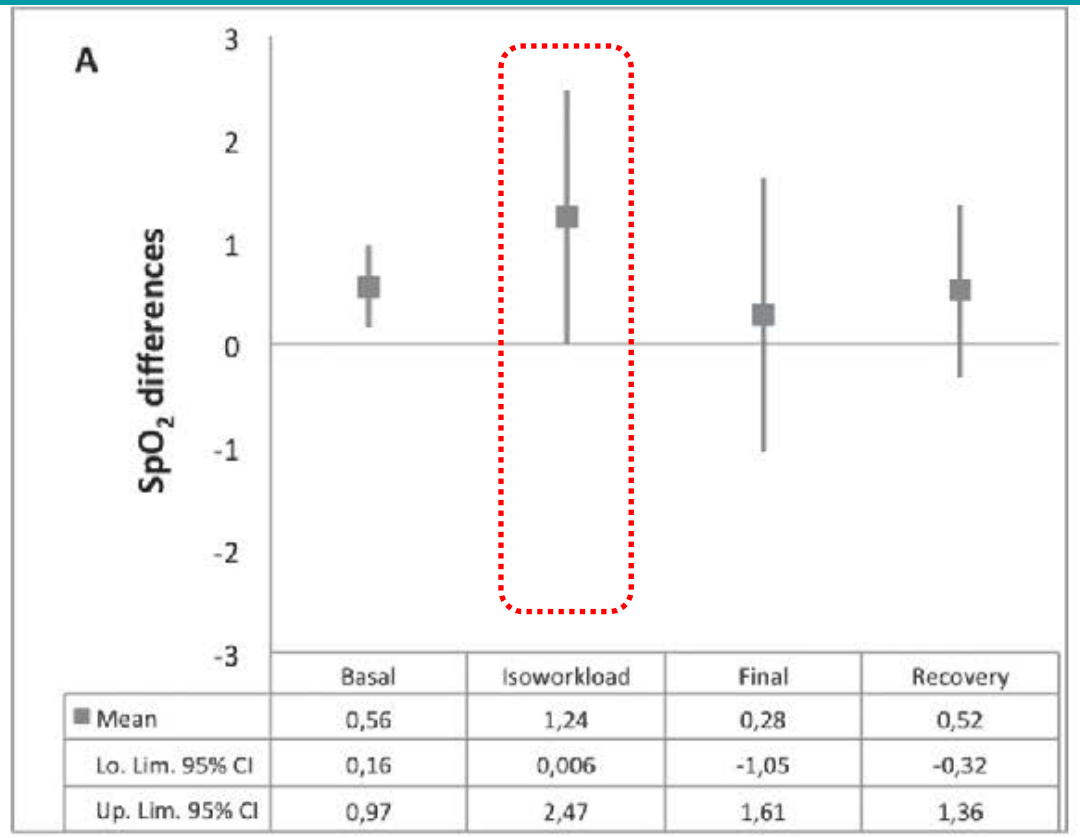
Fig. 1. Effect of the HFNC on exercise capacity during a constant-load test compared to a control condition in which the test was performed at the same FiO_2. In all patient HFNC significantly increased the exercise performance. Tlim = exercise duration. *Solid line* = mean value.



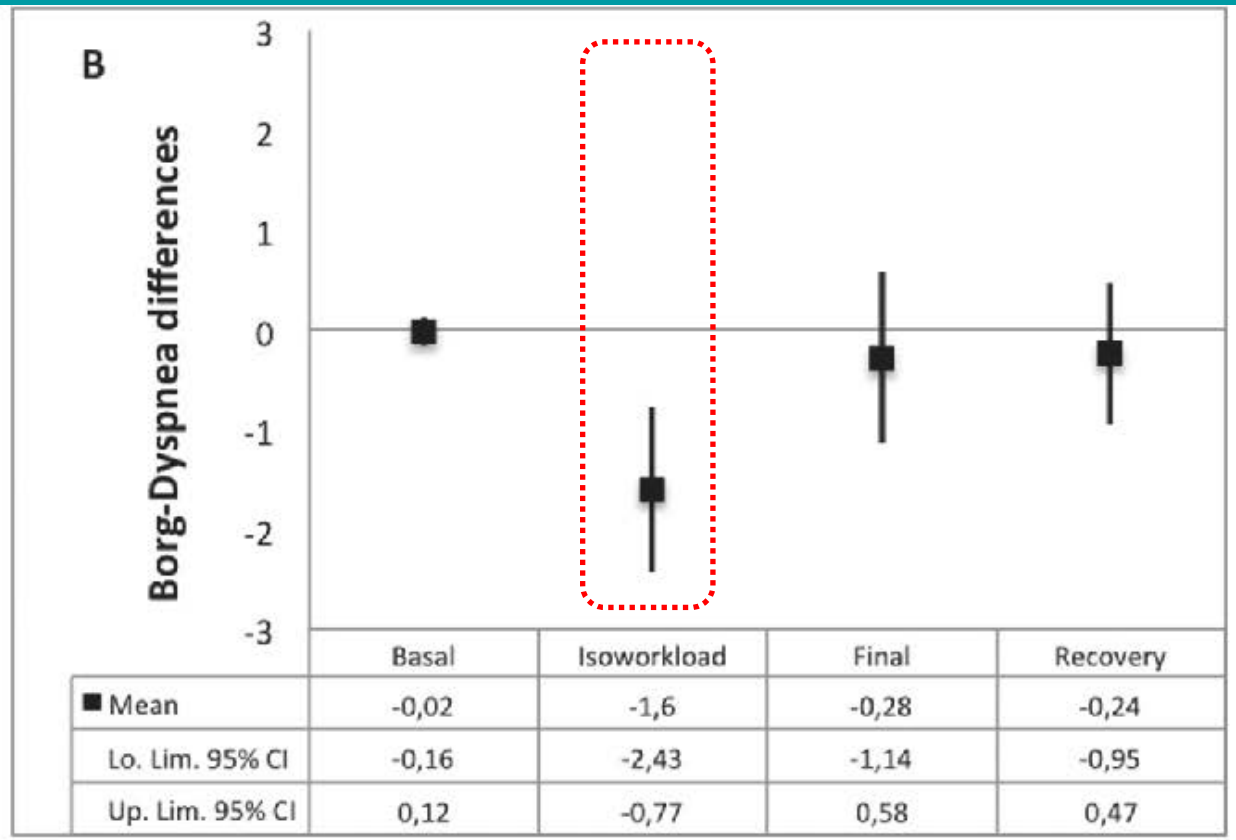
- N=12 BPCO, VEMS#40 %; Randomisé crossover 2 tests d'endurance Pcst à 75 % de Pmax cycloergometre
- OHD vs O2 (FiO2<>, optiflow vs venturi)
  - Temps endurance ↗
  - Dyspnée et fatigue isotime ↘

Cirio S, Piran M, Vitacca M, Piaggi G, Ceriana P, Prazzoli M, Paneroni M, Carlucci A. Effects of heated and humidified high flow gases during high-intensity constant-load exercise on severe COPD patients with ventilatory limitation. Respir Med. 2016 Sep;118:128-132. doi: 10.1016/j.rmed.2016.08.004. Epub 2016 Aug 8. PMID: 27578482.

