Réentrainement sous VNI de la théorie à la pratique

20ème Congrès de Pneumologue de Langue Française

AT 22 – Kinésithérapeutes 3

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Déclaration de liens d'intérêts

J'ai actuellement, ou j'ai eu au cours des trois dernières années, une affiliation ou des intérêts financiers ou intérêts de tout ordre avec les sociétés commerciales suivantes **en lien avec la santé**.

Aucun lien d'intérêt.

Réentrainement sous VNI du patient obstructif

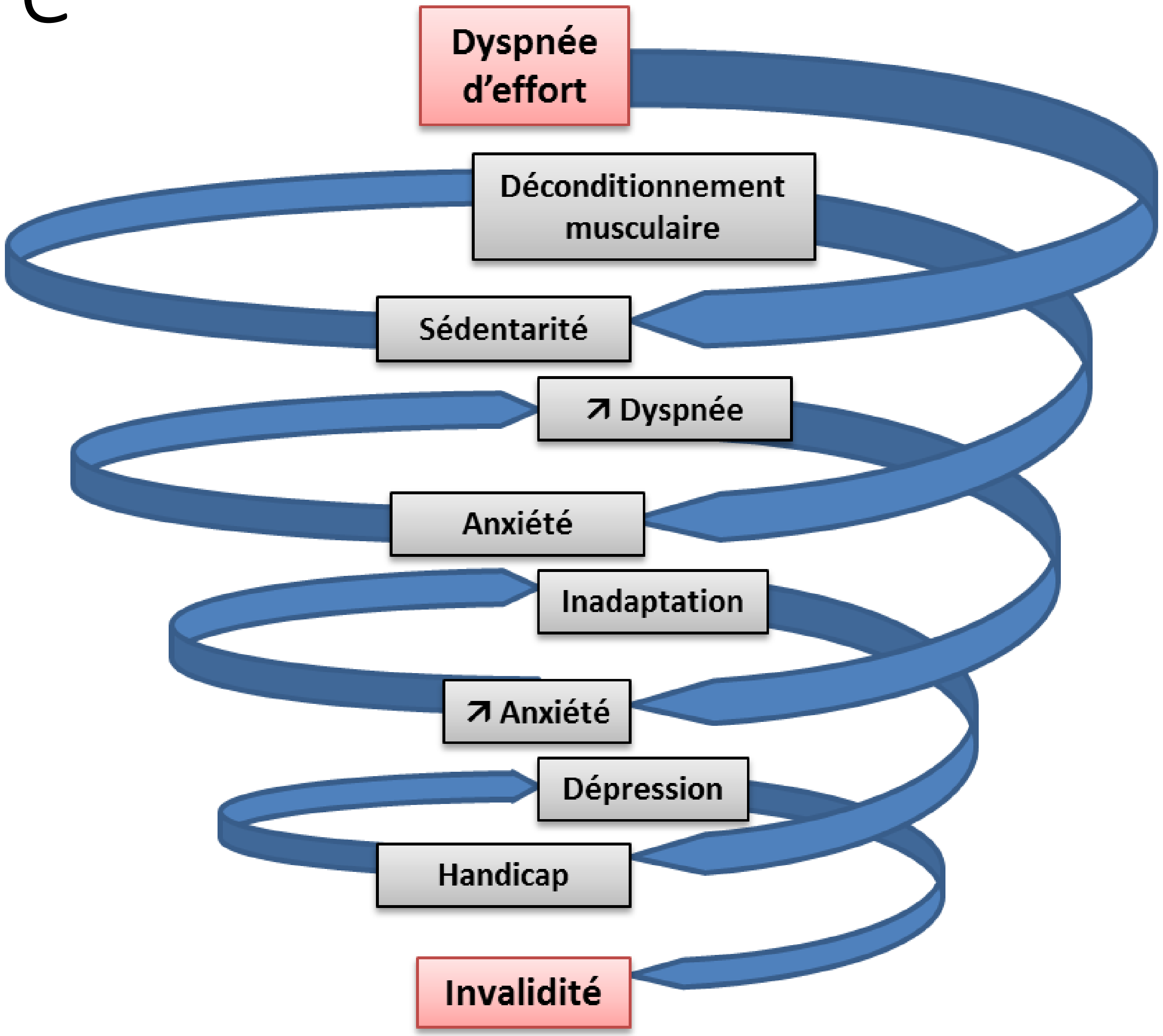
Plan

- Introduction
- Mécanismes de la dyspnée
- Situation clinique
- Questions pratiques autour de la VNI
- Conclusion

Réhabilitation respiratoire

- Toutes les maladies respiratoires
  - BPCO ++

  - Recommandations internationales



SPLF. Recommendation for the clinical practice management of COPD. *Revue des maladies respiratoires* 2010; 27: 522-548
Bolton CE et al. British Thoracic Society guideline on pulmonary rehabilitation in adults. *Thorax* 2013; 68 Suppl 2: ii1-30
Nici L et al. American Thoracic Society/European Respiratory Society statement on pulmonary rehabilitation. *American journal of respiratory and critical care medicine* 2006; 173: 1390-1413

Réhabilitation respiratoire

- Transdisciplinaire
  - Réentrainement à l'effort (end + force)
  - Education thérapeutique
  - KR (entrainement des muscles inspirateurs)
  - Sevrage tabagique
  - Soutien psychologique, nutritionnel, social

Bénéfices

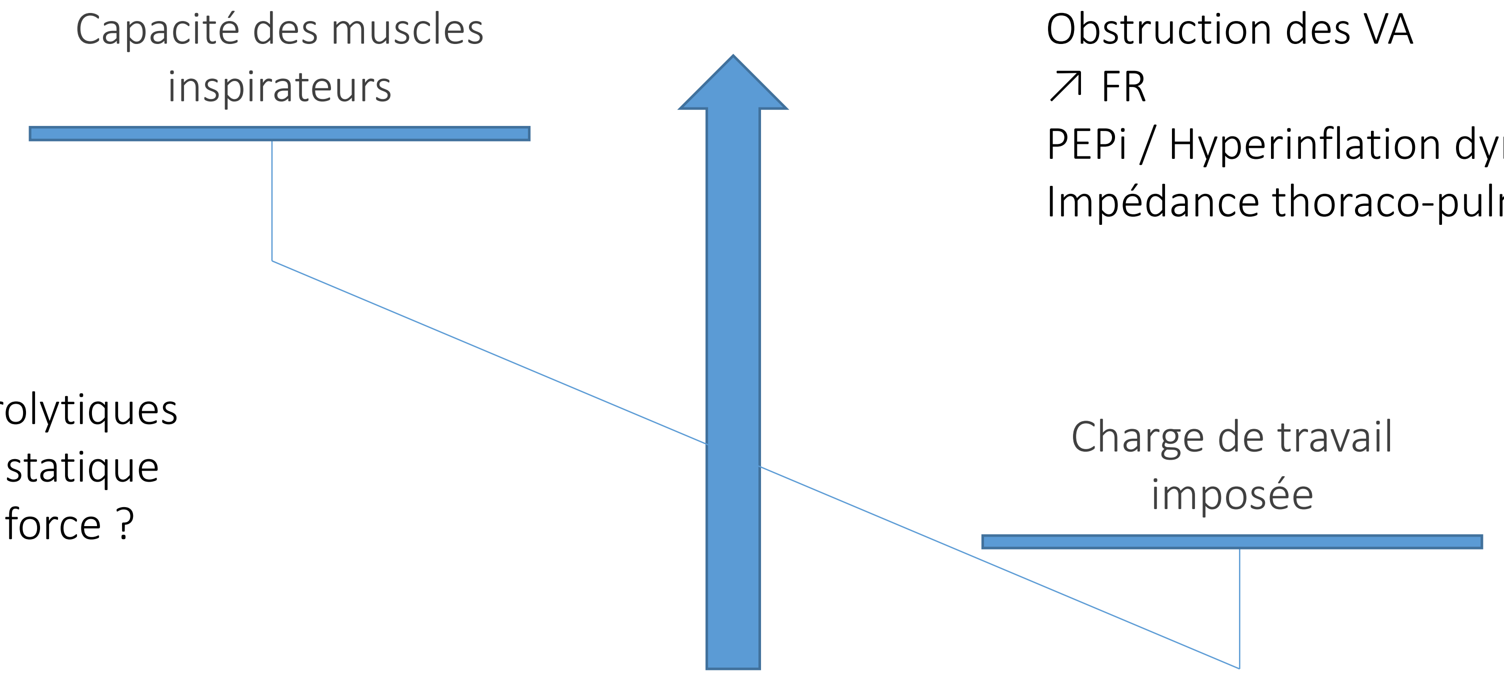
- Dyspnée
- Tolérance à l'effort
- Qualité de vie

- Nombre et durée des hospitalisations
- Seul traitement dans la BPCO à améliorer la mortalité avec OLD

Mc Carthy et al. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2015: CD003793
Puhan MA et al. Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2011: CD005305

Quels mécanismes de la dyspnée chez le patient obstructif ?

