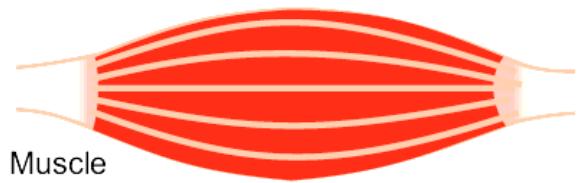


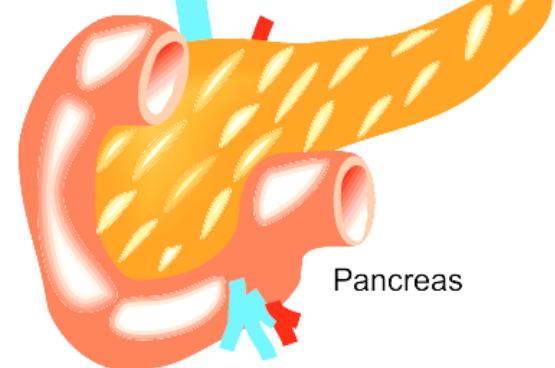


Creteil

22^{ème} Journée d'Actualités en Ventilation Artificielle



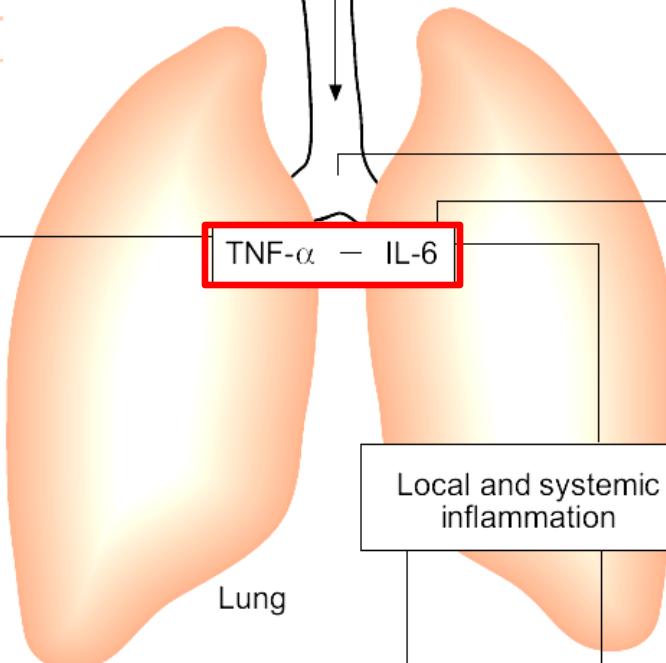
Cigarette smoke
pollutants



Muscle
weakness/wasting

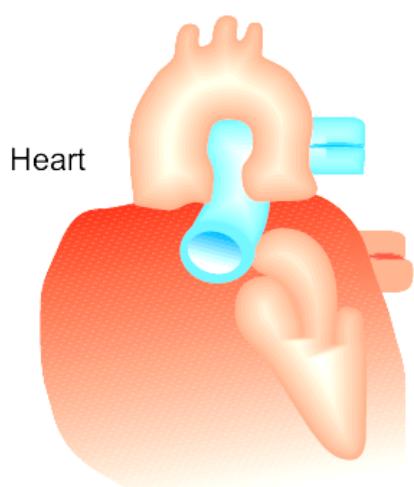
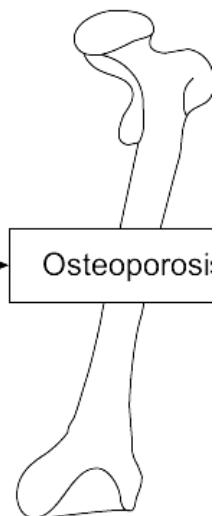
TNF- α — IL-6

Metabolic syndrome
type 2 diabetes

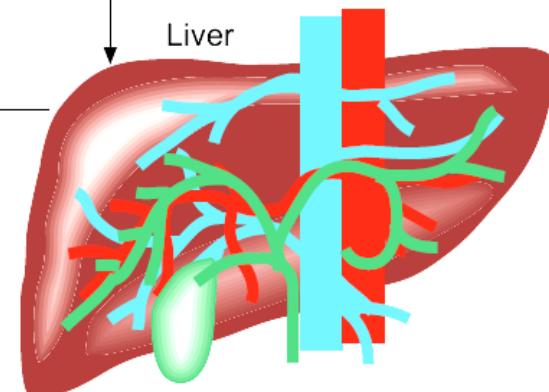


Local and systemic
inflammation

?



Cardiovascular
events

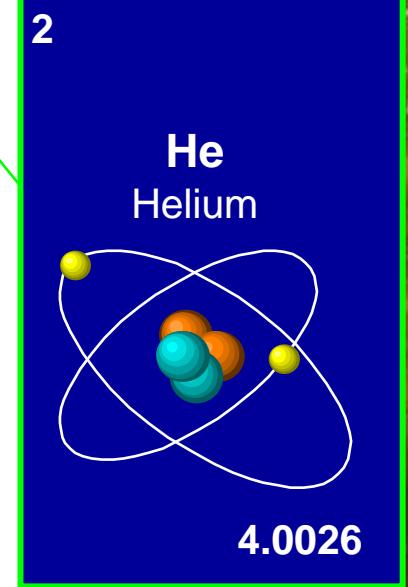


+ve

CRP



1A		2A																8A	
1	H	3	4															2	He
2	Li	Be	7	9															10 Ne
3	Na	Mg	23	24	3B	4B	5B	6B	7B	8B	1B	2B	5	6	7	8	9	10	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	31	32	33	34	35	36	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac	Unq	Unp	Unh													