DellEra 2019: OHD vs O2



	Basal	Isoworkload	Final	Recovery
Mean	0,56	1,24	0,28	0,52
Lo. Lim. 95% CI	0,16	0,006	-1,05	-0,32
Up. Lim. 95% CI	0,97	2,47	1,61	1,36



	Basal	Isoworkload	Final	Recovery
Mean	-0,02	-1,6	-0,28	-0,24
Lo. Lim. 95% CI	-0,16	-2,43	-1,14	-0,95
Up. Lim. 95% CI	0,12	-0,77	0,58	0,47

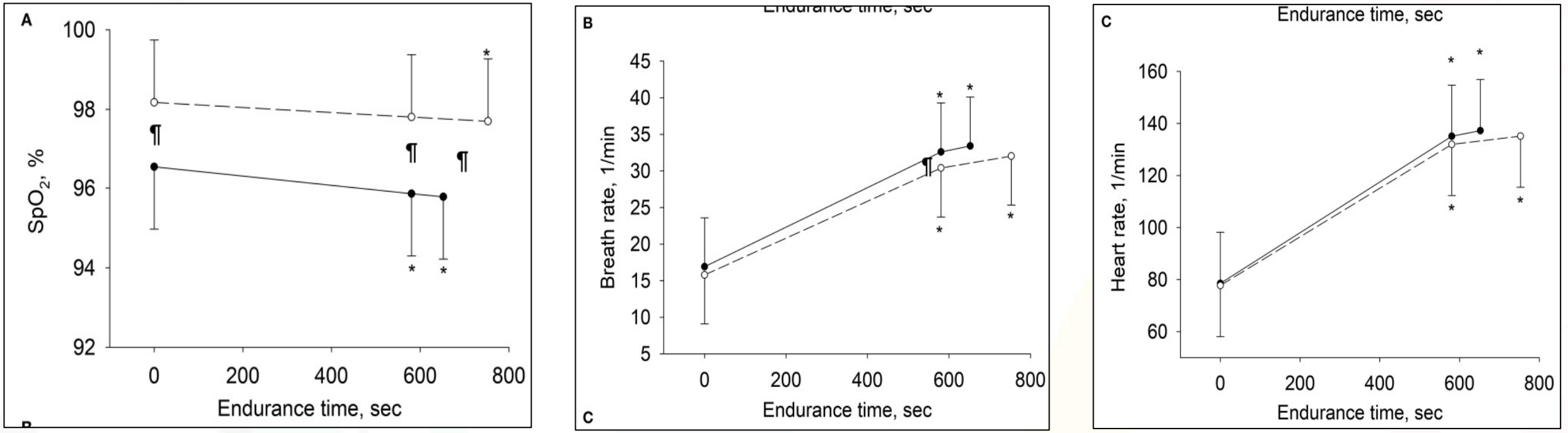
- N=28 BPCO, VEMS# 44%
- Randomisé crossover, tapis/90% de Vitesse max
- OHD vs O2 (VM)

- OHD vs O2(VM)
  - Tolérance exercice ↗ vitesse.max. ↗ (5.9 vs. 5.7 km/h; p = 0.0002)
  - Oxygénation
  - Dyspnée isotime ↘

Silvina, Dell'Era, Roux Nicolás, Gimeno Elena, Terrasa Sergio, Castellano Barneche María Florencia, Balestrieri María Carolina, Gracia Guadalupe, Bykhovsky Ilona and Midley Alejandro. "The High Flow Nasal Cannula Improves the Exercise Capacity in Patients with Chronic Obstructive Pulmonary Disease: Randomized, Crossover Clinical Trial." (2019).

Bitos 2021: 79 BPCO modérés OHD vs O2

FIGURE 3 | Changes in physiologic variables over the course of exercise in per-protocol analyses. Means and SD bars are shown for values at rest, at isotime (i.e., end-exercise time in tests with shorter endurance and corresponding time in tests with longer endurance), and at end-exercise. Open circles represent tests with high-flow, closed circles with low-flow oxygen therapy. **(A–C)** Depict pulse oximetry (SpO_2), breath rate and heart rate. *$P < 0.05$ vs. rest within same treatment, ¶$P <$ 0.05 high-flow vs. low-flow oxygen therapy at corresponding stage of exercise.



Randomisé cross over
BPCO stable, test endurance à 75% Pmax
O2 3l/min vs OHD (60 L/min, FiO2 0.45)

n=79 , âge 58, VEMS#63%
Tlim O2= 688 ± 463’’; Tlim OHD=773 ± 471’’; Diff.= 13%
Isotime, FR & SpO2 meilleurs dans groupe OHD

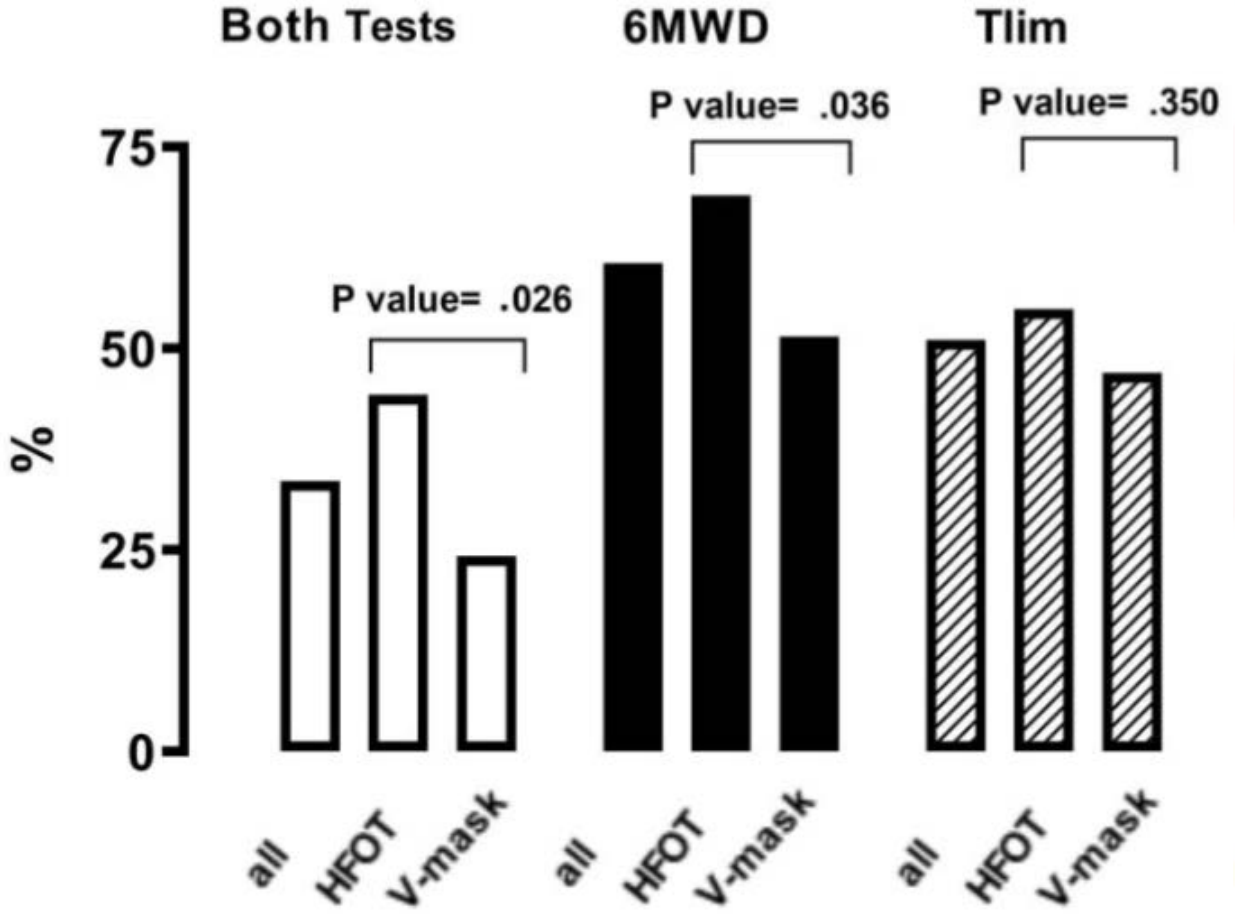
Konstantinos Bitos Effect of High-Flow Oxygen on Exercise Performance in COPD Patients. Randomized Trial
Sec. Pulmonary Medicine Fev 2021 | https://doi.org/10.3389/fmed.2020.595450