- **Déséquilibre de la balance capacité/charge**



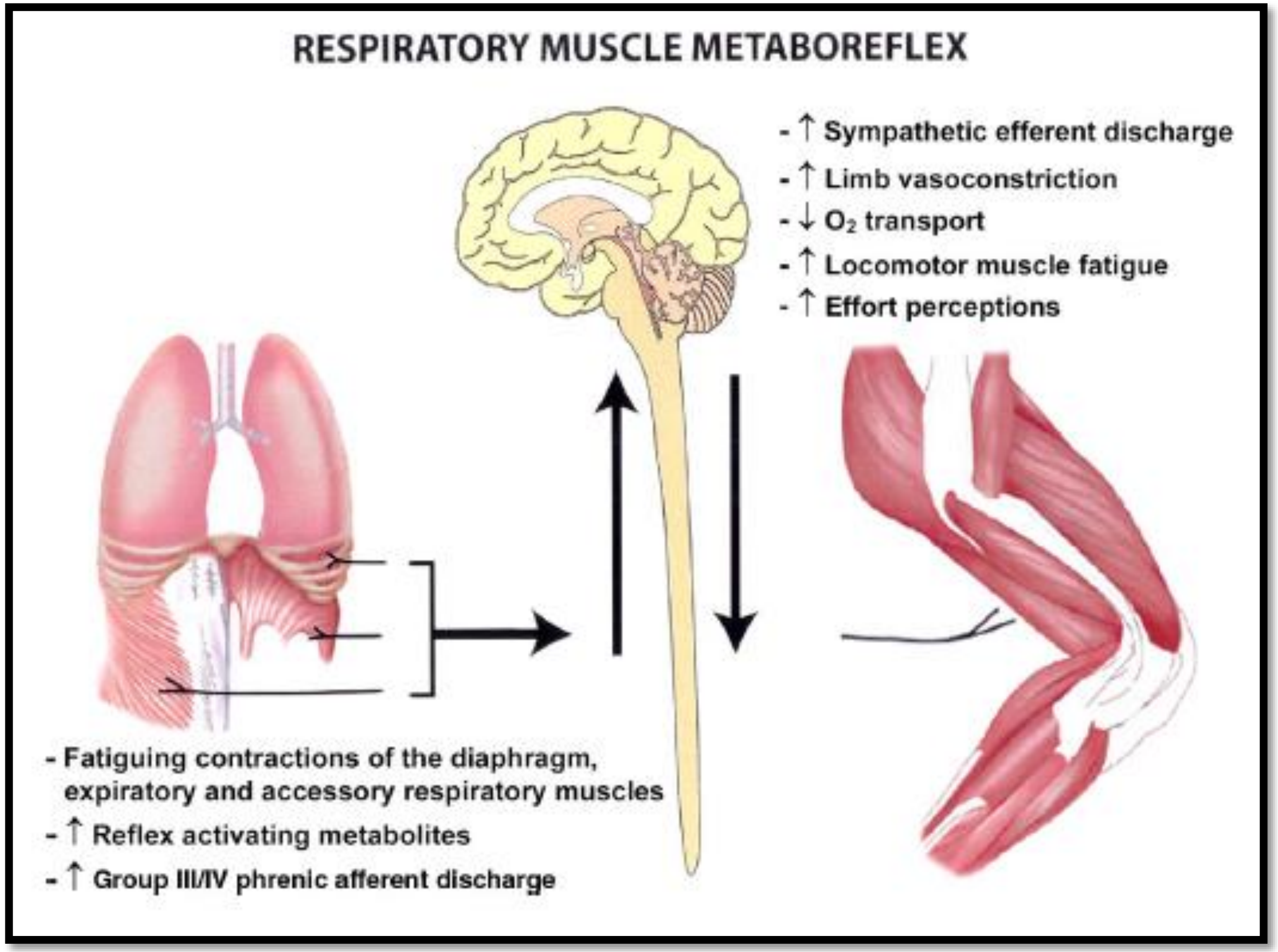
Obstruction des VA
↗ FR
PEPi / Hyperinflation dynamique
Impédance thoraco-pulmonaire

Dénutrition
Troubles électrolytiques
Hyperinflation statique
Diminution de force ?

Rapport Pi/PiMax => dyspnée + fatigue

Rahn, H et al. The pressure-volume diagram of the thorax and lung. *American journal of physiology* 1946; 146: 161-78
Frisk B et al. Airway obstruction, dynamic hyperinflation, and breathing pattern during incremental exercise in COPD patients. *Physiological report* 2014; 2:e00222
O'Donnell DE et al. Qualitative aspects of exertional breathlessness in chronic airflow limitation: pathophysiologic mechanisms. *Am J Respir Crit Care Med* 1997; 155:109-15

Conséquences : fatigue des muscles inspirateurs



Romer LM et al. Exercice-induced respiratory muscle fatigue : implications for performance. *J Appl Physiol* 2008; 104 : 879-88
Amann M et al. Inspiratory muscle work in acute hypoxia influences locomotor muscle fatigue and exercise performance of healthy humans. *Am J Physiol Regul Integr Comp Physiol* 2007; 293 : 2036-40

Quelle stratégie adopter face à une dyspnée limitant le réentrainement?

- Diminuer la charge de travail ?

- Adopter une stratégie visant à améliorer les performances et s'affranchir de la dyspnée (O_2/VNI/Hélium) ?

Quelle intensité d'entrainement ?

- Lien entre l'intensité de l'entrainement et les bénéfices

TABLE 3

EFFECT OF TRAINING ON THE RESPONSES TO IDENTICAL LEVELS OF HEAVY EXERCISE*

	High Constant Work Rate Test			
	High Work Rate Training Group (n = 11)		Low Work Rate Training Group (n = 8)	
	Before	After	Before	After
Lactate, mEq/L	6.0 ± 1.8	4.0 ± 1.8†‡	4.8 ± 1.0	4.1 ± 1.1§
$\dot{V}E$, L/min	52.5 ± 6.6	45.5 ± 6.0†‖	46.5 ± 10.8	45.4 ± 11.4
$\dot{V}E$ drift, L/min	9.5 ± 4.2	2.8 ± 2.6†‖	6.1 ± 1.6	4.8 ± 2.2
f, breaths/min	31 ± 4	29 ± 6	30 ± 5	29 ± 5†
$\dot{V}CO_2$, L/min	1.62 ± 0.24	1.46 ± 0.15¶	1.35 ± 0.25	1.37 ± 0.26
$\dot{V}CO_2$ drift, L/min	0.26 ± 0.11	0.11 ± 0.06¶	0.17 ± 0.05	0.16 ± 0.06
$\dot{V}O_2$, L/min	1.55 ± 0.19	1.46 ± 0.14§	1.37 ± 0.25	1.34 ± 0.21
$\dot{V}O_2$ drift, L/min	0.14 ± 0.08	0.04 ± 0.06‡§	0.13 ± 0.06	0.04 ± 0.08
$\dot{V}E/\dot{V}O_2$	34.4 ± 5.4	30.5 ± 4.4¶**	34.1 ± 5.0	33.1 ± 5.1
Heart rate, beats/min	147 ± 17	136 ± 14†	135 ± 13	135 ± 10
Blood pressure, mm Hg	201/101 ± 31/9	190/106 ± 36/17	191/103 ± 37/11	187/101 ± 23/14
Pa_{O_2}, mm Hg	86 ± 13	78 ± 13†	80 ± 15	77 ± 10
Pa_{CO_2}, mm Hg	43 ± 8	46 ± 10	42 ± 6	41 ± 8
pHa	7.33 ± 0.03	7.33 ± 0.04	7.32 ± 0.03	7.34 ± 0.03¶
Exercise duration, min	6.6 ± 2.3	11.4 ± 4.0†‡	6.9 ± 3.2	7.5 ± 3.0

Casaburi R, Patessio A, Ioli F, Zanaboni S, Donner CF, Wasserman K. Reductions in exercise lactic acidosis and ventilation as a result of exercise training in patients with obstructive lung disease. *The American review of respiratory disease* 1991; 143: 9-18
Gimenez M, Servera E, Vergara P, Bach JR, Polu JM. Endurance training in patients with chronic obstructive pulmonary disease: a comparison of high versus moderate intensity. *Archives of physical medicine and rehabilitation* 2000; 81: 102-109

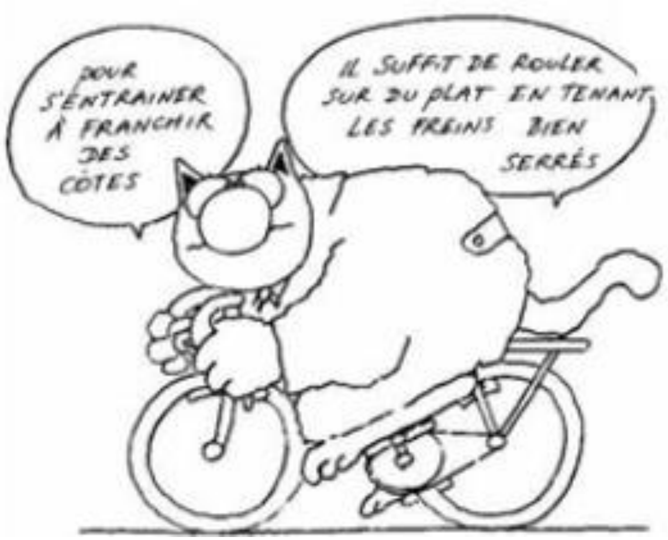
Cela est-il vraiment réalisable ?

- Entrainement à haute intensité (> 70% PMax) mal toléré
  - 37/42

Maltais F et al. Intensity of training and physiologic adaptation in patients with chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine* 1997; 155: 555-561

Réentrainement sous VNI

A partir d’un cas clinique



Patients IRC (BPCO IV + HTAP)

- IMC=15.3kg/m²
- OLD 2.5L/min au repos
- VNI la nuit
- MRC = 4/4
- Projet de greffe pulmonaire

Epreuve à charge croissante réalisée sur bicyclette ergométrique.

	Stable	Seuil ventilatoire	Maximum	Théorique au max
Temps (min)				
Puissance			40	115
CARDIOVASCULAIRE				
FC (batt/min)	110		141	179
PAS (mmHg)	113		150	
PAD (mmHg)	79		80	
HEMATOSE				
SaO2tc (%)	93		91	

MOTIF DE L'ARRET : **Dyspnée**

Déroulement du test sous O2 :

Débit O2 (L/min)	Durée (min)	Puissance (W)	FC(/min)	SaO2tc (%)	E.V.A souffle
3,0		0	110	93	0,0
4,0	3	10	115	91	0,0
4,0	1	15	117	92	1,0
4,0	1	20	120	91	2,0
4,0	1	25	122	91	3,5
4,0	1	30	128	91	7,5
4,0	1	35	132	91	9,0
4,0	1	40	141	91	10,0

Séances de réhabilitation respiratoire

S1

17/07	Repos	5min 5 W	5min 2W	5min 5W	Remarque
Type effort		Ech =	Seuil =	RA =	Distance :
FC	97	126	124	132	
Sp02	93	94	94	92	4,8 km
Dyspnée	0	8	5	8	
Fatigue m.	0	6			

Ech = Echauffement
Seuil = Watt au seuil ventilatoire
RA = Repos actif

S2

23/07	Repos	5min 5W (3W)	5min 5W (3W)	5min 15 (5)	5min	Remarque
Type effort		Ech =	Seuil =	Seuil =	RA =	
FC	95	121	126	126		
Sp02	89	93	91	91		
Dyspnée	1	5	5	4-5		
Fatigue m.	1	3				

	Repos	5min	5min	5min	5min 5/15	5min 2W	Remarque
Type effort		Ech =	Seuil =	Seuil =	Seuil =	RA =	
FC					128	124	
Sp02					91	92	d = 6,9 km
Dyspnée					5	3	
Fatigue m.							