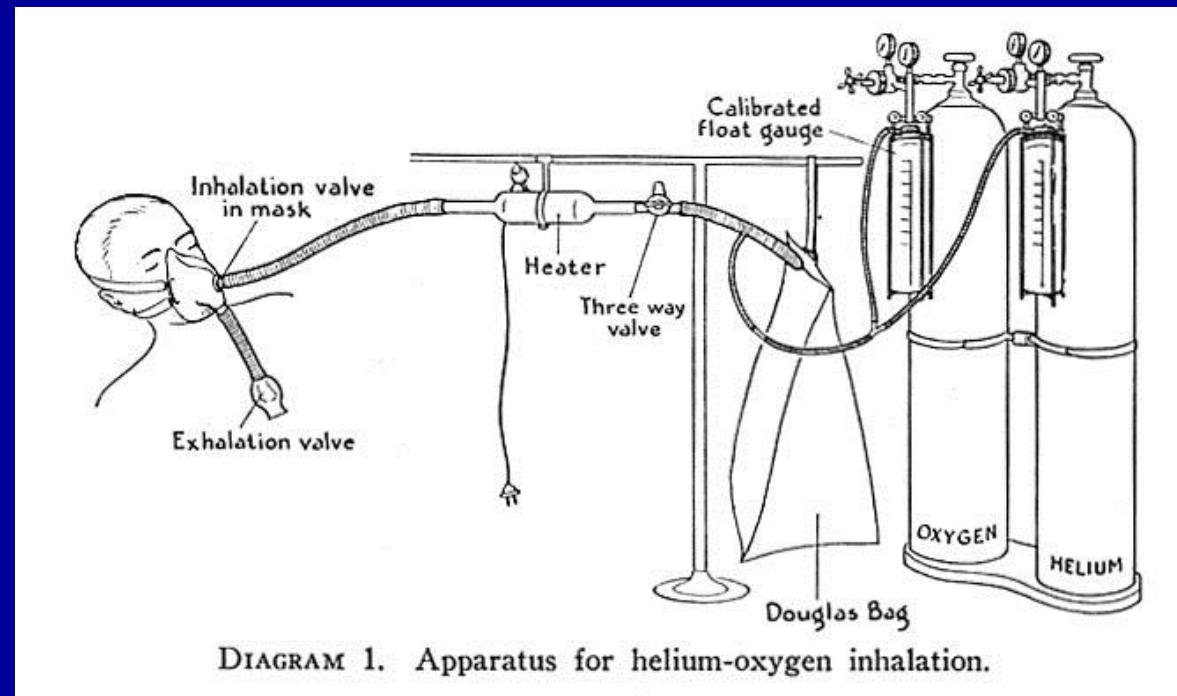
58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
140	141	144	145	150	152	157	159	163	165	167	169	173	175
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	No	Lw	
232	231	238	237	242	243	247	249	251	254	253	256	254	257

Incolore, inodore, insipide, inerte

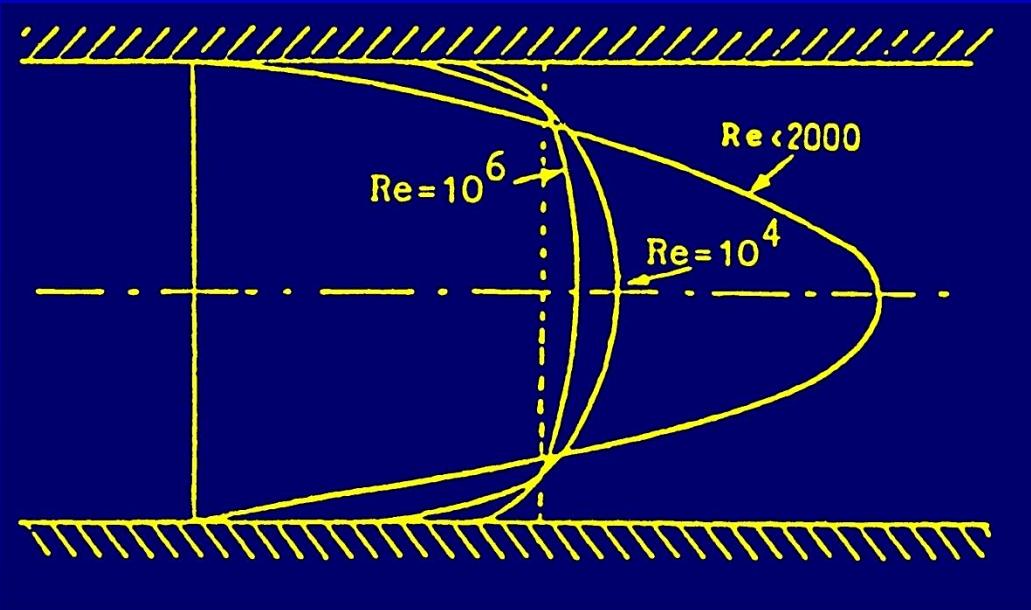
THE USE OF HELIUM IN THE TREATMENT OF ASTHMA AND OBSTRUCTIVE LESIONS IN THE LARYNX AND TRACHEA

By ALVAN BARACH, M.D., F.A.C.P., New York,
N.Y.