Vitaca 2020: High-Flow Oxygen Therapy During Exercise Training in Patients With COPD: A Multicenter Randomized Controlled Trial

- **Méthode:**
  - 137 BPCO, 8 centres, essai randomisé contrôlé
  - Entraînement supervisé sur cycloergomètre, 20 séances, **FiO2 <>**
- Mesures pré & post:
  - Temps d'endurance (Tlim), TM6,
- **Résultats:**
  - Tlim: NS
  - TM6: 17 m
- **Conclusion:**
  - Bénéfice clinique évident avec OHD
  - Étude considérée non négative selon p

56 % vs 47 %

TM6: plus de répondeurs à l'entrainement dans le groupe OHD (MCID 30m atteint)



Vitacca M, et al. High-Flow Oxygen Therapy During Exercise Training in Patients With Chronic Obstructive Pulmonary Disease and Chronic Hypoxemia: A Multicenter Randomized Controlled Trial. Phys Ther. 2020 Aug 12;100(8):1249-1259. doi: 10.1093/ptj/pzaa076. PMID: 32329780.

L
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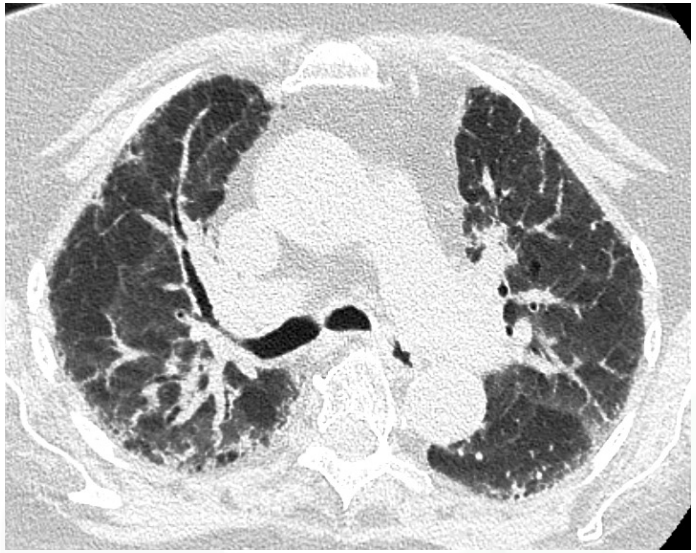
C

Temps d’endurance, oxygénation ↗
Dyspnée, Fatigue M inf. ↘

OHD et exercice chez les patients atteints de fibrose

La contrainte ventilatoire dans la fibrose pulmonaire



- **Fréquence ↗↗**
- **travail ventilatoire ↗↗**
- **SpO2 ↘↘**

- **Fréquence ↘↘**
- **travail ventilatoire ↘↘**
- **SpO2 ↗↗**

Badenes 2021: OHD & exercice dans la fibrose

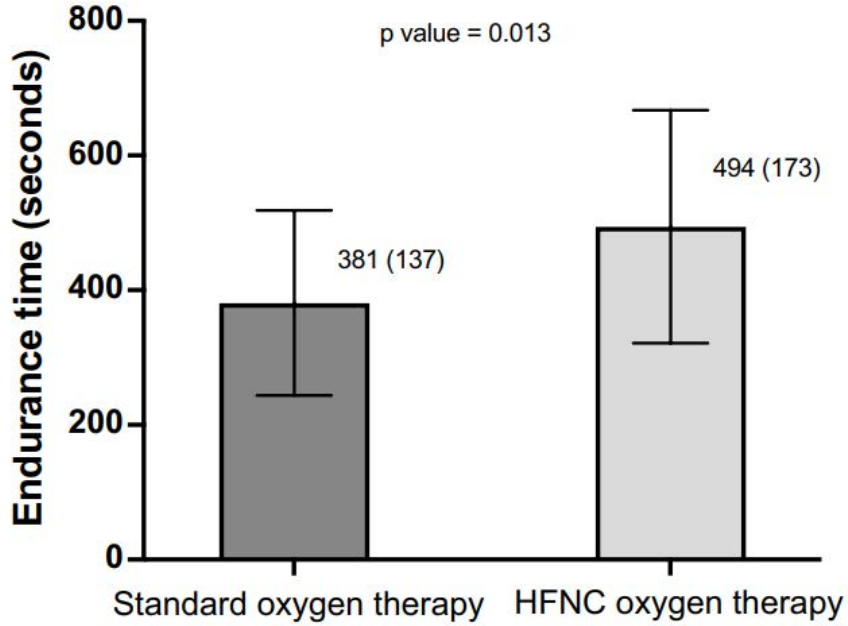


Fig. 2 Endurance time (seconds) with standard oxygen therapy and HFNC during CPET. *HFNC* high-flow nasal cannula, *CPET* cardiopulmonary exercise test. Data are presented as mean and standard deviation

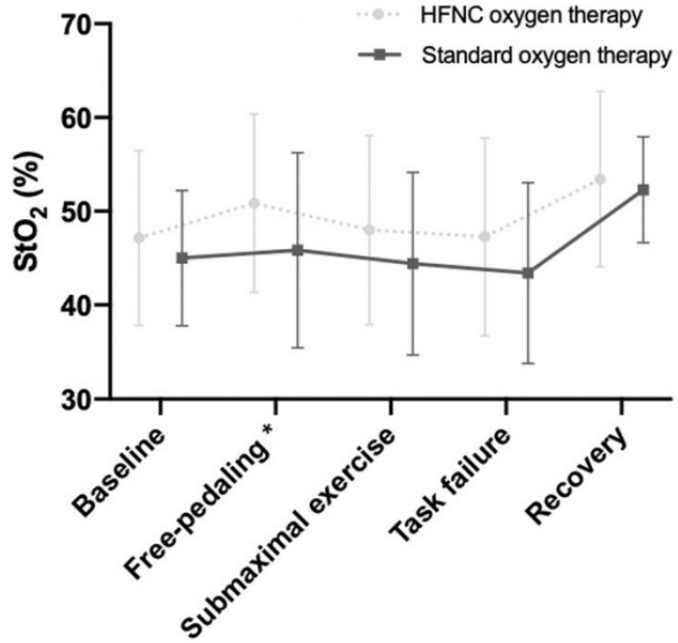


Fig. 3 Peripheral muscle oxygen saturation (StO_2) measured by NIRS during CPET performance with both oxygen devices (n = 7). *StO_2* muscle oxygen saturation, *NIRS* near-infrared spectroscopy device, *CPET* cardiopulmonary exercise test, *HFNC* high-flow nasal cannula. *$p < 0.05$. Data are presented as mean and standard deviation