IT

Réentrainement sous VNI

- Paramètres effort ≠ repos
  - Nouvelle titration
- Adaptation de l'interface
  - Facial
  - Nasal
  - Embout buccal ?
- Choix du ventilateur
  - Vitesse de pressurisation < 100ms
- Chronophage +++ surtout si naïf de la ventilation

Bilan de fin de réhabilitation

S24

17/09	Repos	5min	5min 20	5min	5min 20	5min	5min	5min 30	5min 30	5min	Remarque
Type effort		Ech =	S + 20 =	S + 20 =	S + 30 =	S + 30 =	S + 30 =	S + 30 =	S + 30 =	RA =	
FC	97		126		134			137	139	132	18,8 km
Sp02			93		90			89	89	93	
Dyspnée	2		2		3			3	4	4	
Fatigue m.	2		2		3			3	4	4	

Bilan initial : 01/07/2014	Bilan Final : 24/09/2014
VEMS (% théorique) : 24%	VEMS (% théorique) : 25%
TDM6 (mètre) : 365m	TDM6 (mètre) : 385m
Index BODE : 5	Index BODE : 5
QLDV (SGRQ) : ND	QLDV (SGRQ) : 47%

Suite du programme en rapport avec le projet de greffe

31/07	Repos	5min	5min 50	5min 60	5min 50	5min 60	5min 50	5min 60	5min 50	5min ↘	Remarque
Type effort		Ech =	S +10 =	S + 20 =	S + 20 =	S + 20 =	S + 20 =	S + 20 =	S + 20 =	RA =	
FC	84		104.		111		117		122.	113	
Sp02	91		95		93		92		91	93	17,2 km.
Dyspnée	2		2		3		3		4	2	
Fatigue m.	0		1		2		4		5	3	

- Poursuite en libéral sous VNI (2ème ventilation au cabinet)

Quels bénéfices de la VNI à l’effort ?

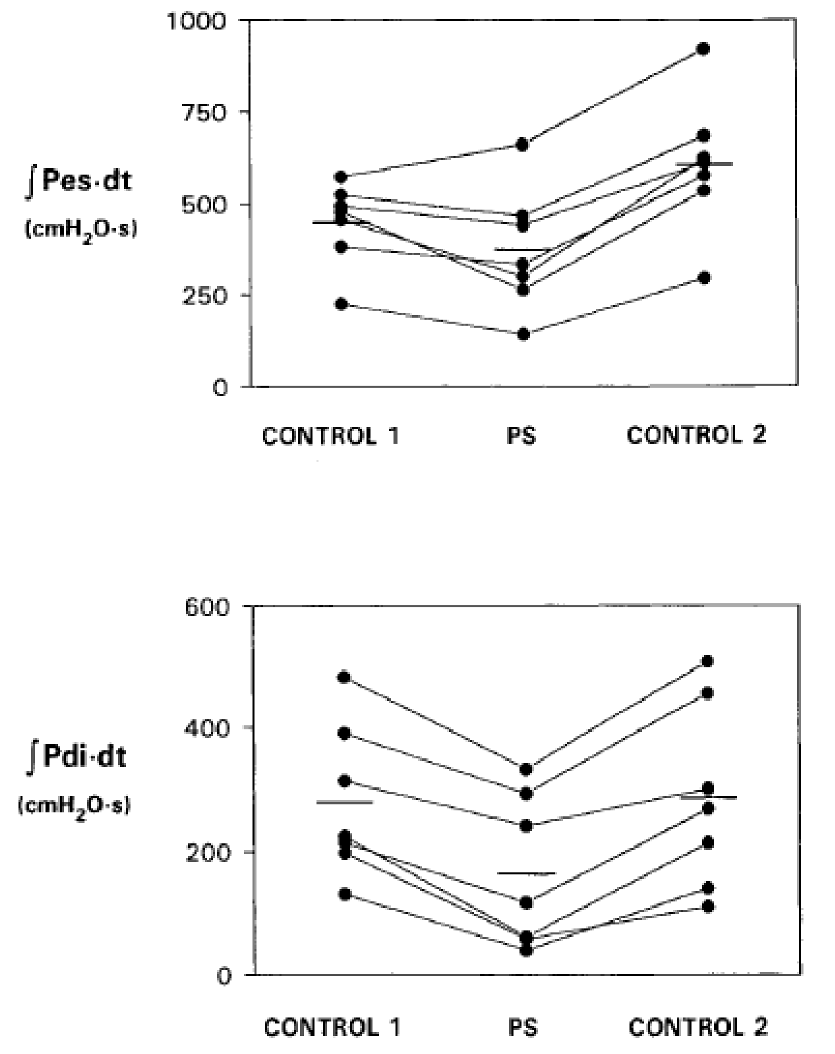
Effets aigus et tests physiologiques

Diminution du travail des muscles respiratoires et amélioration du pattern ventilatoire

TABLE 3

EFFECT OF PRESSURE SUPPORT ON BREATHING PATTERN*

	Control 1	Pressure Support	Control 2
VT, L	0.88 ± 0.10	1.06 ± 0.14[†]	0.89 ± 0.13
RR, breaths/min	21.4 ± 1.9	23.8 ± 3.1[‡]	24.1 ± 2.5[§]
V̇E, L/min	18.1 ± 1.7	23.2 ± 2.0[†]	20.2 ± 2.1
TI, s	1.06 ± 0.11	0.92 ± 0.10[‡]	0.91 ± 0.10[§]
TE, s	1.87 ± 0.13	1.84 ± 0.24	1.73 ± 0.16
TI/TTOT	0.36 ± 0.02	0.34 ± 0.02	0.34 ± 0.09
VT/TI, L/s	0.83 ± 0.06	1.14 ± 0.05[†]	0.98 ± 0.09[§]
VT/TE, L/s	0.47 ± 0.05	0.61 ± 0.07[†]	0.52 ± 0.06



Maltais F et al. Pressure support reduces inspiratory effort and dyspnea during exercise in chronic airflow obstruction. *Am J Respir Critical Care* 1995 ; 151: 1027-33

Préservation de l’hypoxémie (VNI + O2)

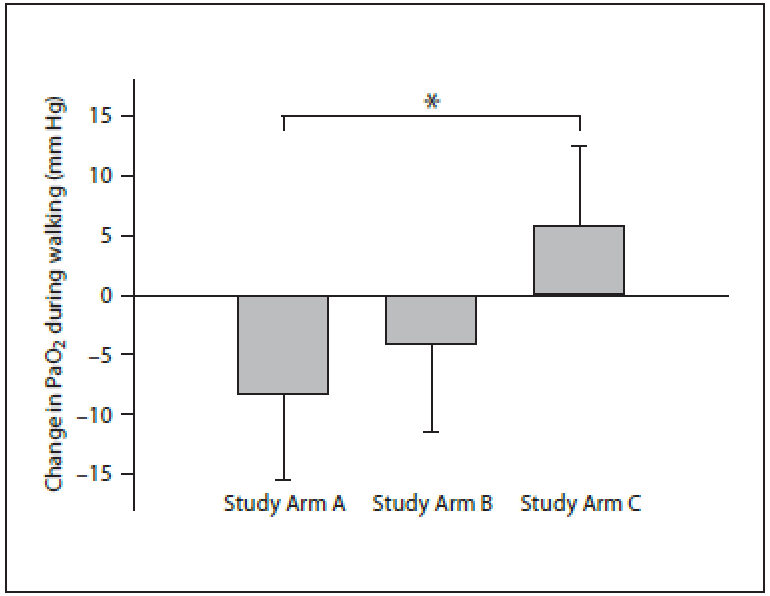


Fig. 3. Changes in PaO_2 during the 12MWT with single (Study Arm A) and double (Study Arm B) dosages of supplemental oxygen and with NPPV in addition to the single dosage of supplemental oxygen (Study Arm C). * Unadjusted p = 0.0036 (critical level = 0.017) following one-way RM-ANOVA (overall significance level = 0.05, including an all-pairwise comparison using the Holm-Sidak method). T bars represent the 95% CI.

- Amélioration distance sous VNI si poussée
- Diminution distance si portée

Dreher M et al. Noninvasive ventilation during walking in patients with sever COPD: a randomised cross-over trial. *ERJ* 2007 ; 29 : 930-6

Dreher M et al. Preserving oxygenation during walking in severe chronic obstructive pulmonary disease : noninvasive ventilation versus oxygen therapy. *Respiration* 2009 ; 78 : 154-60

Dyspnée et fatigue des MI

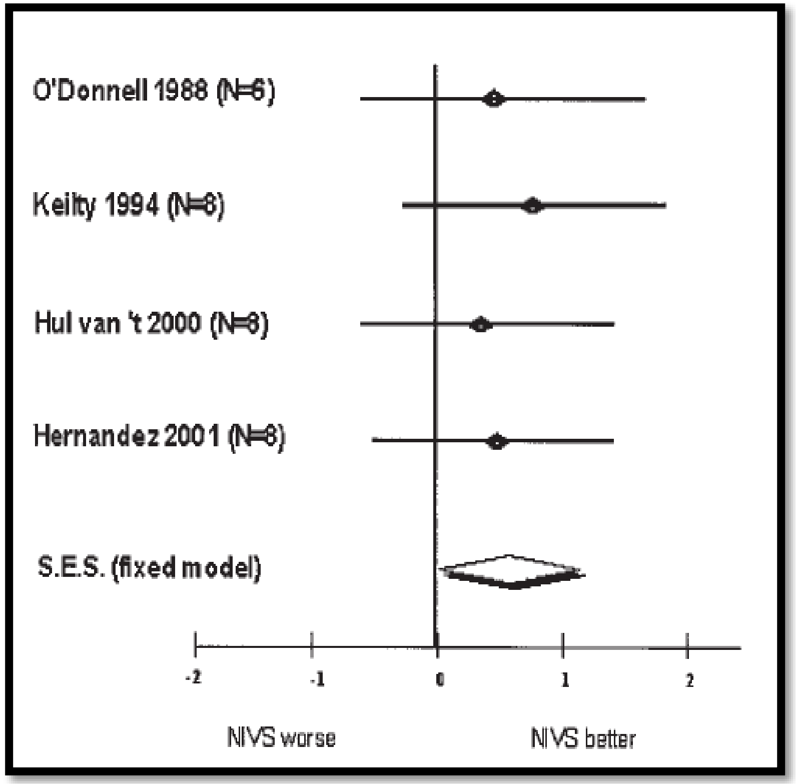


Table 1 Effects of proportional assisted ventilation (PAV) and sham ventilation on selected metabolic, ventilatory and subjective responses at isotime (the shortest test between the two experimental conditions in a given subject) and at exercise cessation (Tlim) (N = 16)