Ann Int Med 1935; 9: 739-765

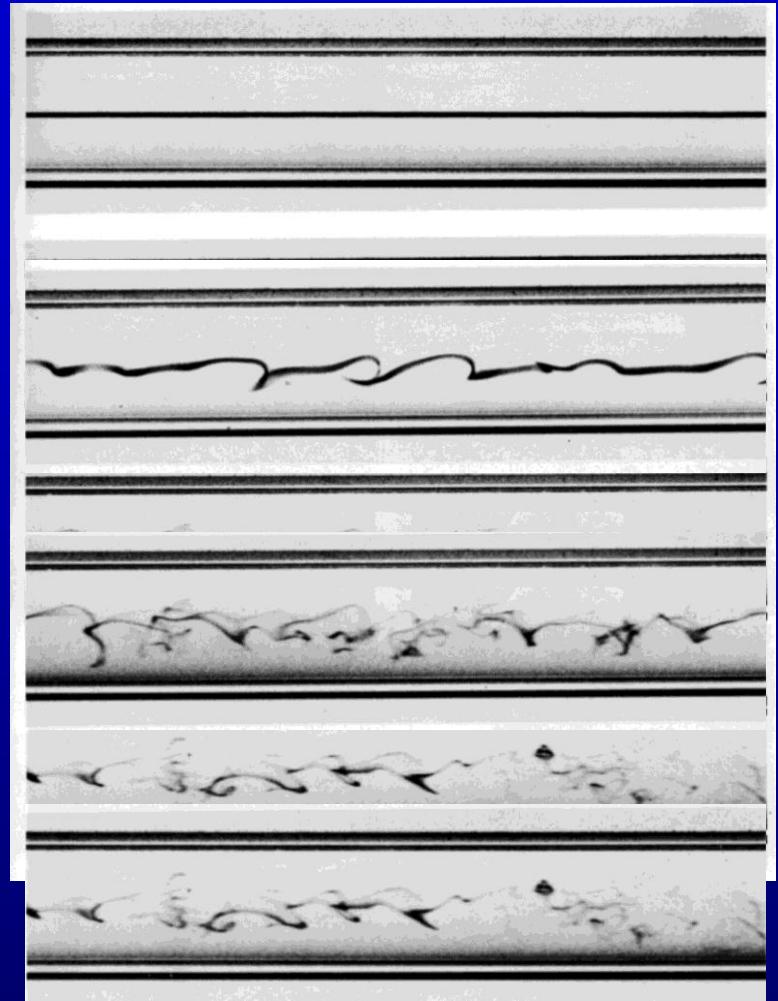


Velocity profiles in long straight tubes with axisymmetrical flow



Helium-oxygen makes flow more laminar

laminar



turbulent

	μ/μ_{air}	ρ/ρ_{air}	ν/ν_{air}^*
• Air	1.0	1.0	1.0
◦ HeO ₂	1.19	0.33	3.59

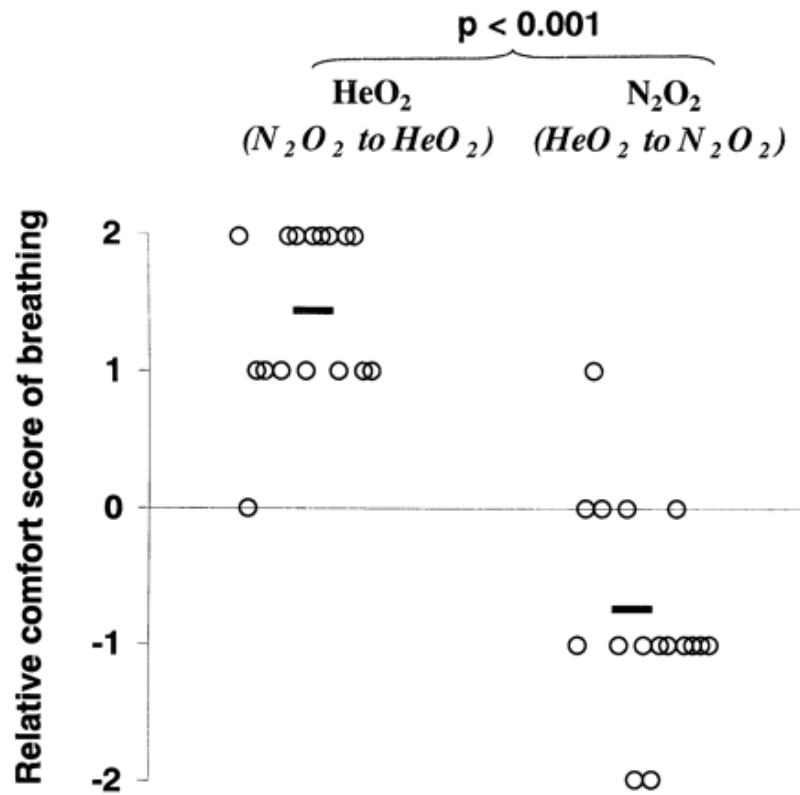
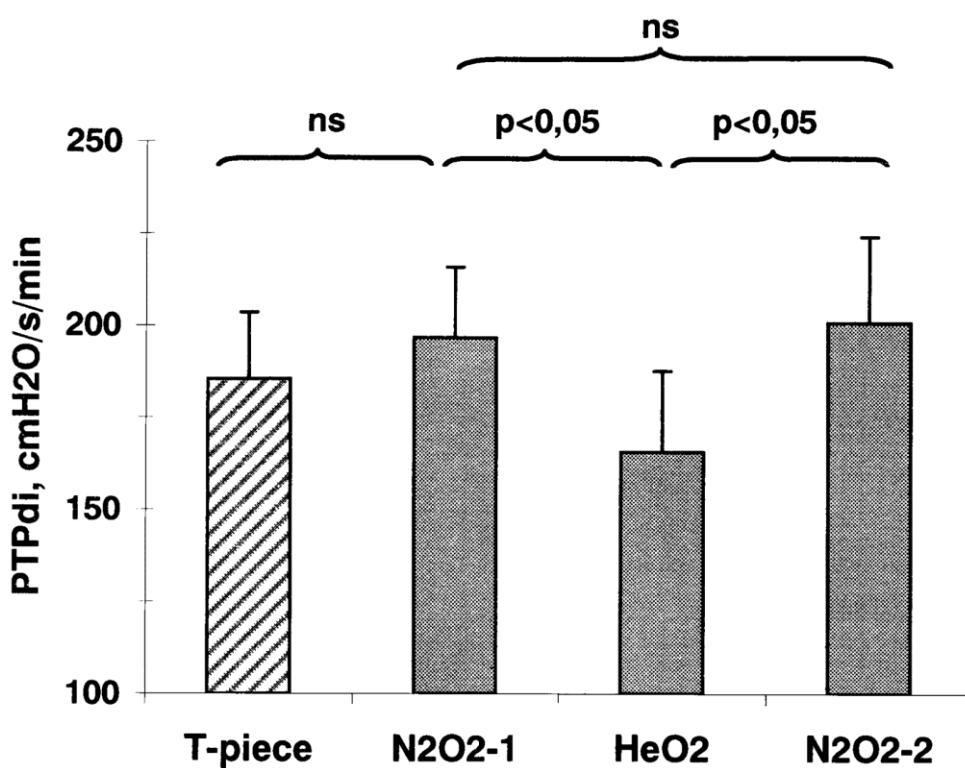
The Reynolds number is decreased by 3.6 with an 80:20% He-O₂ mixture