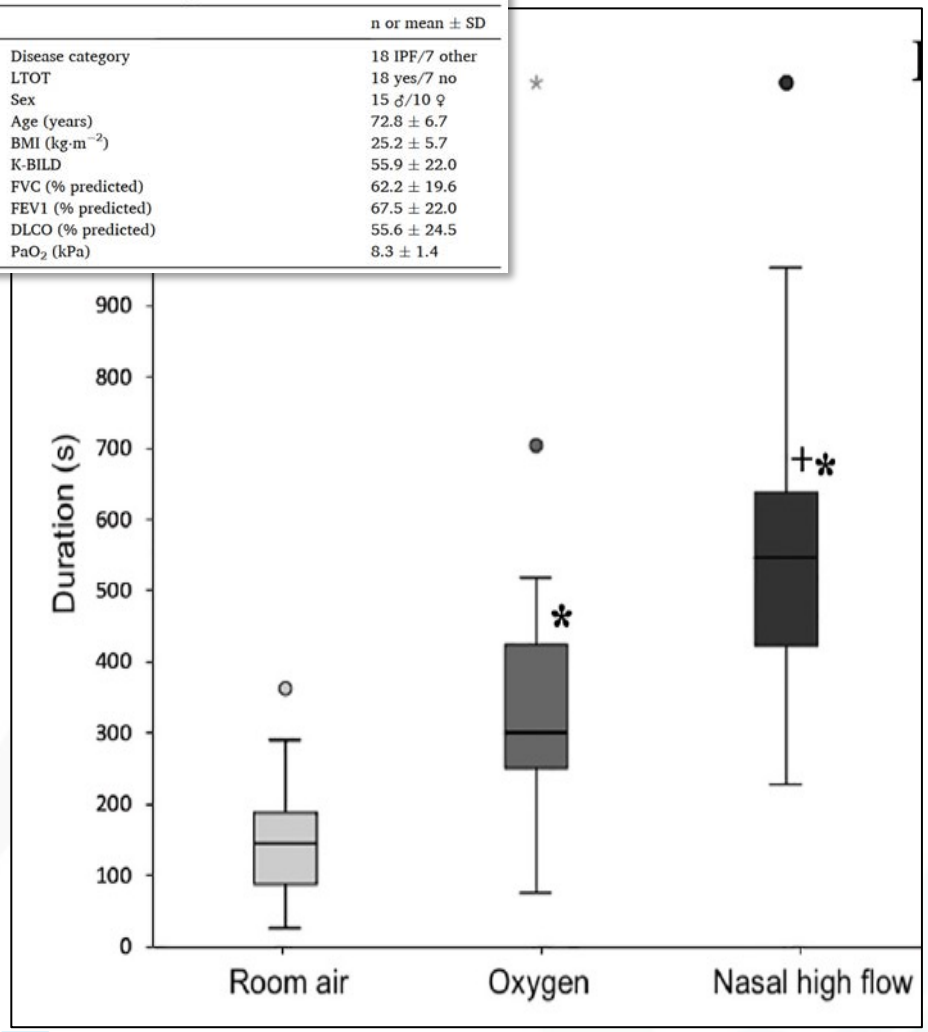
- ✓ Endurance time significantly greater (30%) with $NHFO_2$ *vs* standard O_2 therapy
- ✓ Higher peripheral muscle O_2 saturation with $NHFO_2$ *vs* standard O_2 therapy

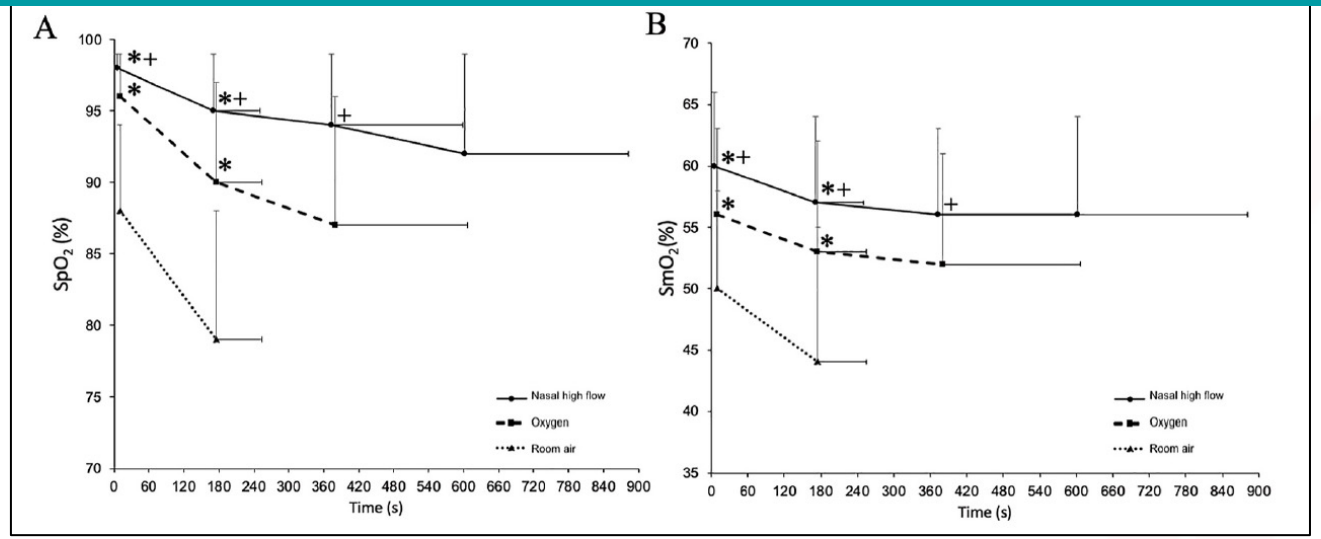
Badenes-Bonet D, Cejudo P, Rodó-Pin A, Martín-Ontiyuelo C, Chalela R, Rodríguez-Portal JA, Vázquez-Sánchez R, Gea J, Duran X, Caguana OA, Rodriguez-Chiaradia DA, Balcells E. Impact of high-flow oxygen therapy during exercise in idiopathic pulmonary fibrosis: a pilot crossover clinical trial. BMC Pulm Med. 2021 Nov 8;21(1):355. doi: 10.1186/s12890-021-01727-9. PMID: 34749699; PMCID: PMC8573951.

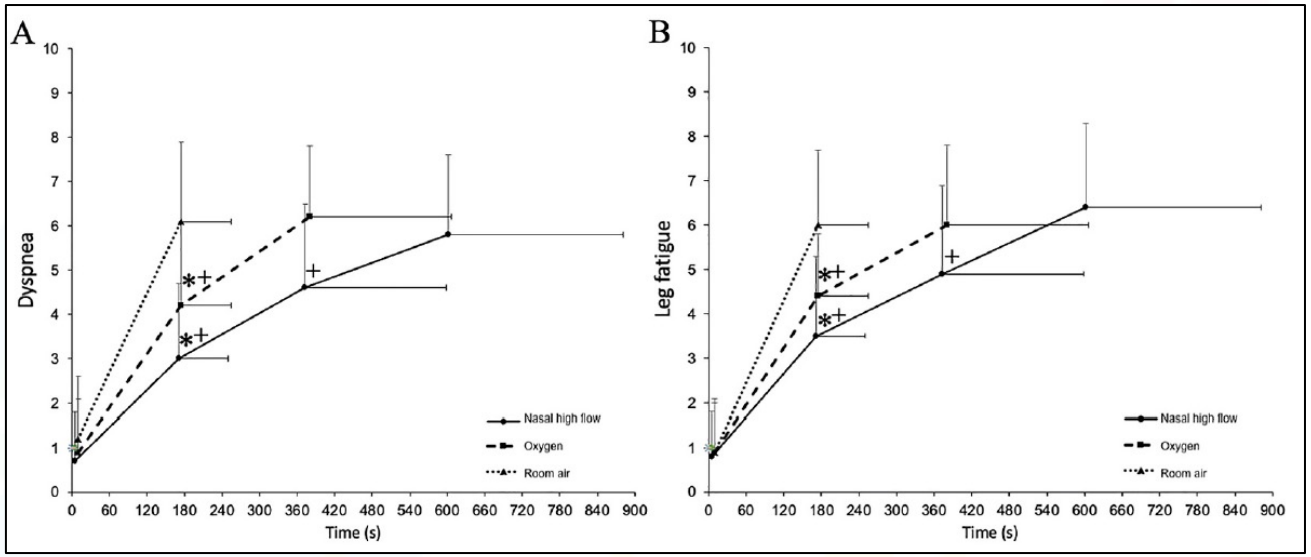
Al chikhanie 2021: OHD & exercice dans la fibrose

Characteristics of the ILD patients.