	At isotime		At Tlim	
Variables	**Sham ventilation**	**PAV**	**Sham ventilation**	**PAV**
Subjective				
Dyspnoea scores	6 (2–9)	4.5 (3–9)*	6.5 (2–10)	6 (3–10)
Dyspnoea/Tlim (ratings/min)	–	–	1.45 (0.6–1.8)	0.9 (0.2–1.2)*
Leg effort scores	6 (2–9)	4.5 (2–9)*	6.5 (2–10)	6.5 (2–10)
Leg effort/Tlim (ratings/min)	–	–	1.3 (0.7–1.4)	0.95 (0.3–1.2)*

- Limites (différents modes et paramètres)
- Amélioration de 2 points (Borg)

van't Hul A et al. The acute effects of noninvasive ventilator support during exercise on exercise endurance and dyspnea in patients with chronic obstructive pulmonary disease : a systematic review. *J Cardiopulm Rehabil* 2002 ; 22 : 290-7

Borghi-Silva A et al. Respiratory muscle unloading improves leg muscle oxygenation during exercise in patients with COPD. *Thorax* 2008 ; 63 : 910-5

Dans quelle proportion ?

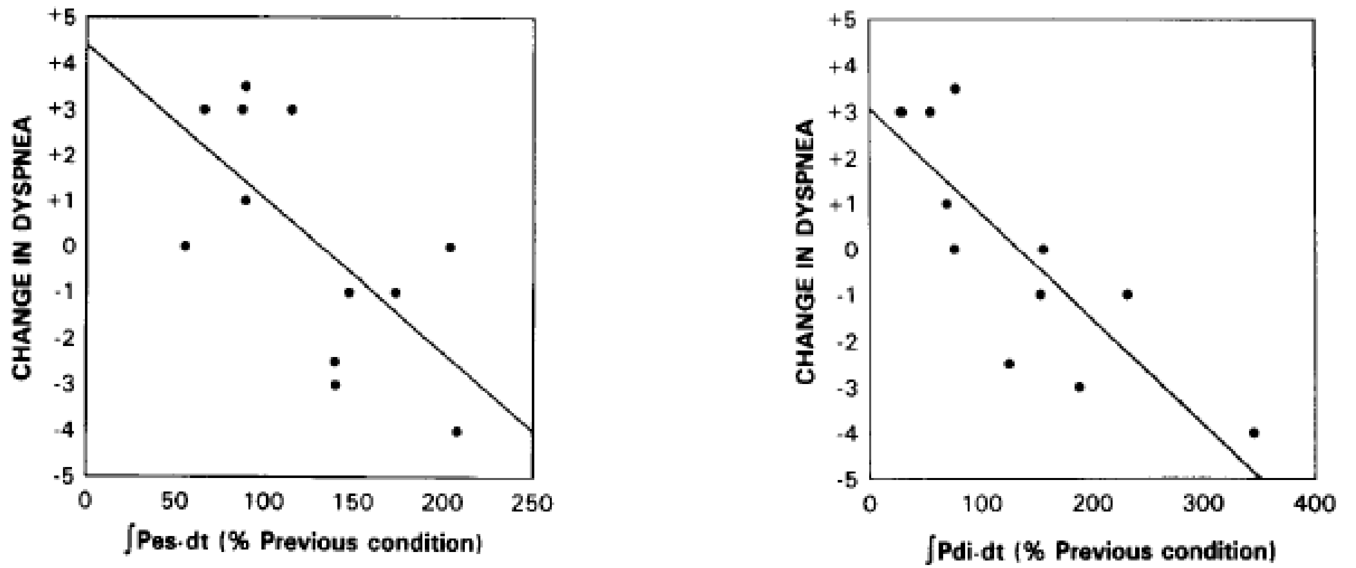


Figure 6. Relationship between changes in dyspnea and inspiratory effort with addition or removal of pressure support. There was a significant correlation between changes in dyspnea and the pressure-time integral of the inspiratory muscles (∫Pes·dt) ($r = 0.67$, $p < 0.05$) and the diaphragm (∫Pdi·dt) ($r = 0.83$, $p < 0.01$).

- Confirme le rôle de la fatigue des muscles inspirateurs dans la genèse de la dyspnée

Maltais et al. Pressure support reduces inspiratory effort and dyspnea during exercise in chronic airflow obstruction. *Am J Respir Crit Care Med* 1995 ; 151 : 1027-30

Amélioration de l'endurance

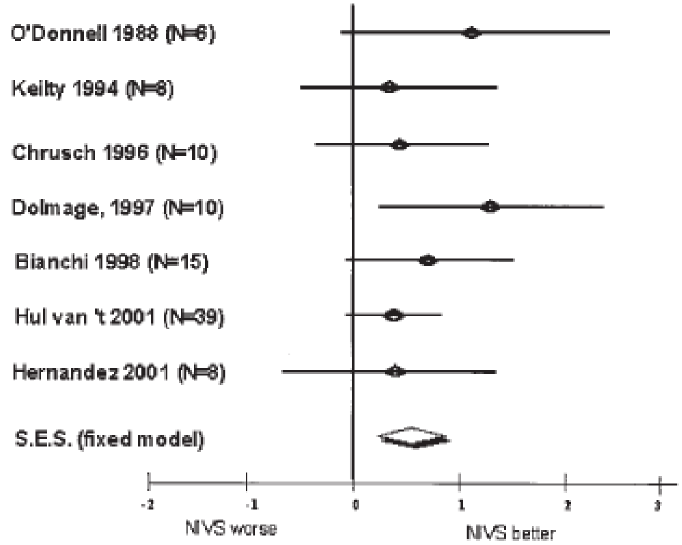


Figure 2. Effect sizes based on Glass δ (and 95% confidence intervals [CI]) for exercise endurance in the best-case scenario. (See Figure 1 for a detailed explanation.) A moderate but significant effect size was found after pooling of the mean effect sizes of all studies (0.58; 95% CI 0.29-0.87; *P* < .001; n = 97 patients with chronic obstructive pulmonary disease).

+3.3min (55%)

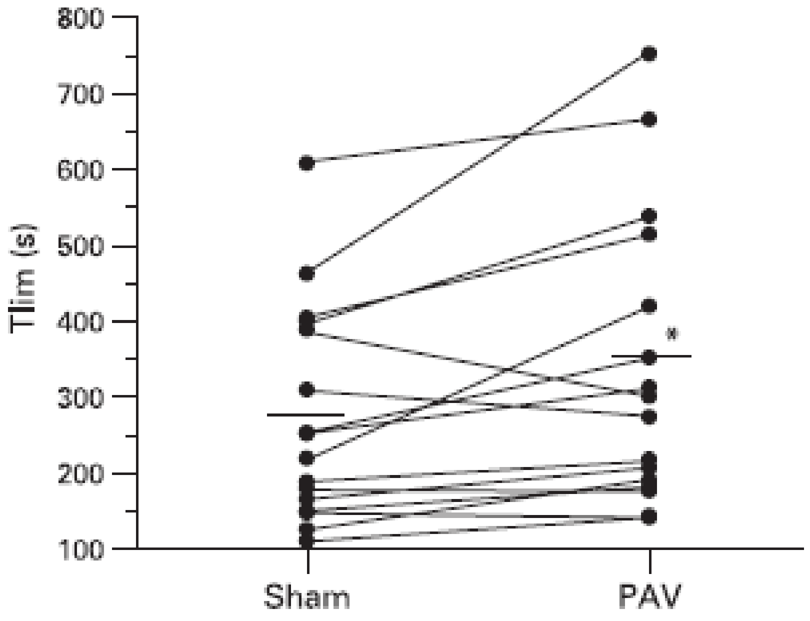


Figure 1 Effects of proportional assisted ventilation (PAV) and sham ventilation on the tolerance to high-intensity constant work rate exercise (Tlim) in 16 patients with moderate to severe chronic obstructive pulmonary disease.

van't Hul A et al. The acute effects of noninvasive ventilator support during exercise on exercise endurance and dyspnea in patients with chronic obstructive pulmonary disease : a systematic review. *J Cardiopulm Rehabil* 2002 ; 22 : 290-7

Borghi-Silva A et al. Respiratory muscle unloading improves leg muscle oxygenation during exercise in patients with COPD. *Thorax* 2008 ; 63 : 910-5

Oui … mais les patients n'utilisent pas leur VNI au quotidien !

L'entrainement sous VNI est-il bénéfique lorsque les patients réalisent ensuite un effort sans VNI ?

Physical Training and Noninvasive Ventilation in COPD Patients: A Meta-Analysis

Cristian Ricci PhD, Stefano Terzoni PhD, Maddalena Gaeta MD, Antonio Sorgente MD, Anne Destrebecq MSc, and Francesco Gigliotti MD

Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease (Review)

Menadue C, Piper AJ, van 't Hul AJ, Wong KK

- Tendance en faveur des patients ventilés
  - FC
  - Lactates
  - Charge de travail
  - VO2

- Tendance en faveur des patients ventilés
  - VO2 [95% CI : -0,08-0,31]
  - QLDV
  - Dyspnée

THE COCHRANE COLLABORATION®

Ricci C et al. Physical training and noninvasive ventilation in COPD patients: a meta-analysis. *Respiratory care* 2014 ; 59 : 709-717
Menadue C et al. Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2014 ; 5

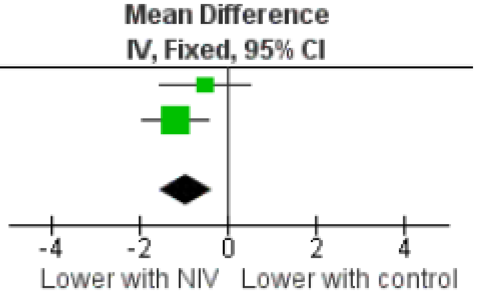
Mais … des résultats encourageants

Figure 4. Forest plot of comparison: 1 Non-invasive ventilation during exercise training versus exercise training alone or exercise training with sham non-invasive ventilation, outcome: 1.3 Exercise capacity: percentage change.