The effects are attenuated as FiO₂ is increased

He/O_2 post-extubation

Jaber et al., Am J Respir Crit Care Med 2001; 164: 633-637

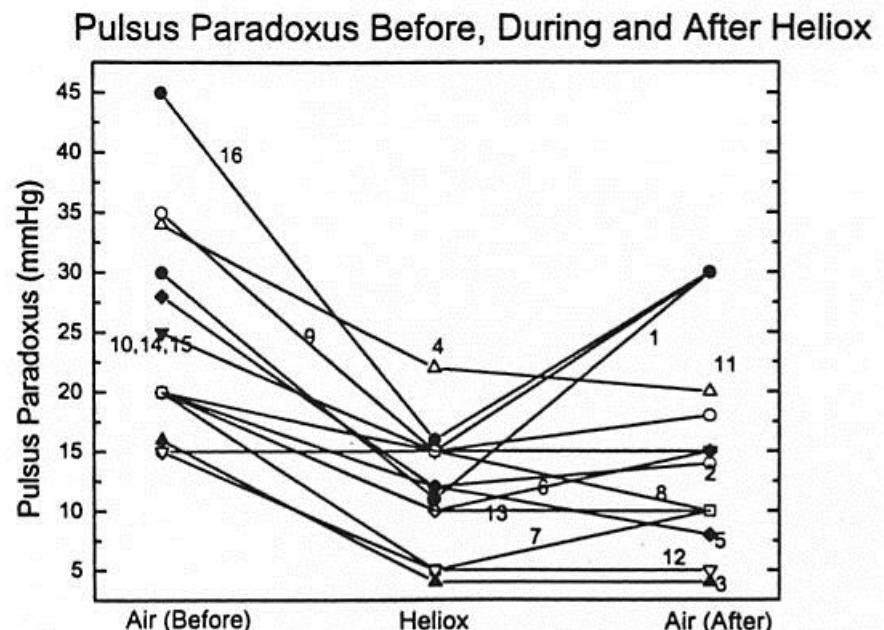
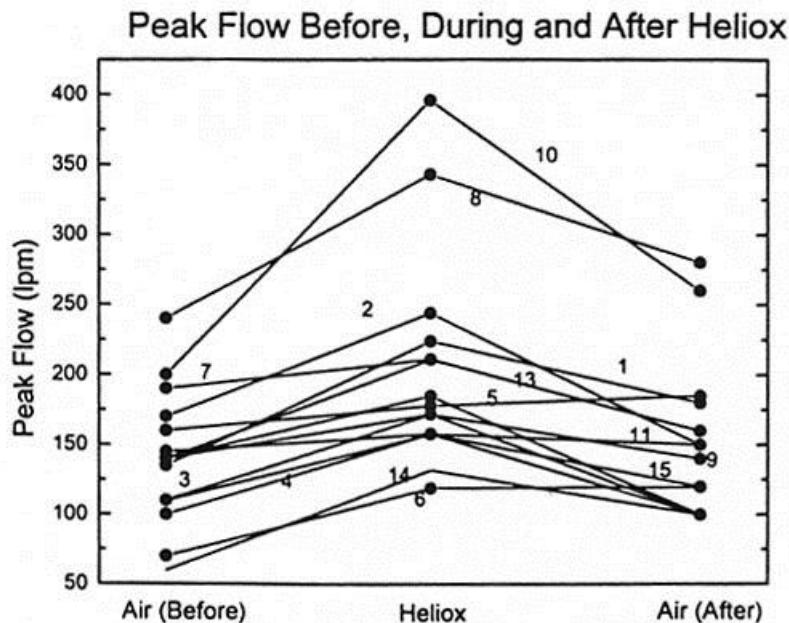
18 patients (\emptyset COPD), VM > 48 h, post-extubation