	n or mean ± SD
Disease category	18 IPF/7 other
LTOT	18 yes/7 no
Sex	15 ♂/10 ♀
Age (years)	72.8 ± 6.7
BMI (kg·m^{-2})	25.2 ± 5.7
K-BILD	55.9 ± 22.0
FVC (% predicted)	62.2 ± 19.6
FEV1 (% predicted)	67.5 ± 22.0
DLCO (% predicted)	55.6 ± 24.5
PaO_2 (kPa)	8.3 ± 1.4



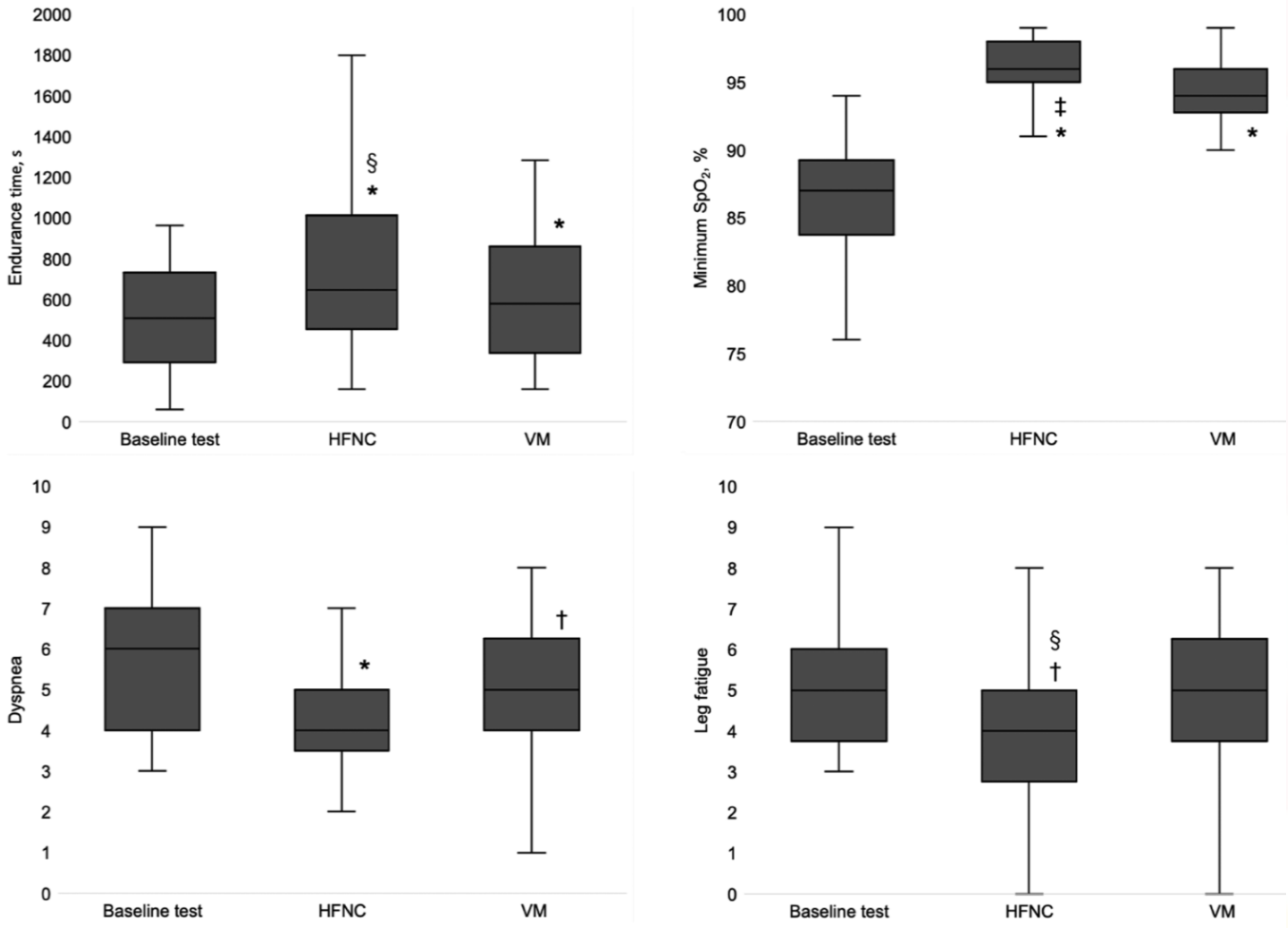




Al Chikhanie Y, Veale D, Verges S, Hérengt F. The effect of heated humidified nasal high flow oxygen supply on exercise tolerance in patients with interstitial lung disease: A pilot study. Respir Med. 2021 Sep;186:106523. doi: 10.1016/j.rmed.2021.106523. Epub 2021 Jun 29. PMID: 34225230.

Harada 2022: OHD & exercice dans la fibrose

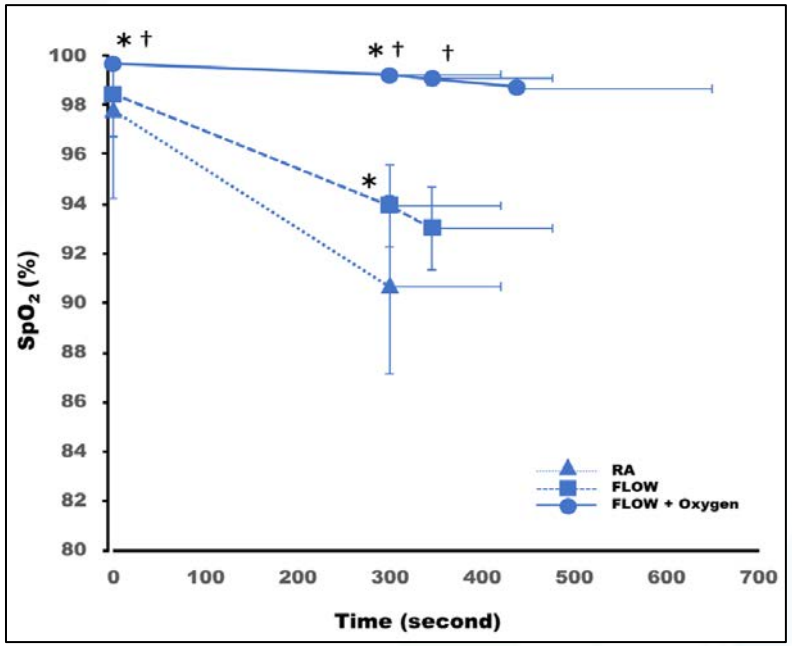
- N=24, (75% men; age: 77.5 [68.8–83.0]
- OHD (60 l/min, 60%) vs Venturi mask (12 l/min, 50%)
- Charge constante 80% Pmax
- Tlim, FC, Fatigue Minf,
- OHD améliore:
  - Tlim 647'' vs. 577''
  - SpO_2 96% vs. 94%
  - Fatigue Minf
- **HFNC increased exercise tolerance** in patients with stable IPF experiencing exercise-induced hypoxaemia.