Figure 7. Forest plot of comparison: 1 Non-invasive ventilation during exercise training versus exercise training alone or exercise training with sham non-invasive ventilation, outcome: 1.7 Physiological outcomes: Isoload lactate (mmol/L).

	NIV			Control				Mean Difference
Study or Subgroup	**Mean**	**SD**	**Total**	**Mean**	**SD**	**Total**	**Weight**	**IV, Fixed, 95% CI**
Hawkins 2002	2.09	0.38	10	2.61	1.56	9	33.6%	-0.52 [-1.57, 0.53]
Toledo 2007	1.3	0.7	9	2.5	0.9	9	66.4%	-1.20 [-1.94, -0.46]
Total (95% CI)			**19**			**18**	**100.0%**	**-0.97 [-1.58, -0.36]**

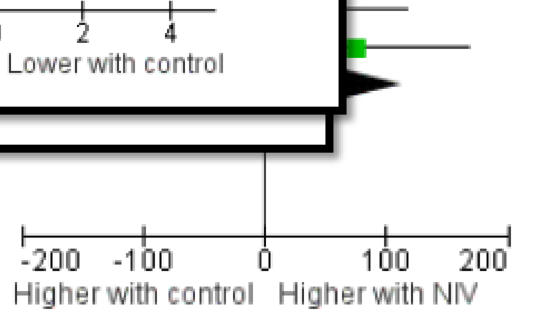
Heterogeneity: Chi² = 1.08, df = 1 (P = 0.30); I² = 7%
Test for overall effect: Z = 3.14 (P = 0.002)



- > M

(34%)

Test for overall effect: Z = 2.09 (P = 0.04)



Puente-Maestu L et al. Clinical relevance of constant power exercise duration changes in COPD. *The European respiratory journal* 2009 ; 34 : 340-345
Menadue C et al. Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2014 ; 5

La VNI peut-elle être un frein à la réhabilitation ?

La VNI n’augmente pas le taux d’abandon

Analysis 1.13. Comparison 1 Non-invasive ventilation during exercise training versus exercise training alone or exercise training with sham non-invasive ventilation, Outcome 13 Dropouts.

Review: Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease

Comparison: 1 Non-invasive ventilation during exercise training versus exercise training alone or exercise training with sham non-invasive ventilation

Outcome: 13 Dropouts

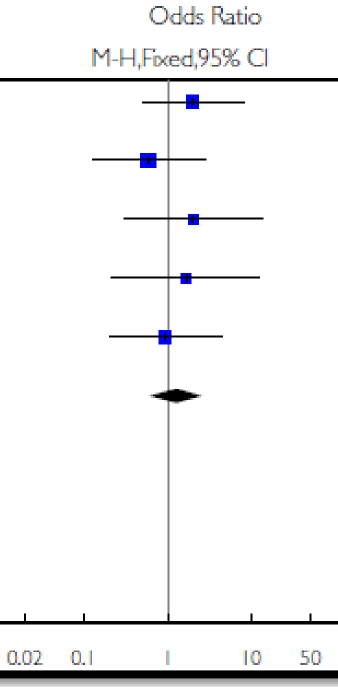
Study or subgroup	NIV n/N	Control n/N	Weight	Odds Ratio M-H,Fixed,95% CI
Bianchi 2002	9/18	5/15	20.7 %	2.00 [0.49, 8.24]
Hawkins 2002	4/14	6/15	31.4 %	0.60 [0.13, 2.84]
Johnson 2002	4/15	2/13	11.9 %	2.00 [0.30, 13.26]
Reuveny 2005	3/12	2/12	11.4 %	1.67 [0.22, 12.35]
van 't Hul 2006	4/19	4/18	24.6 %	0.93 [0.20, 4.47]
Total (95% CI)	**78**	**73**	**100.0 %**	**1.26 [0.61, 2.59]**

Total events: 24 (NIV), 19 (Control)

Heterogeneity: $Chi^2 = 1.73$, df = 4 (P = 0.79); $I^2 = 0.0\%$

Test for overall effect: Z = 0.63 (P = 0.53)

Test for subgroup differences: Not applicable



Menadue C et al. Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2014 ; 5

Mais …

Mise en place longue (moins si déjà ventilés)

- Familiarisation avec le matériel (choix interface)
- Initiation de la ventilation au repos puis adaptation à l'effort

Nécessite une surveillance rapprochée

- Tolérance
- Asynchronismes (ventilateur avec courbe +++)

Chronophage+++ + Efficacité discutable = Nécessité d'identifier les patients les plus répondeurs

Comment choisir les patients ?

Sévérité de la pathologie ?

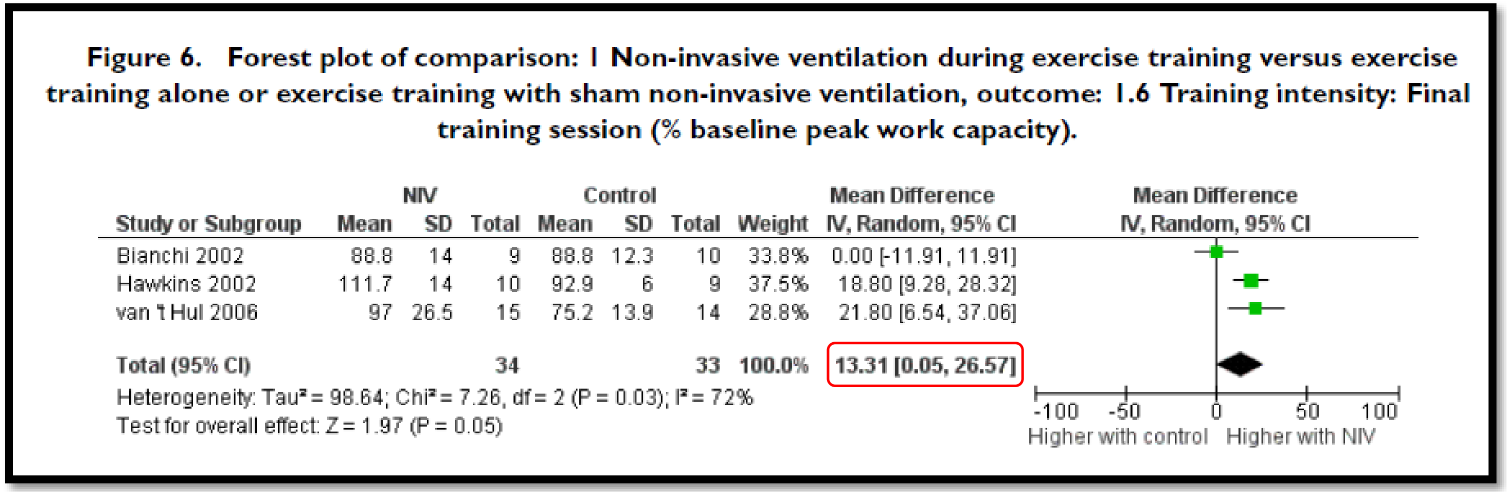


Figure 6. Forest plot of comparison: 1 Non-invasive ventilation during exercise training versus exercise training alone or exercise training with sham non-invasive ventilation, outcome: 1.6 Training intensity: Final training session (% baseline peak work capacity).

	NIV			Control				Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI
Bianchi 2002	88.8	14	9	88.8	12.3	10	33.8%	0.00 [-11.91, 11.91]
Hawkins 2002	111.7	14	10	92.9	6	9	37.5%	18.80 [9.28, 28.32]
van 't Hul 2006	97	26.5	15	75.2	13.9	14	28.8%	21.80 [6.54, 37.06]
Total (95% CI)			**34**			**33**	**100.0%**	**13.31 [0.05, 26.57]**

Heterogeneity: Tau² = 98.64; Chi² = 7.26, df = 2 (P = 0.03); I² = 72%
Test for overall effect: Z = 1.97 (P = 0.05)

- Si retrait des patients de [Bianchi 2002] (patients modérés)
  - +20% [95% IC : 12-28] ; I^2=0

- Plus de bénéfice pour les patients les plus sévères ?

Menadue C et al. Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2014; 5: CD007714

Faiblesse des muscles inspirateurs

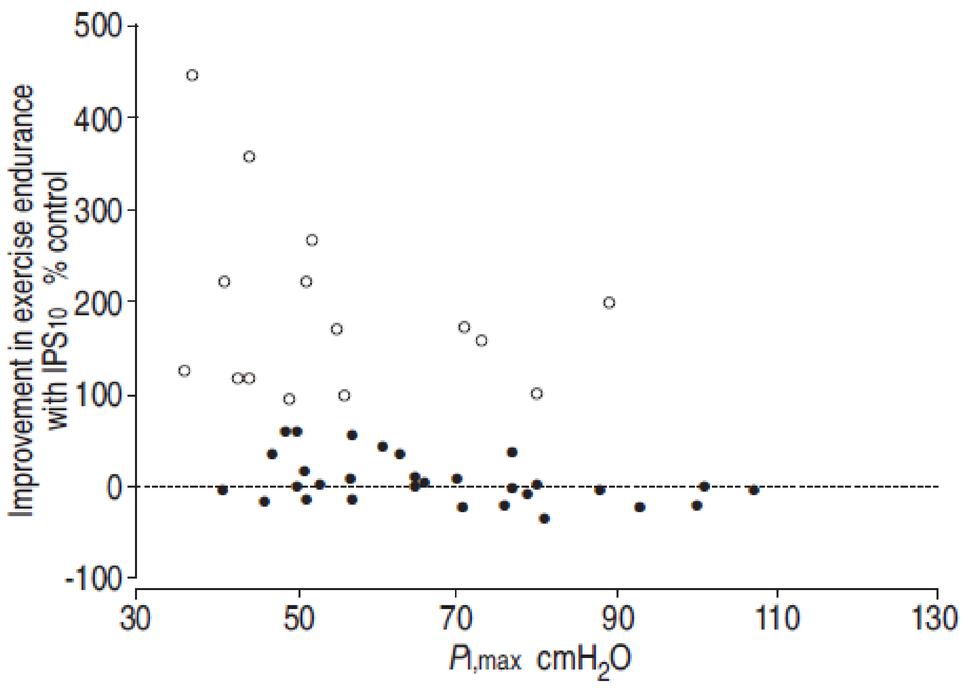


Fig. 2. – Relationship (r=-0.49, p=0.001) between improvement in exercise endurance and maximal inspiratory pressure ($P_{I,max}$). IPS10: inspiratory pressure support of 10 cmH_2O. ●: patients with a change in exercise endurance <100%, n=15; ○: patients with a change in exercise endurance of ⩾100% (at least doubled).

van't Hul et al. Acute effects of inspiratory pressure support during exercise in patients with COPD. *ERJ* 2004 ; 23 : 34-40

Autres déterminants ?