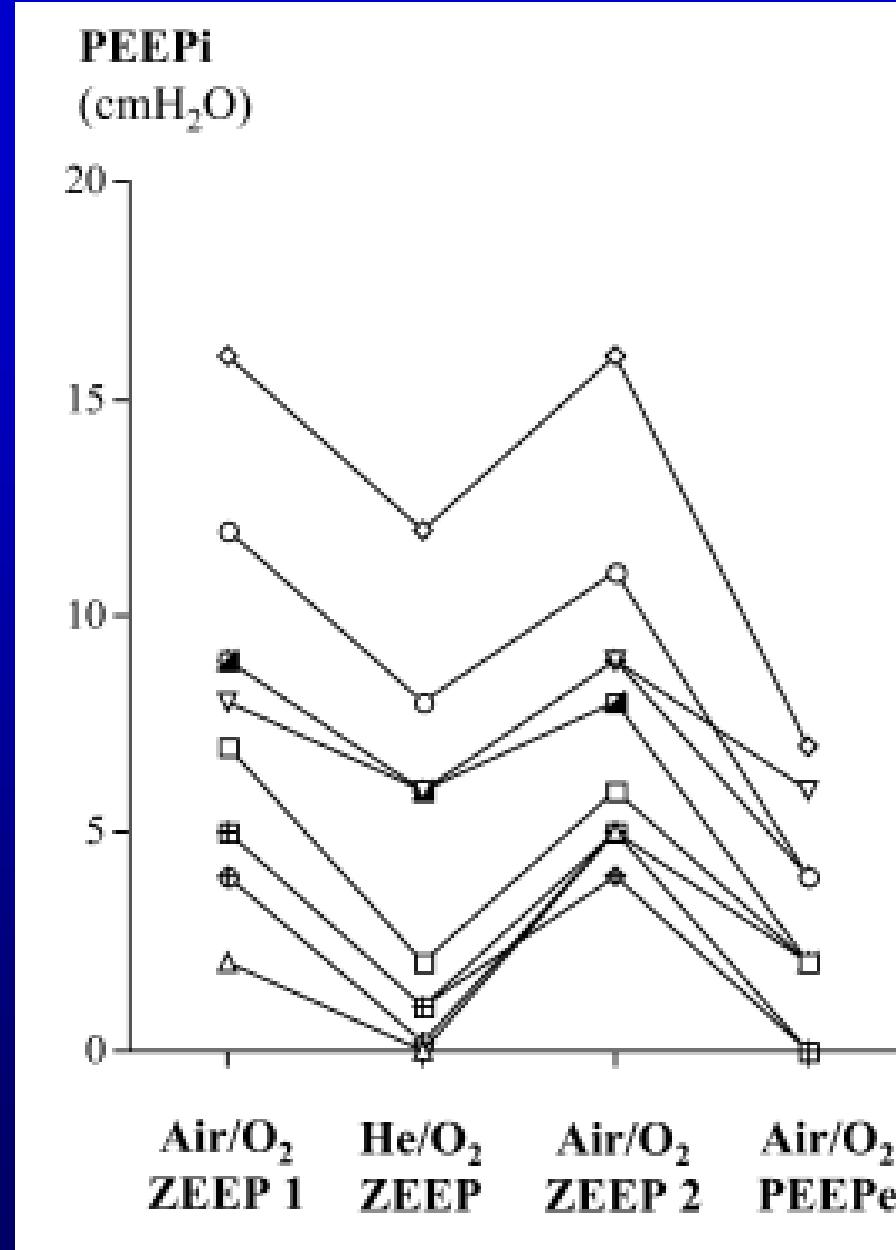
He/O₂ lors d'asthme aigu sévère

Manthous et al., Am J Respir Crit Care Med 1995; 151: 310-314

27 pts en respiration spontanée

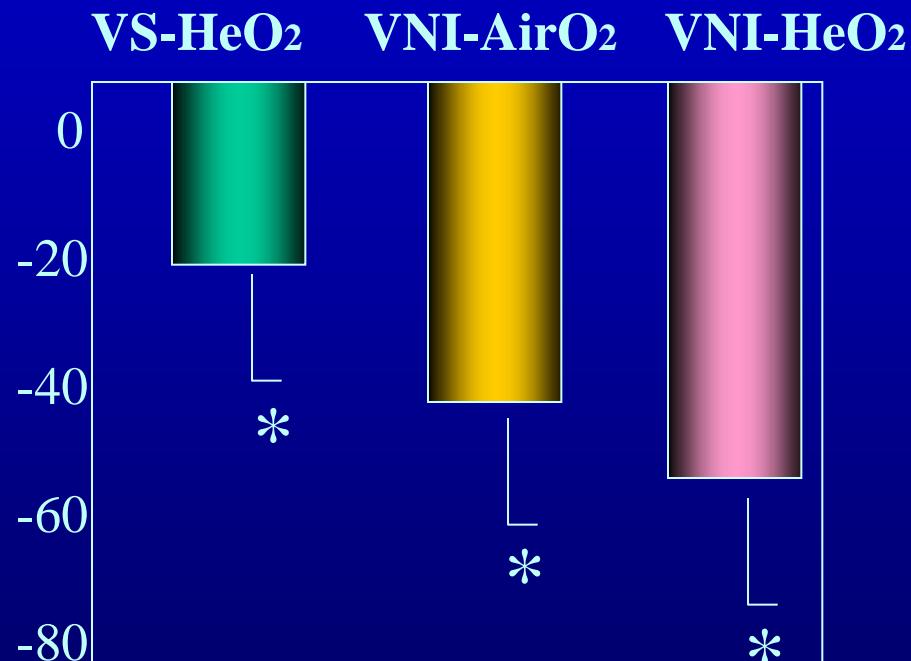


COPD under Mechanical Ventilation

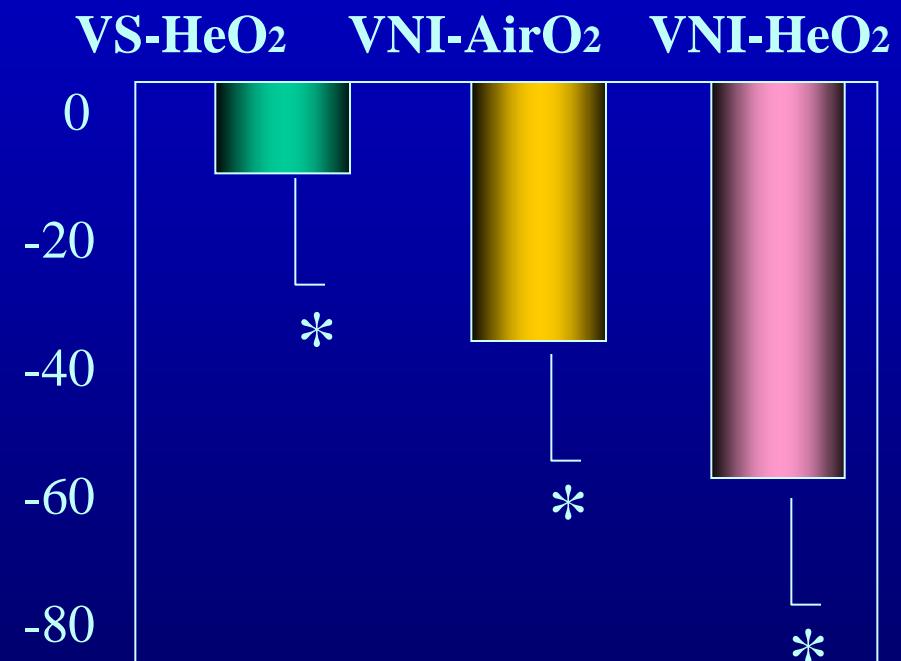


Noninvasive Ventilation with Helium–Oxygen in Acute Exacerbations of Chronic Obstructive Pulmonary Disease. Jaber,...Brochard. AJRCCM 2000; 161: 1191