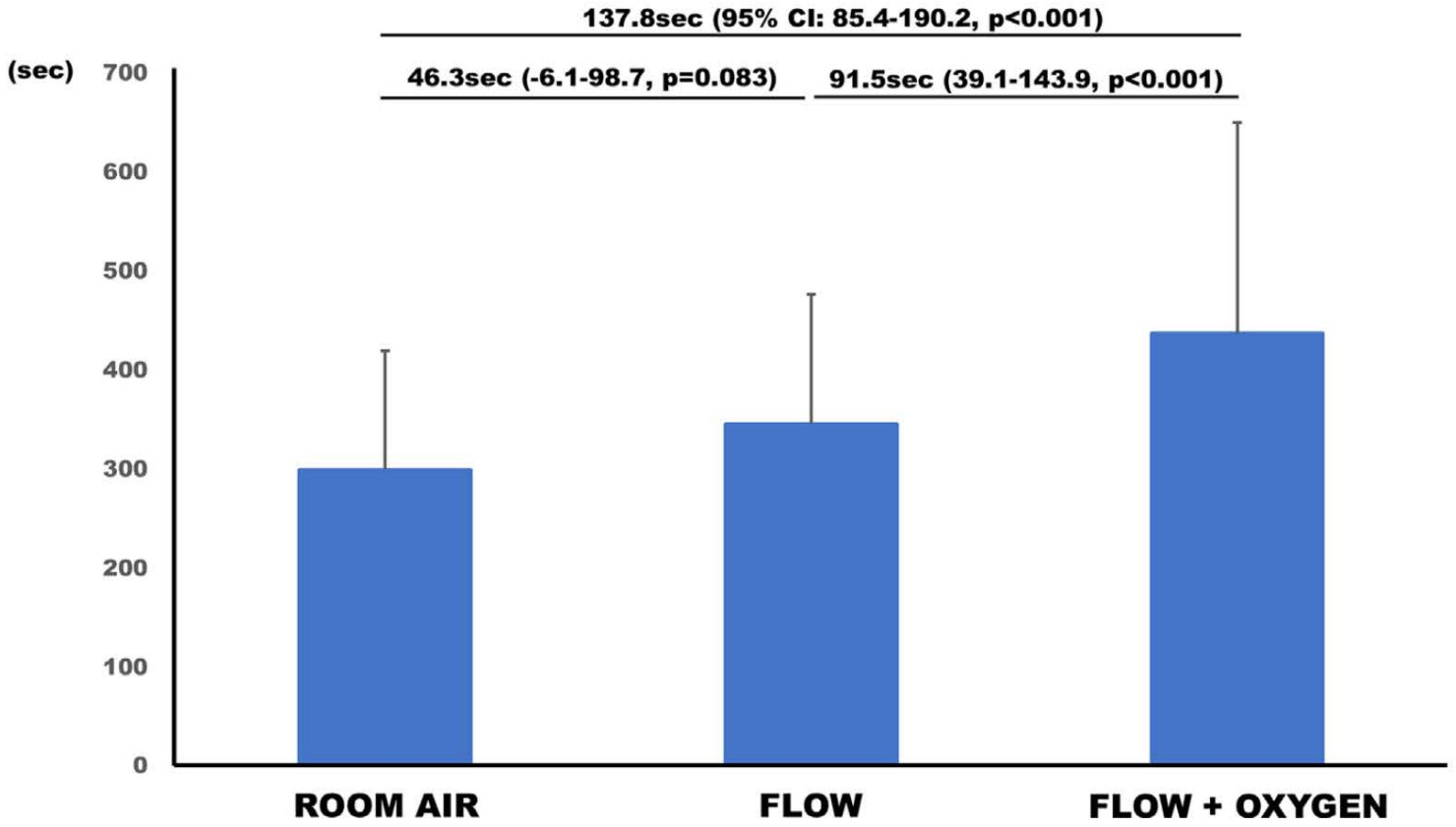


Jumpei Harada, et al. Effect of high-flow nasal cannula oxygen therapy on exercise tolerance in patients with idiopathic pulmonary fibrosis: A randomized crossover trial First published: 02 November 2021 https://doi.org/10.1111/resp.14176

NHFO2 and exercice capacity in ILD: Yanagita 2024

FIGURE 3 Comparison of exercise duration across three different HFNC conditions: ROOM AIR, FLOW and FLOW + OXYGEN. ROOM AIR is at HFNC setting Flow 0 L/min, FiO_2 0.21. FLOW is at HFNC setting Flow 40 L/min, FiO_2 0.21. And FLOW + OXYGEN is the HFNC setting of Flow 40 L/min, FiO_2 0.6.





Yanagita Y, Arizono S, Yokomura K, Ito K, Machiguchi H, Tawara Y, Katagiri N, Iida Y, Nakatani E, Tanaka T, Kozu R. Enhancing exercise tolerance in interstitial lung disease with high-flow nasal cannula oxygen therapy: A randomized crossover trial. Respirology. 2024 Feb 22. doi: 10.1111/resp.14684. Epub ahead of print. PMID: 38387607.

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Temps d'endurance, oxygénation ↗
Dyspnée, Fatigue M inf. ↘

MERCI !

ESSAI CLINIQUE PIDOX

RAPPORT TRIMESTRIEL MARS. 2024

N°IDRCB: 2022-A00774-39

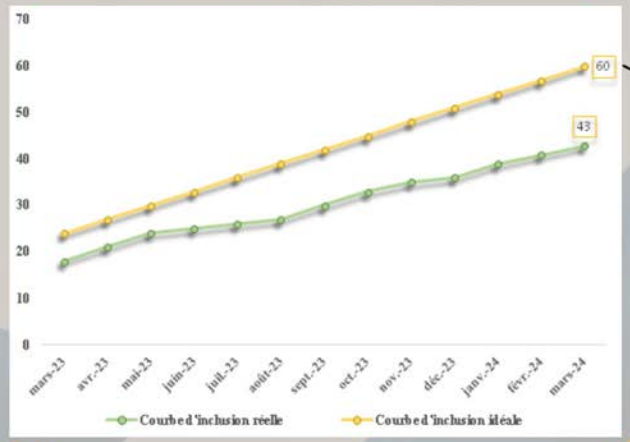
N°SI RIPH 2G: 22.01385.000088

L'étude visant à évaluer l'effet de la **réhabilitation respiratoire** sous **oxygénothérapie à haut débit** sur la **capacité d'exercice** des patients atteints de **fibrose pulmonaire** se poursuit dans notre centre.

A ce jour,

43 inclusions ont été réalisées, dont **35 inclusions complètes.**

COURBE D'INCLUSION



Sur la base d'une inclusion idéale de 3 patients/mois

Nous avons besoin de

70 patients

Ayant une PID bien établie

Et admis au Centre Dieulefit Santé pour

5 semaines

de réhabilitation respiratoire

Il nous manque :

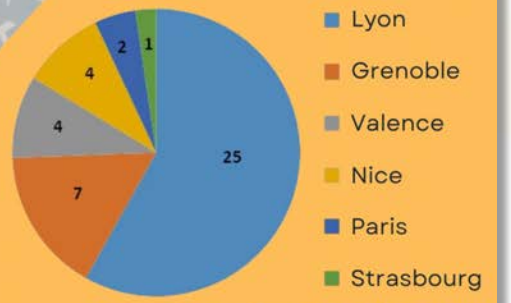
27 patients

Recommandation SPLF 2022 -31

"Il est proposé de prescrire un programme de réhabilitation respiratoire chez un patient ayant un diagnostic confirmé de FPI et présentant une limitation de la capacité à l'exercice et/ou une dyspnée invalidante."