Table 3. Characteristics of Responders and Non-Responders

	Noninvasive Ventilation			Supplemental Oxygen		
	Responders (n = 9) (mean ± SD)	Non-Responders (n = 5) (mean ± SD)	P	Responders (n = 6) (mean ± SD)	Non-Responders (n = 8) (mean ± SD)	P
Age (y)	65 ± 10	72 ± 4	.13	63 ± 6	71 ± 4	.01
Body mass index (kg/m^2)	25 ± 4	21 ± 2	.04	24 ± 3	26 ± 4	.24
FEV_1 (% predicted)	34 ± 10	33 ± 10	.80	34 ± 5	33 ± 8	.57
P_{aO_2} at rest (mm Hg)	66 ± 6	64 ± 7	.60	67 ± 6	61 ± 8	.14
Maximum inspiratory pressure (cm H_2O)	41 ± 32	39 ± 20	.64	39 ± 22	41 ± 19	.84
Peak torque (Newton-meters)	100 ± 38	91 ± 5	.46	90 ± 25	85 ± 31	.14
6-min walk distance (m)	356 ± 129	353 ± 99	.45	392 ± 95	332 ± 105	.28
Maximum speed (km/h)	3.5 ± 1.4	3.0 ± 1.0	.48	3.2 ± 1.0	2.9 ± 1.0	.60
$\dot{V}_{CO_2}$ (% predicted)	60 ± 20	50 ± 14	.30	62 ± 14	43 ± 11	.02
Heart rate (% predicted)	71 ± 10	69 ± 9	.59	73 ± 10	73 ± 12	.95
$\dot{V}_{O_2}$/heart rate (% predicted)	85 ± 34	74 ± 24	.45	86 ± 20	64 ± 21	.04
Lactate/speed (mmol/L/km/h)	0.65 ± 0.4	0.47 ± 0.3	.23	0.52 ± 0.2	1.0 ± 0.5	.03
Dyspnea (Borg score [0–10 scale])	6 ± 2	5 ± 1	.39	4 ± 2	6 ± 1	.01
Peak S_{pO_2} (%)	88 ± 2	87 ± 3	.65	88 ± 2	85 ± 1	.01
SGRQ Scores						
Activity	54 ± 28	45 ± 21	.55	38 ± 8	48 ± 20	.01
Impacts	53 ± 15	46 ± 21	.05	35 ± 8	56 ± 23	.01
Total	51 ± 21	58 ± 14	.45	35 ± 20	52 ± 19	.001

- Petite population

Borghi-Silva A et al. Adjuncts to physical training of patients with severe COPD: oxygen or noninvasive ventilation ? *Respir Care* 2010 ; 55 : 885-94

Peut-on vraiment prédire à priori quels patients vont le plus progresser vous VNI ?

- NON
  - Sévérité de la pathologie
  - Faiblesse des muscles inspirateurs
  - IMC/QLDV

- Hyperinflation dynamique (mesure de la CI ?)
- Limitation ventilatoire à l’EFX (RR < 30%)
- Recrutement des muscles abdominaux
- Tolérance à l’effort
  - Nécessité de nombreuses pauses ?
  - Puissance < 20-25W ?
- Evaluation clinique du praticien
- Déjà équipés ?

Menadue C et al. Non-invasive ventilation during exercise training for people with chronic obstructive pulmonary disease. *The Cochrane database of systematic reviews* 2014; 5: CD007714
van 't Hul A et al. Acute effects of inspiratory pressure support during exercise in patients with COPD. *The European respiratory journal* 2004; 23: 34-40
Kyroussis D et al. Respiratory muscle activity in patients with COPD walking to exhaustion with and without pressure support. *ERJ* 2000 ; 15 : 649-55

Tenter d'identifier et tester !

- Relation entre :
  - L'amélioration du test d'endurance initiale sous 10cmH2O AI
  - Augmentation de la charge de travail pendant l'entrainement

  - $r = 0.45$, $p=0.02$

van't Hul A et al. Training with inspiratory pressure support in patients with severe COPD. *ERJ* 2006 ; 27 : 65-72

Quel mode de ventilation ?

CPAP

- B
- P
  in
- V

Table 4—*Mean (SD) of Exercise Parameters at the End of Each Session**

	Baseline	Sham	CPAP	PAV	PAV+CPAP
n	10	9	8	10	9
Power, W	33 (10)	33 (10)	31 (12)	31 (13)	32 (8)
Heart rate, beats/min	115 (18)	122 (20)	125 (18)	129 (20)	125 (19)
$\dot{V}_E$, L/min	26.6 (6.4)	31.0 (6.2)	32.8 (11.9)	33.4 (12.7)	36.2† (6.7)
V_T, L	1.000 (0.289)	1.136 (0.342)	1.178 (0.458)	1.210 (0.494)	1.316 (0.325)
Frequency, breaths/min	27.7 (7.1)	29.0 (8.2)	28.9 (8.8)	28.4 (8.3)	28.4 (6.2)
$\dot{V}O_2$, L/min	0.74 (0.21)	0.93 (0.18)	0.86 (0.30)	0.90 (0.34)	0.90 (0.16)
$\dot{V}CO_2$, L/min	0.67 (0.20)	0.78 (0.19)	0.75 (0.25)	0.78 (0.30)	0.77 (0.15)
Breathing effort, Borg scale	7 (3)	7 (2)	7 (2)	7 (3)	7 (2)
End exercise, min	4.92 (1.38)	6.60 (3.12)	8.26 (5.54)	7.10 (2.83)	12.88‡ (8.74)

*$\dot{V}_E$=minute ventilation; V_T=tidal volume; $\dot{V}O_2$=oxygen consumption; $\dot{V}CO_2$=carbon dioxide production.
†Significantly different from baseline ($p<0.05$).
‡Significantly different from all other sessions ($p<0.05$).

- A associer à un autre mode de ventilation pour un effet potentialisé

O'Donnell DE et al. Effect of continuous positive airway pressure on respiratory sensation in patients with chronic obstructive pulmonary disease during submaximal exercise. *Am Rev Respir Dis* 1998 ; 138 : 1185-90
Nava S et al. Effect of nasal pressure support ventilation and external PEEP on diaphragmatic activity in patients with severe stable COPD
Dolmage TE et al. Proportional assist ventilation and exercise tolerance in subjects with COPD. *Chest 1997* ; 111 : 948-54

Quel mode de ventilation ?

Effet aigu

Table 5 • EFFECTS OF CONTINUOUS POSITIVE AIRWAY PRESSURE, PRESSURE SUPPORT, PROPORTIONAL ASSIST VENTILATION ON EXERCISE ENDURANCE

NIVS mode	Number studies	Summary effect size (CI)	*P*	Q-statistic	Average effect
CPAP	5	0.36 (−0.04 – 0.77)	.10	2.16 = NS	124 sec. (30% control)
PS	3	0.41 (0.06 – 0.78)	.02	0.02 = NS	133 sec. (46% control)
PAV	3	0.46 (−0.01 – 0.94)	.12	1.91 = NS	149 sec. (37% control)

- Faibles effectifs
- Paramètres de ventilation varient entre les études

Effet après réentrainement sous VNI

statistically significant. Two studies (Bianchi et al[12] and Hawkins et al[13]) used PAV, whereas other studies employed PSV. Sub-analysis considering stratification by ventilation protocol did not result in any statistically significant difference from the pooled analysis.

van't Hul A et al. The acute effects of noninvasive ventilator support during exercise on exercise endurance and dyspnea in patients with chronic obstructive pulmonary disease : a systematic review. *J Cardiopulm Rehabil* 2002 ; 22 : 290-7

Ricci C et al. Physical training and noninvasive ventilation in COPD patients: a meta-analysis. *Respir Care* 2014 ; 59 : 709-17

Quels réglages ?

Niveau d’aide inspiratoire

- Idem effet aigu ou pendant un programme de réhabilitation

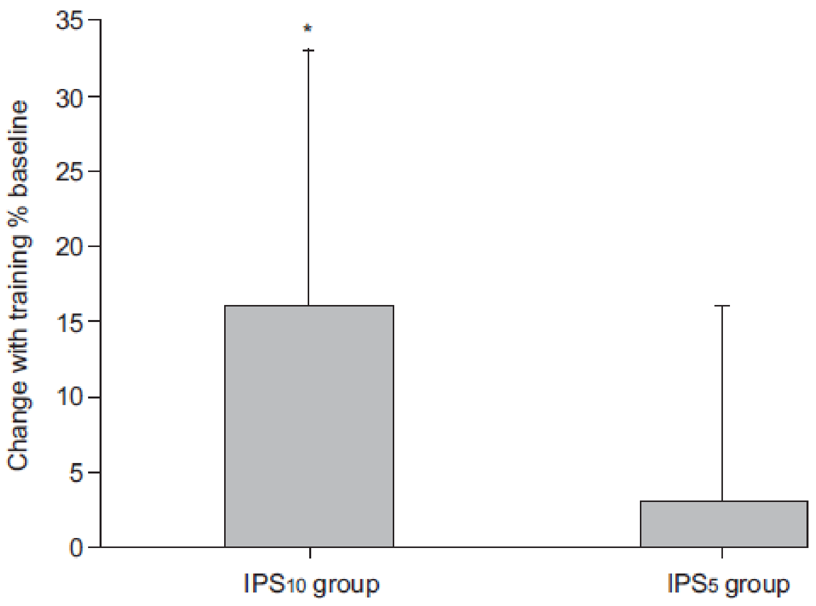


FIGURE 2. Change in incremental shuttle walking distance with training. *: $p<0.05$.