NIV + helium-O₂ = external + internal Assistance



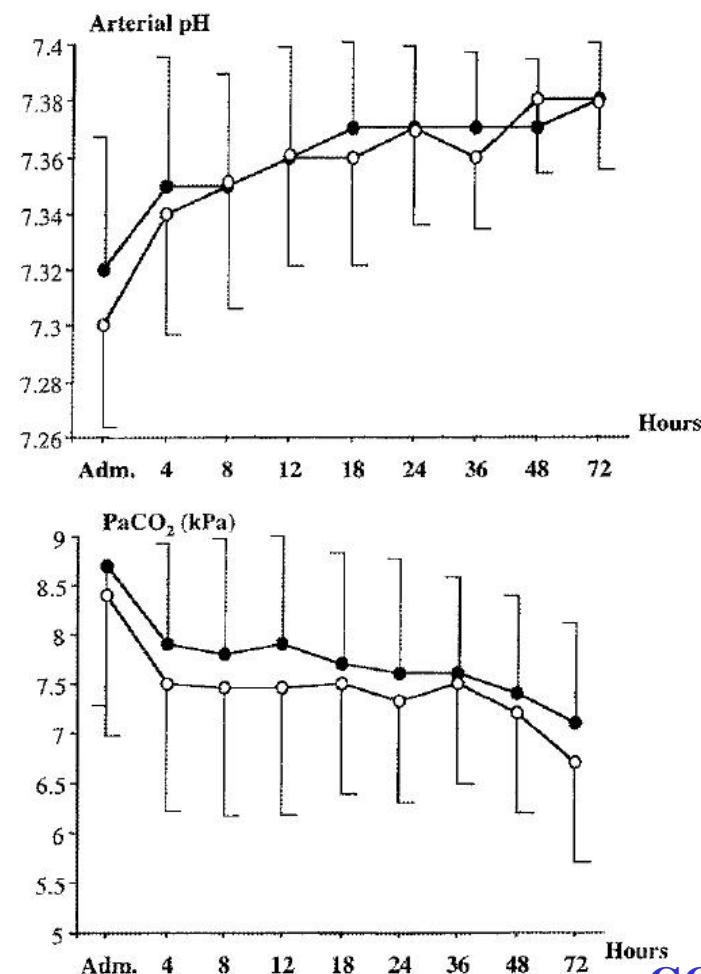
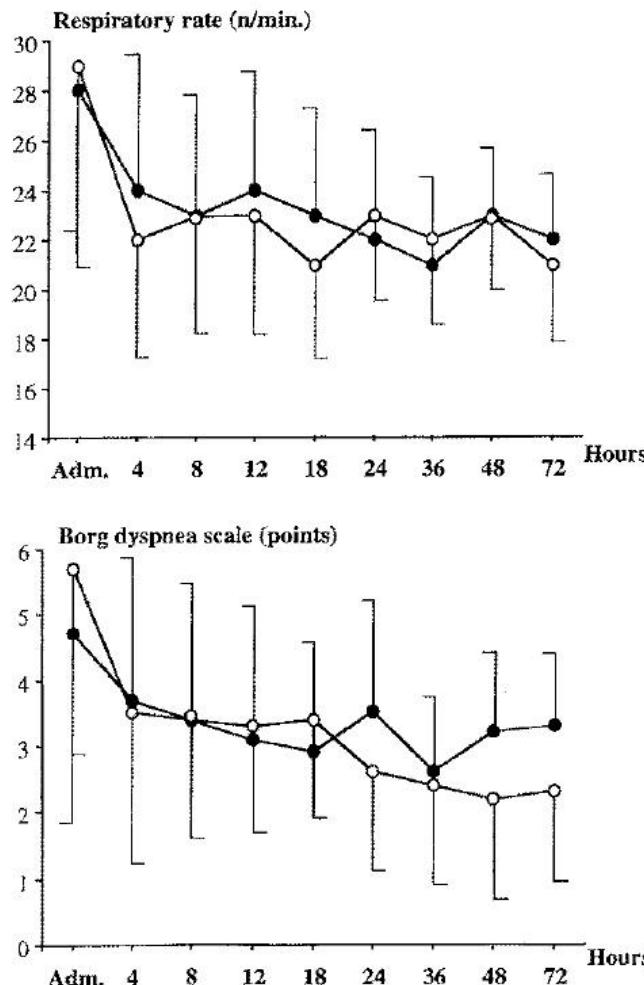
WOB



ΔPdi

Helium-oxygen versus air-oxygen noninvasive pressure support in decompensated chronic obstructive disease: A prospective, multicenter study*

Philippe Jolliet; Didier Tassaux; Jean Roeseler; Luc Burdet; Alain Broccard; William D'Hoore; François Borst; Marc Reynaert; Marie-Denise Schaller; Jean-Claude Chevrolet