Cottin et al., 2022

INCLUSIONS PAR PROVENANCE



Contact: f.herengt@dieulefit-sante.org

Conclusion:
le réentrainement à l'effort avec ventilation à haut débit nasal **est plus efficace pour le patient**

OHD pour le soignant, pour le patient


SOLAR IMPULSE
Un tour du monde en avion grâce
à la seule énergie du Soleil

Bpco: 4 essais

Chatila W, Chest. 2004

Prieur G, Respirology. 2019

Cirio S, Respir Med. 2016

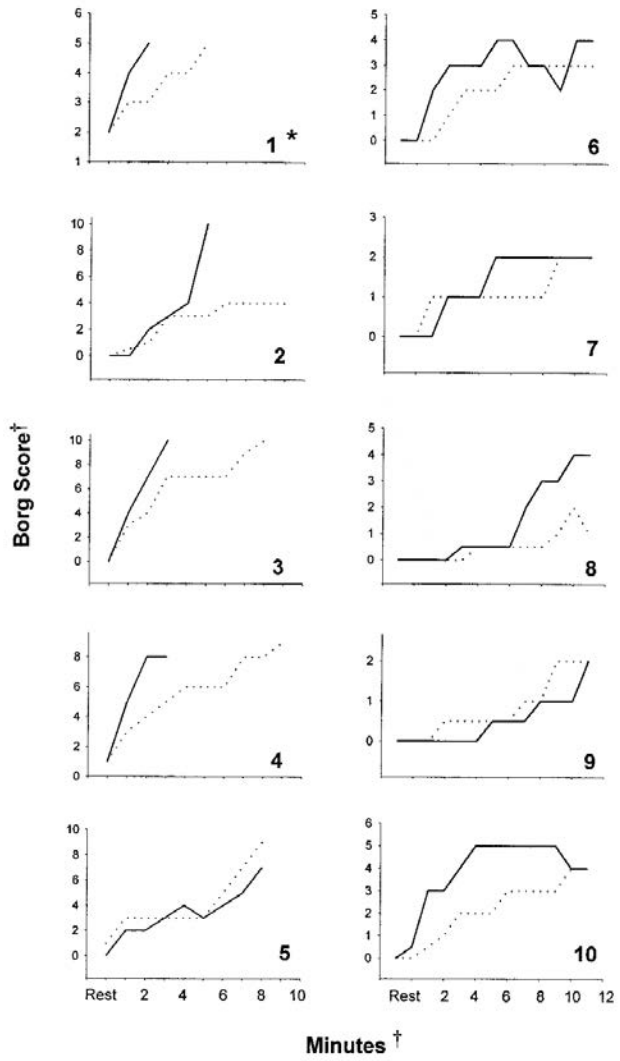
Dell'Era S, et al Rev Am Med Respir. 2019

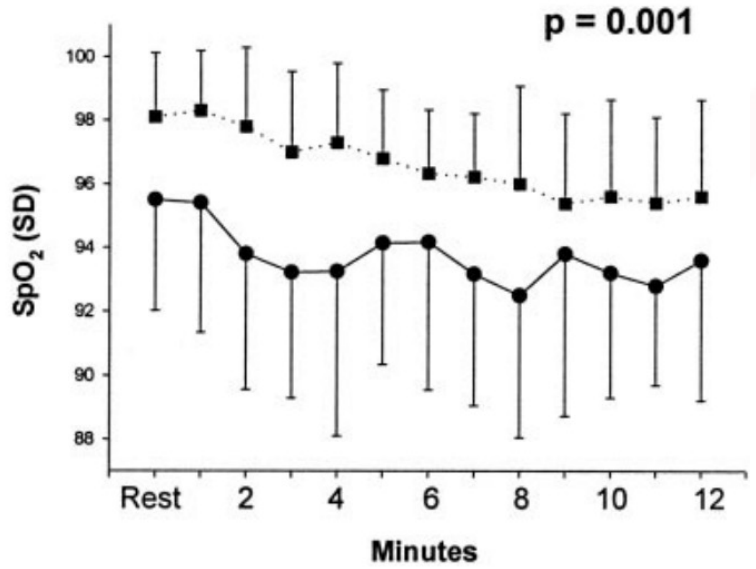
Ref.	Study design	Type of exercise	NHFT settings	Population	Patients, *n*	Main results
NHFT compared to oxygen therapy						
[54]	Prospective nonrandomized trial: HFT vs. low-flow oxygen	CWRT unloaded	Flow 20 L/min, temp 36°C, FiO_2 39±11%	Stable severe COPD (FEV_1 23% of pred.)	10	Increase in exercise endurance with less dyspnea and better oxygenation during HFT
NHFT compared to standard care						
[55]	Cross-over RCT: NHFT vs. standard care (ambient air or oxygen therapy)	CWRT at 80% of estimated peak work rate	Flow 60 L/min, temp 31°C, FiO_2 0.23±0.03 ($n = 9$)	Recently discharged with AECOPD (FEV_1 29% of pred.)	19	No difference in endurance time. Reduced heart rate and nocturnal $PtCO_2$ during NHFT
NHFT compared to Venturi mask						
[56]	Cross-over RCT: NHFT vs. VM	CWRT at 75% of peak work rate	Flow 58.7 L/min, FiO_2 44±11% ($n = 8$)	Stable severe COPD (FEV_1 35% of pred.) with exercise limitation	12	Increased endurance time, less dyspnea and leg fatigue, and better oxygenation during NHFT
[51]	Cross-over RCT: NHFT vs. VM	IET and CWRT at 90% of maximal speed achieved during the IET	Flow 50 L/min, FiO_2 40%	Stable COPD (FEV_1 44% of. pred.)	28	Increased exercise tolerance during both IET and CWRT with less dyspnea, and better oxygenation during NHFT

NHFT, nasal high-flow therapy; CWRT, constant work rate test, FiO_2, fraction of inspired oxygen; FEV_1, forced expiratory volume in 1 s; RCT, randomized controlled trial; AECOPD, acute exacerbation of COPD; $PtCO_2$, transcutaneous carbon dioxide pressure; VM, Venturi mask; IET, incremental exercise test.

Elshof J, Duiverman ML. Clinical Evidence of Nasal High-Flow Therapy in Chronic Obstructive Pulmonary Disease Patients. Respiration. 2020;99(2):140-153. doi: 10.1159/000505583. Epub 2020 Jan 28. PMID: 31991408; PMCID: PMC7050681.