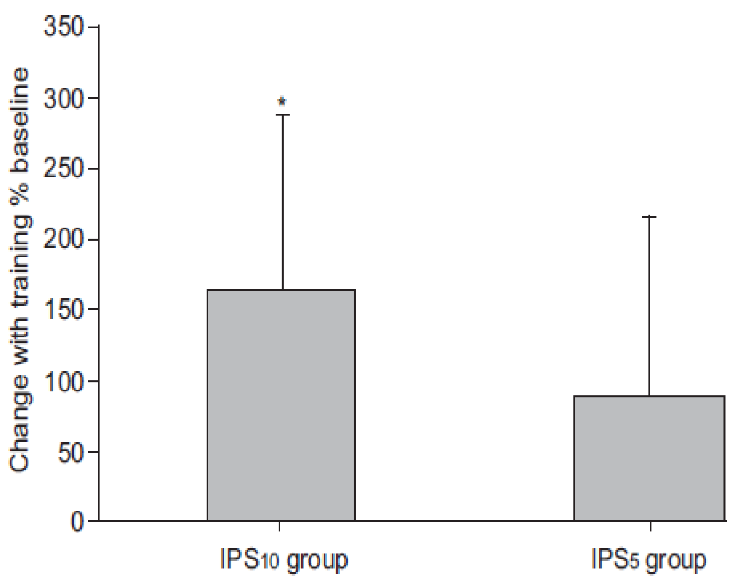


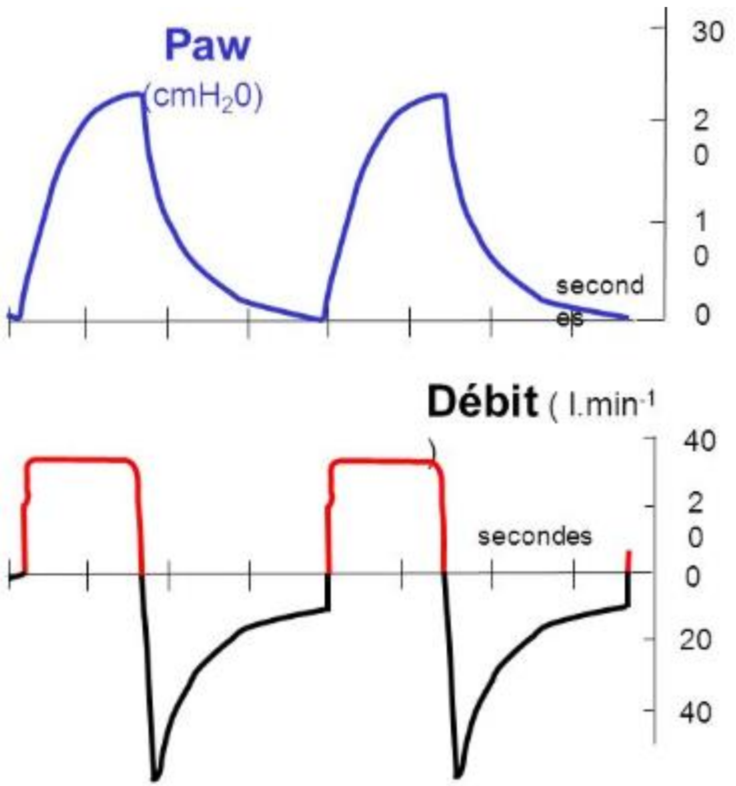
FIGURE 3. Change in constant-load cycle endurance with training. *: $p<0.05$.

van’t Hul A et al. Training with inspiratory pressure support in patients with severe COPD. *ERJ* 2006 ; 27 : 65-72
van’t Hul A et al. Acute effects of inspiratory pressure support during exercise in patients with COPD. *ERJ* 2004 ; 23 : 34-40

Comment adapter les réglages ?

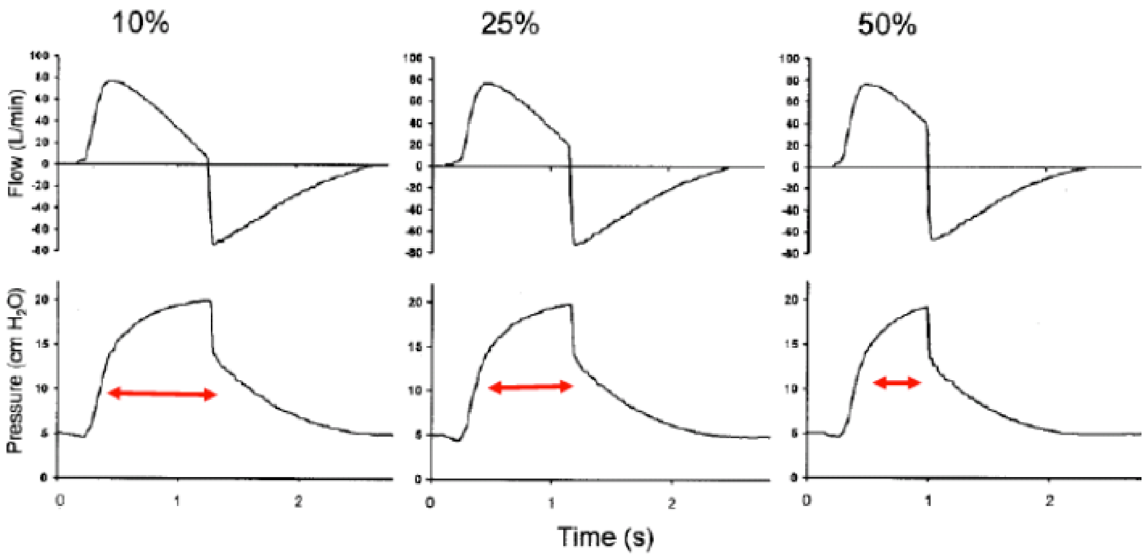
- AI
  - 10cmH2O min
  - Titrer pour soulager la dyspnée
  - Ne pas majorer l'hyperinflation dynamique
    - surveiller les courbes

- PEP
  - 5cmH2O
  - Titrer pour soulager la dyspnée
  - Compenser l'hyperinflation dynamique



Comment adapter les réglages ?

- Pente
  - Selon la tolérance du patient
  - Minimale le plus souvent



- Trigger inspiratoire
  - Selon la tolérance
  - Pas trop sensible
- Cyclage
  - Selon la tolérance
  - A l'effort, surtout chez les patients obstructifs, favoriser un cyclage haut pour permettre une expiration prolongée

Et si la VNI était utilisée hors des séances ?

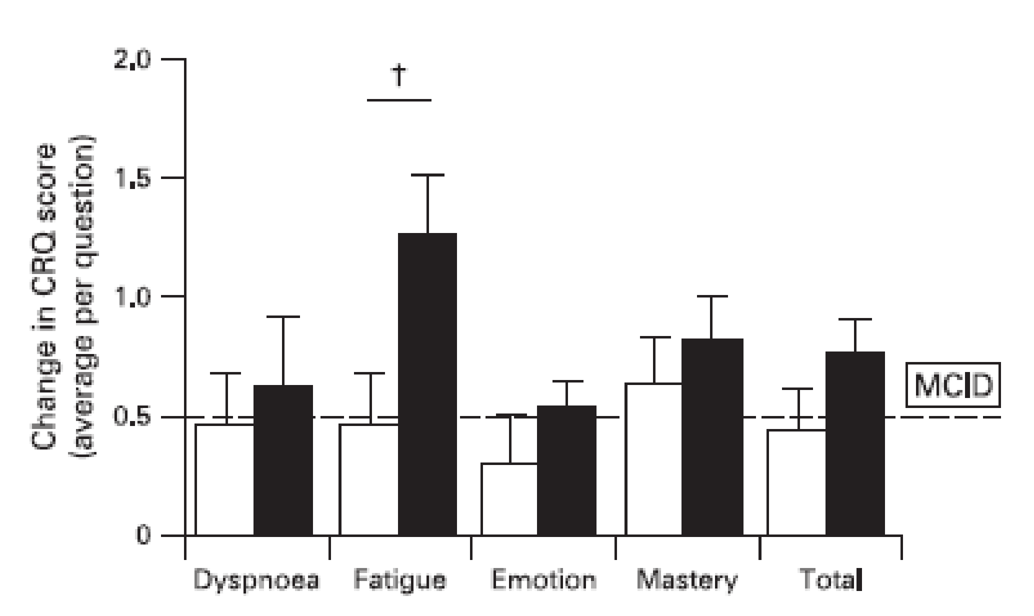
VNI nocturne au cours d'un programme de réhabilitation

Intérêt de la VNI nocturne pendant un programme de réhabilitation

- Programme de 12 sem (3x/sem) de réhabilitation
  - Avec VNI nocturne
  - Sans VNI nocturne

Table 2 Mean (SD) changes in arterial blood gases after 3 months of treatment

	Baseline	After 3 months	Change within group	Between group difference in change (95% CI)
$Paco_2$ (kPa)				
N+R	6.89 (0.68)	6.44 (0.69)	−0.45	−0.32 (−0.6 to −0.1)*
R	6.81 (0.81)	6.71 (0.58)	−0.10	
VE (l/min)				
N+R	9.8 (3.0)	10.6 (3.1)	0.8	1.4 (0.3 to 2.4)*
R	9.0 (1.9)	8.6 (2.3)	−0.4	
Daily step count (steps/day)				
N+R	1893 (591–3773)	2799 (891–6135)	391	1269 (242–2296)*
R	1680 (699–3538)	2093 (914–3155)	93	



Duiverman ML. Nocturnal non-invasive ventilation in addition to rehabilitation in hypercapnic patients with COPD. *Thorax* 2008 ; 93 : 1052-7

La VNI est-elle supérieure à d'autres stratégies visant à s'affranchir de la dyspnée ?