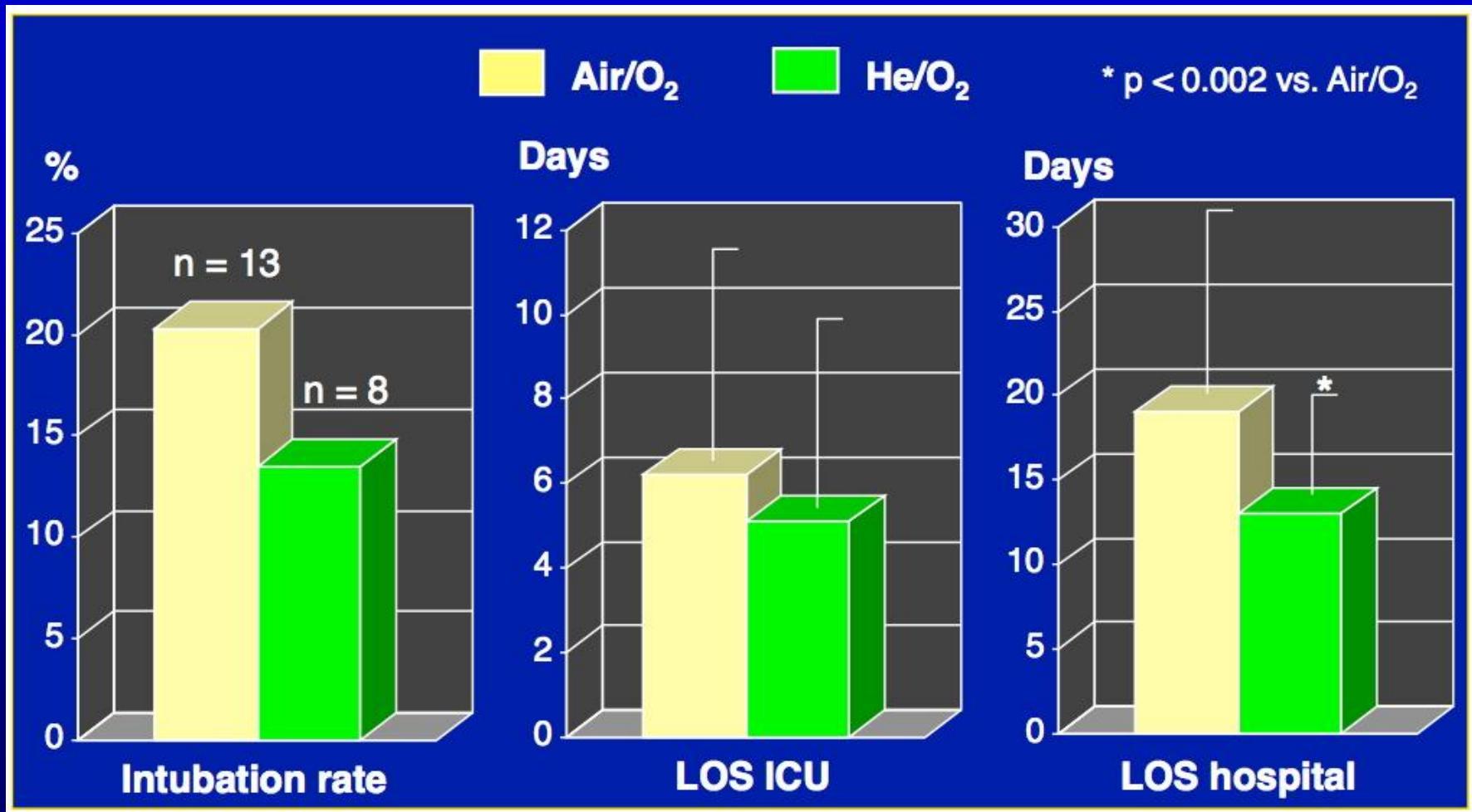


n = 123
Air/O₂
He/O₂

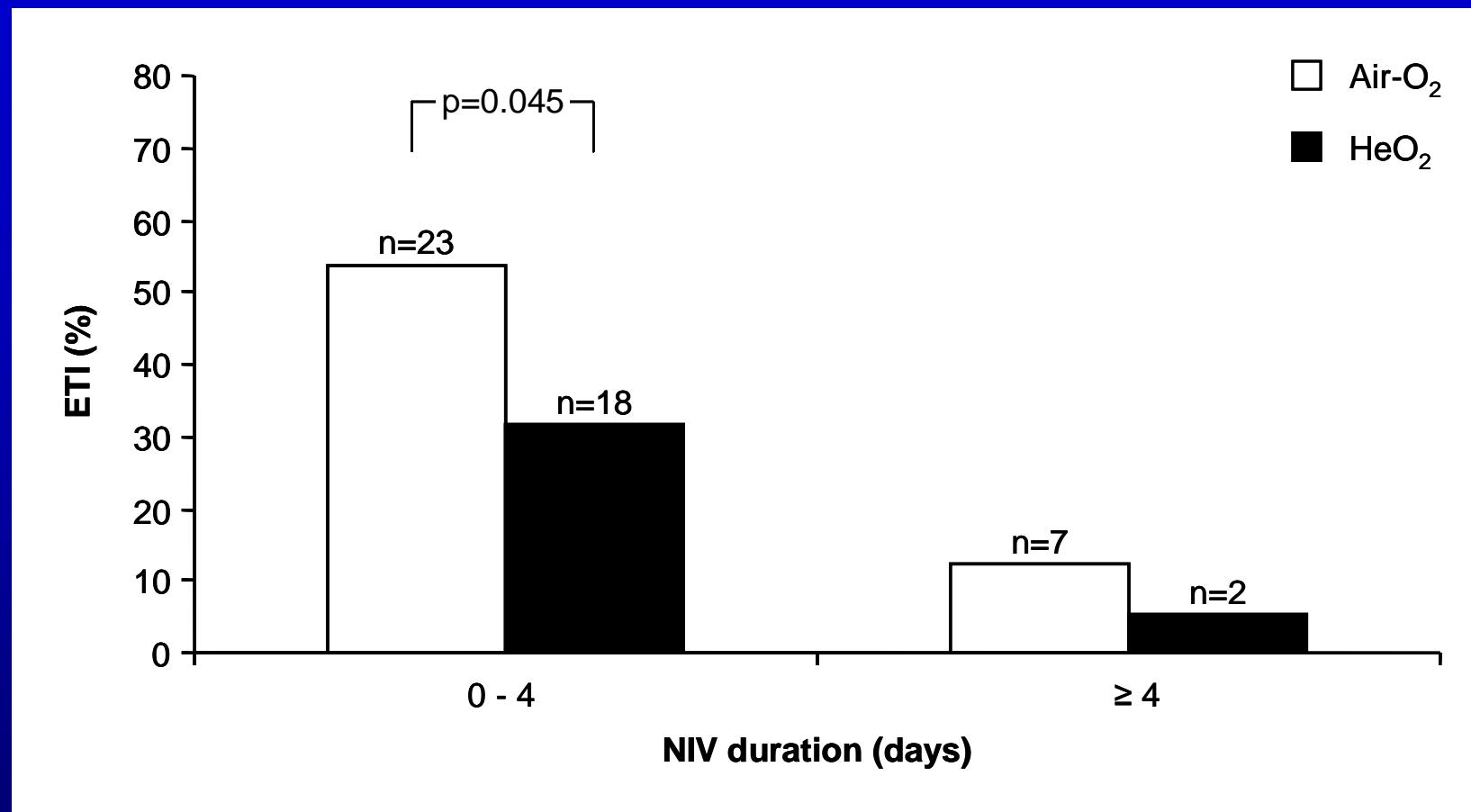
CCM 2003

Patients' ICU course and outcome

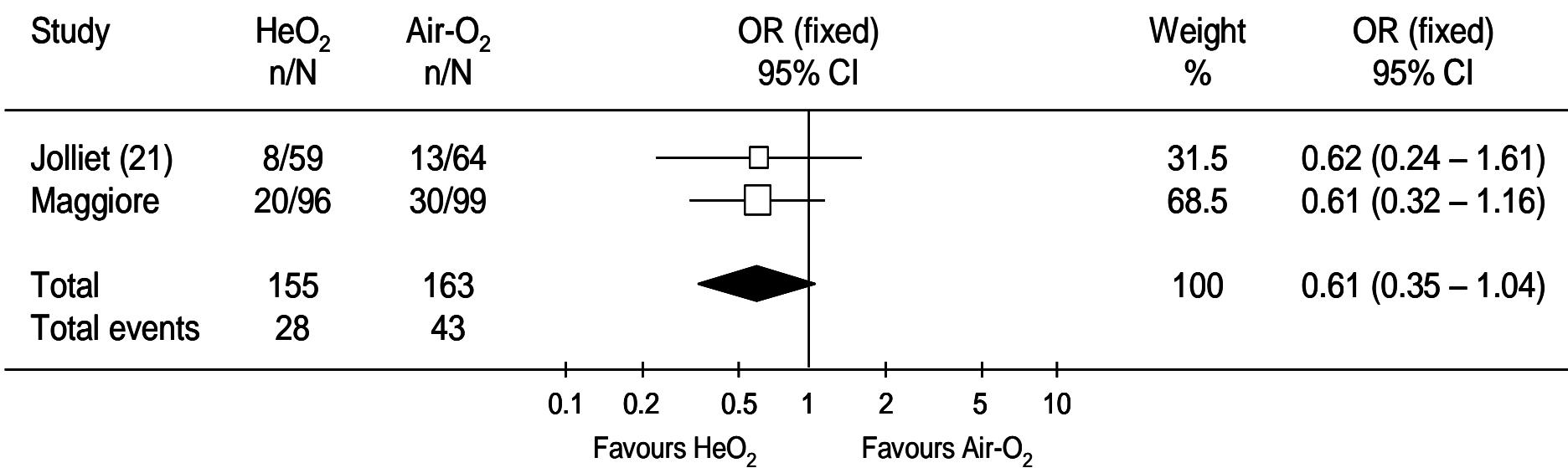
Jolliet et al., Crit Care Med 2003; 31: 878-884



	Noninvasive Ventilation, HeO ₂ Group (n = 102)	Noninvasive Ventilation, Air-Oxygen Group (n = 102)	p
Duration of noninvasive ventilation, days	3.8 ± 2.9	4.2 ± 3.0	0.3
Intubated patients, n; %	25; 24.5	31; 30.4	0.35
Time to intubation, days	2.4 ± 1.8	4.6 ± 6.9	0.09 0.7
Duration of mechanical ventilation, days	17.3 ± 16.0	12.5 ± 11.4	0.19
Length of intensive care unit stay, days	10.6 ± 8.1	10.9 ± 8.1	0.84
Length of hospital stay, days	19.1 ± 8.0	18.5 ± 7.7	0.6
Mortality at day 28, n; %	5; 4.9	10; 9.8	0.18
Intensive care unit mortality, n; %	7; 6.9	12; 11.8	0.23
Hospital mortality, n; %	11; 10.8	15; 14.7	0.4



NIV + helium-O₂ = external + internal Assistance



P= 0.07

From Maggiore S, Richard JC M et al ICM 2009



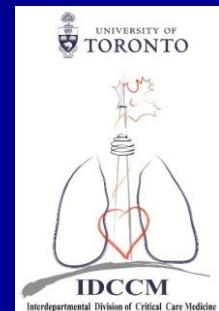
ECHO^{ICU}: A multicenter randomized trial assessing the efficacy of Helium/Oxygen in severe exacerbations of COPD

P. Jolliet, L. Besbes, F. Abroug, J. Ben Kheli, M. Besbes, JM. Arnal, JD. Chiche, F. Daviaud, JL. Diehl,
B. Lortat-Jacob, A. Mercat, N. Lerolle, K. Razazi, C. Brun-Buisson, S. Bertini A. Corrado,
I. Durand-Zaleski, J. Texereau, L. Brochard

on behalf of the ECHO^{ICU} investigators

ClinicalTrials.gov Identifier: NCT01155310

The E.C.H.O.^{ICU} study was sponsored by Air Liquide
HealthCare



Introduction