Chatila et al. 2004: Test endurance OHD vs O2

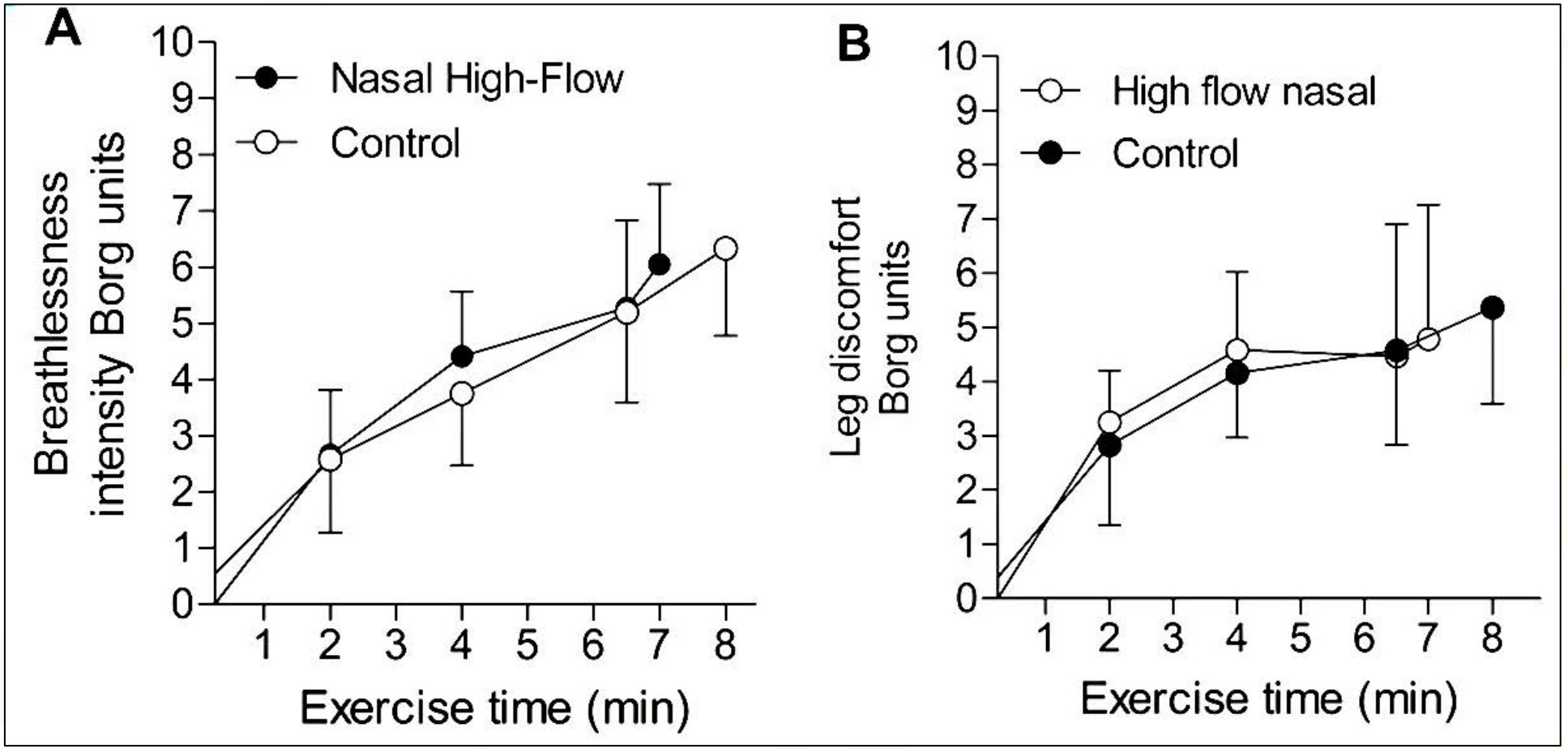




- N=10
- O2 puis OHD
- Temps endurance
  - OHD: 10.0 ± 2.4
  - O2: 8.2 ± 4.3 min, $p < 0.05$,
- dyspneic ↘ ($p = 0.03$)
- oxygenation ↗

Chatila W, Nugent T, Vance G, Gaughan J, Criner GJ. The effects of high-flow vs low-flow oxygen on exercise in advanced obstructive airways disease. Chest. 2004 Oct;126(4):1108-15. doi: 10.1378/chest.126.4.1108. PMID: 15486371.

Prieur et al. 2009: Test endurance OHD vs O2



- N=19
- Randomisé crossover
- OHD vs AA (ou O2)
- Temps endurance: NS
- MAIS OHD:
  - FC, PtcCO2, SmO2 ↘
  - Titration O2
- Inconfort explicable
  - Flow
  - température

Prieur G, Medrinal C, Combret Y, Dupuis Lozeron E, Bonnevie T, Gravier FE, Quieffin J, Lamia B, Borel JC, Reychler G. Nasal high flow does not improve exercise tolerance in COPD patients recovering from acute exacerbation: A randomized crossover study. Respirology. 2019 Nov;24(11):1088-1094. doi: 10.1111/resp.13664. Epub 2019 Aug 6. PMID: 31387158.

NHFO2 and exercice capacity in ILD

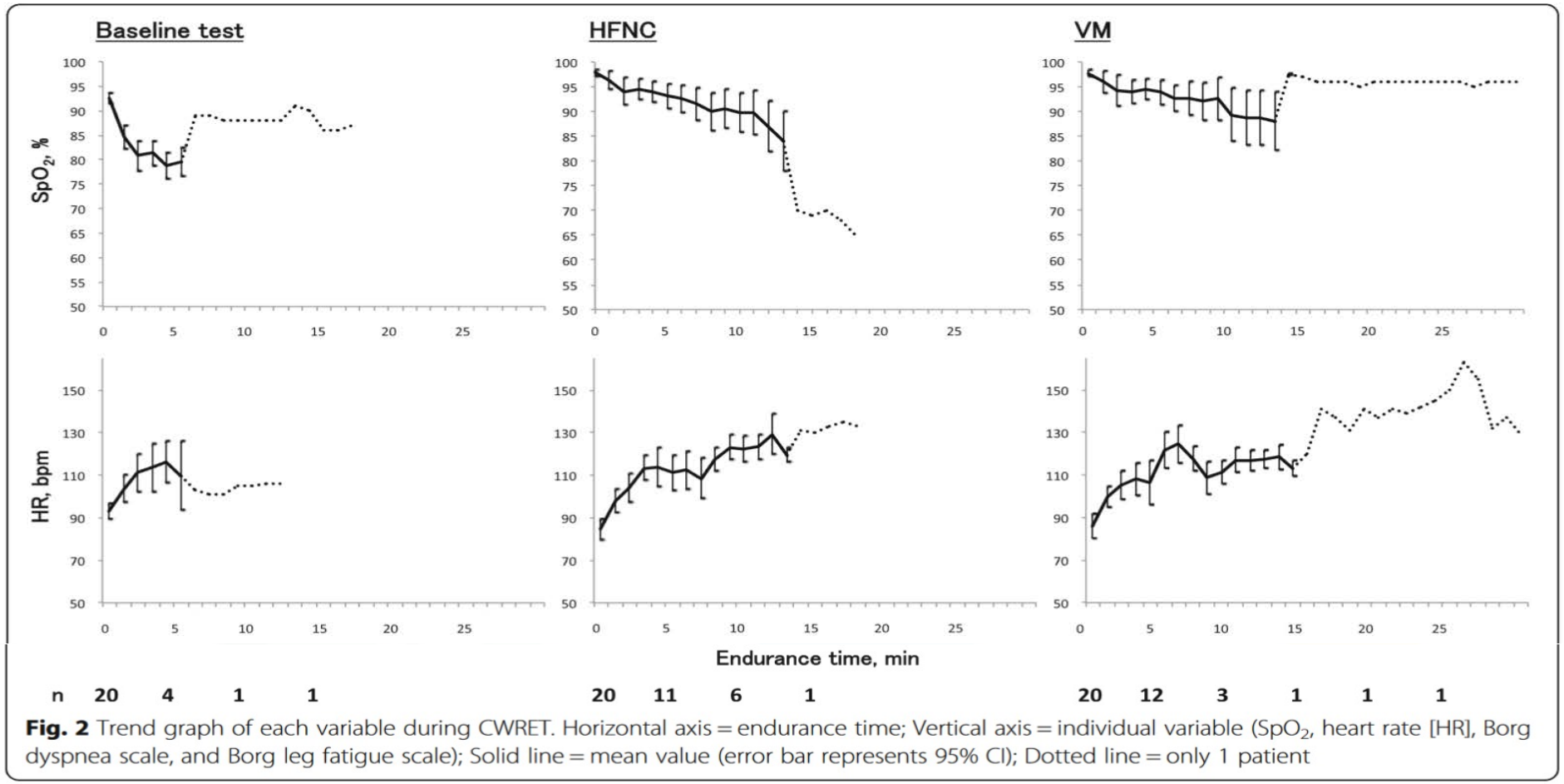


Fig. 2 Trend graph of each variable during CWRET. Horizontal axis = endurance time; Vertical axis = individual variable (SpO_2, heart rate [HR], Borg dyspnea scale, and Borg leg fatigue scale); Solid line = mean value (error bar represents 95% CI); Dotted line = only 1 patient

- N=20
- HFNC 50l, FiO2=0,5 vs venturi 15l, FiO2=0,5
- Réponse <>
  - Tps endurance
  - SpO2
  - Dyspnée isotime

Suzuki A, Ando M, Kimura T, Kataoka K, Yokoyama T, Shiroshita E, Kondoh Y. The impact of high-flow nasal cannula oxygen therapy on exercise capacity in fibrotic interstitial lung disease: a proof-of-concept randomized controlled crossover trial. BMC Pulm Med. 2020 Feb 24;20(1):51. doi: 10.1186/s12890-020-1093-2. PMID: 32093665; PMCID: PMC7041255.