Oxygénothérapie

Hélium

VNI vs O2

- 6 sem
- 3x/sem

Table 2. Effects of Noninvasive Ventilation Versus Supplemental Oxygen

	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*†
Dynamometry				
Peak torque (Newton-meters)	97 ± 33	115 ± 40*	94 ± 24	99 ± 26
Total work (J)	1,315 ± 444	1,481 ± 445*	1,367 ± 366	1,397 ± 379
Total power (W)	46 ± 14	57 ± 21*	46 ± 12	47 ± 12
Fatigue index (SD %)	44 ± 13	32 ± 12*	44 ± 18	49 ± 20†
SGRQ Scores				
Symptoms				41 ± 20*
Activity				34 ± 23
Impacts				41 ± 17*
Total				37 ± 15
Incremental Exercis				
Walk speed (km/				3.7 ± 1.3
Heart rate (beats/				110 ± 12
$\dot{V}_{O_2}$/heart rate (m				8.6 ± 2.1
Minute ventilatio				30.7 ± 7.3
Respiratory rate (				31 ± 4
Tidal volume (L)				1.0 ± 0.18
$\dot{V}_{CO_2}$ (mL/min)				0.96 ± 0.17
$\dot{V}_{O_2}$ (mL/min)				0.95 ± 0.18
Lactate (mmol/L)				2.2 ± 0.7*
Lactate/speed (mmo				0.6 ± 0.3†
S_{pO_2} (%)				87 ± 2
Systolic blood press				177 ± 21
Dyspnea (Borg scor				4.2 ± 2.2

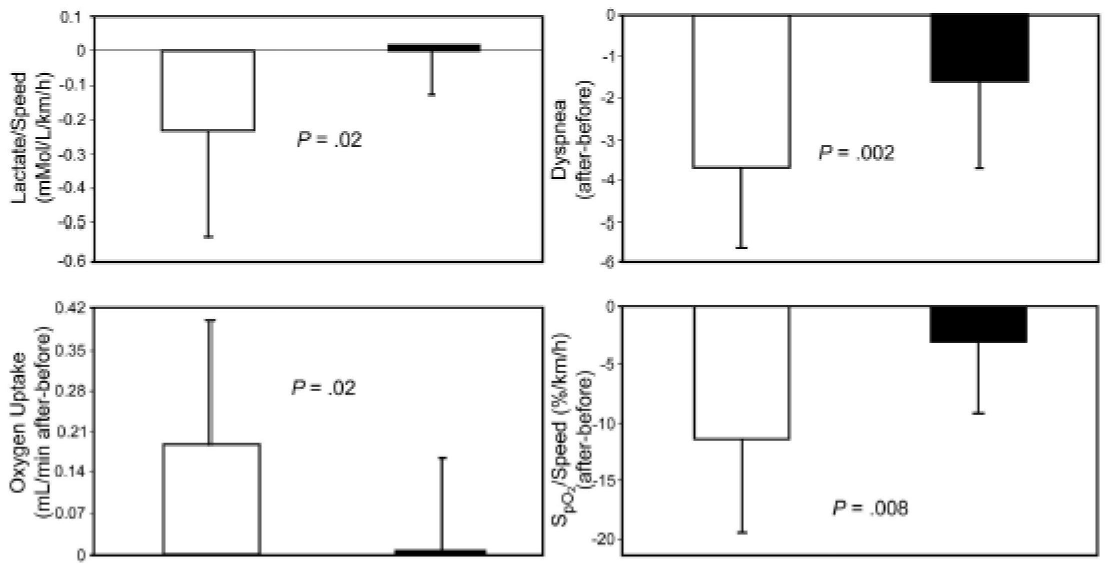


Fig. 3. Changes (before versus after exercise training program) in lactate/speed ratio, dyspnea, $\dot{V}_{O_2}$, and S_{pO_2}/speed at peak exercise in the incremental exercise test. White bars = noninvasive ventilation. Black bars = supplemental oxygen. The error bars show the standard error.

Borghi-Silva A et al. Adjuncts to physical training of patients with severe COPD: oxygen or noninvasive ventilation ? *Respir* Care 2010 ; 5 : 885-94

VNI vs Hélium

- 6 sem
- 2x/sem

Table 4—*Initial and Final Unassisted Exercise Times for the Three Groups**

Variables	Week 1 Exercise Time, min			
UT group	12.3 ± 5.2			
HT group	10.6 ± 4.7			
NT group	7.9 ± 3.5	0.031	14.2 ± 5.6	0.451

*Data are presented as mean
†vs unassisted testing week 1.
d testing week 8.

Table 6—*Percentage Improvement in Unassisted Testing for the Three Groups, Final vs Initial Week**

Variables	Average of Percentage Increase in Exercise Time, min	p Value†	Average of Percentage Increase in Workload, METs	p Value†
UT group	37.0 ± 33.1		38.0 ± 35.0	

Table 5—*Initial and Final Unassisted Maximum Workloads for the Three Groups**

Variables	Week 1 Maximum Workload, METs	p Value†	Week 8 Maximum Workload, METs	p Value‡
UT group	3.88 ± 1.62		5.11 ± 1.71	
HT group	3.20 ± 1.23	0.294	4.59 ± 1.36	0.456
NT group	2.68 ± 0.72	0.036	4.09 ± 1.75	0.181

*Data are presented as mean ± SD.
†vs unassisted testing week 1.
‡vs unassisted testing week 8.

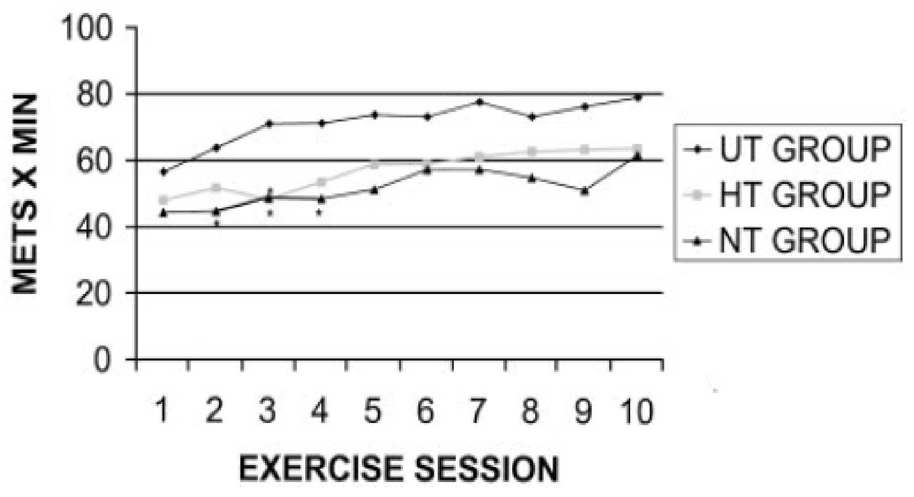


FIGURE 2. Exercise intensity during training. *p < 0.05.

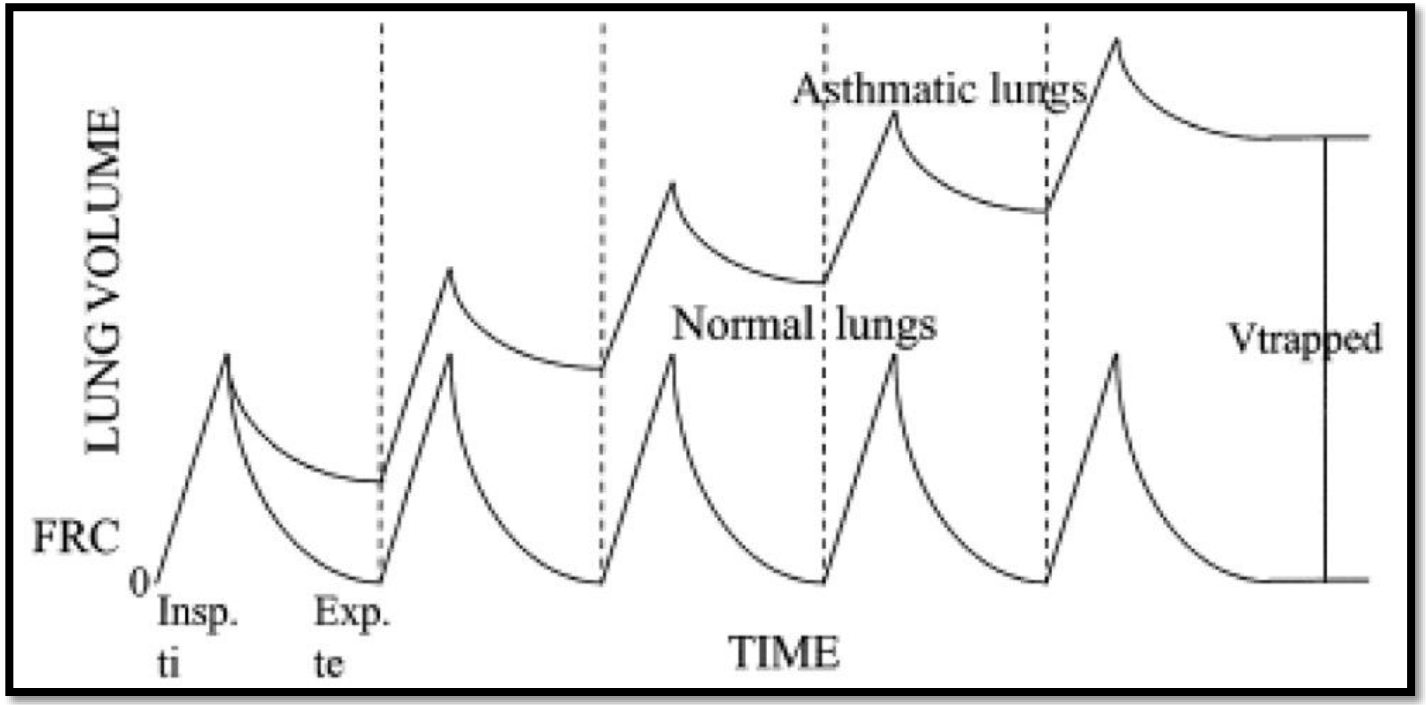
Johnson JE et al. Effects of training with heliox and noninvasive positive pressure ventilation on exercise ability in patients with severe COPD. *Chest* 2002 ; 122 : 464-72

Conclusion

- Résultats encourageants au niveau des études physiologiques
- Bénéfices pendant un programme moins évidents (à confirmer)
- Charge de travail supplémentaire
  - Identifier les patients (critères précis restant à définir)
    - Sévérité / PiMax
    - Critères cliniques
    - Patients déjà ventilés
    - Et tester !
  - Modalités de ventilation à affiner : individualisation des paramètres
- Nécessité de réaliser d'autres études
  - Intérêt de la technique
  - Patients
  - Effets à long terme et maintien des acquis

Merci pour votre attention

Hyperinflation dynamique



Stather DR et al. Clinical review : Mechanical ventilation in severe asthma. *Critical Care* 2005 ; 9: 581-7

Place des modes à volume cible ?

- Non évalués dans la littérature
- Auto adaptation de l'AI et de la PEP
- Vt cible proche du Vt au seuil ventilatoire ?