Due to its reduced density, Helium/O₂ (He/O₂) reduces the work of breathing, intrinsic PEEP and hypercapnia more than Air/O₂ during spontaneous breathing^{1,2} and non-invasive ventilation (NIV)^{2,3}

1. *Am Rev Respir Dis* 1960;81:823-829
2. *Am J Respir Crit Care Med* 2000;161:1191-1200
3. *Crit Care Med* 1999;27:2422-2429

Introduction (2)

Two prospective, randomized multicenter trials were inconclusive in showing a benefit of He/O₂ NIV on outcome (intubation, mortality, length of stay in ICU^{1,2})

	Intubation rate %	
	Air/O ₂	He/O ₂
1. <i>Crit Care Med</i> 2003;31:878-874	20	13
2. <i>Crit Care Med</i> 2010;38:145-151	30.4	24.5

Study objective

To determine whether continuously administered He/O₂ (during NIV and in-between NIV sessions) for 72 hours was superior to Air/O₂ in reducing **NIV failure** in COPD patients with severe hypercapnic exacerbation.

Study end-points

Primary end-point

NIV failure, defined as endotracheal intubation or death without intubation

Secondary end-points

- Physiological parameters
- Duration of ventilation
- ICU and hospital LOS
- 6-month follow-up (recurrence & rehospitalization)
- Medico-economic analysis

Methods

Patients

COPD (known or clinically suspected) requiring NIV for acute hypercapnic respiratory failure.

NIV criteria

Uncompensated respiratory acidosis ($\text{PaCO}_2 \geq 45 \text{ mmHg}$ and $\text{pHa} \leq 7.35$)

and at least one of the following:

- Respiratory rate $\geq 25 \text{ b/min}$
- $\text{PaO}_2 \leq 50 \text{ mmHg}$
- SaO_2 or $\text{SpO}_2 \leq 90\%$

Methods (2)

He/O₂ delivery (up to 3 days)



He/O₂ gas cylinders

Spontaneous
breathing



Sentry He/O₂
blenders



HiOx mask



Hamilton G5
with He/O₂
module

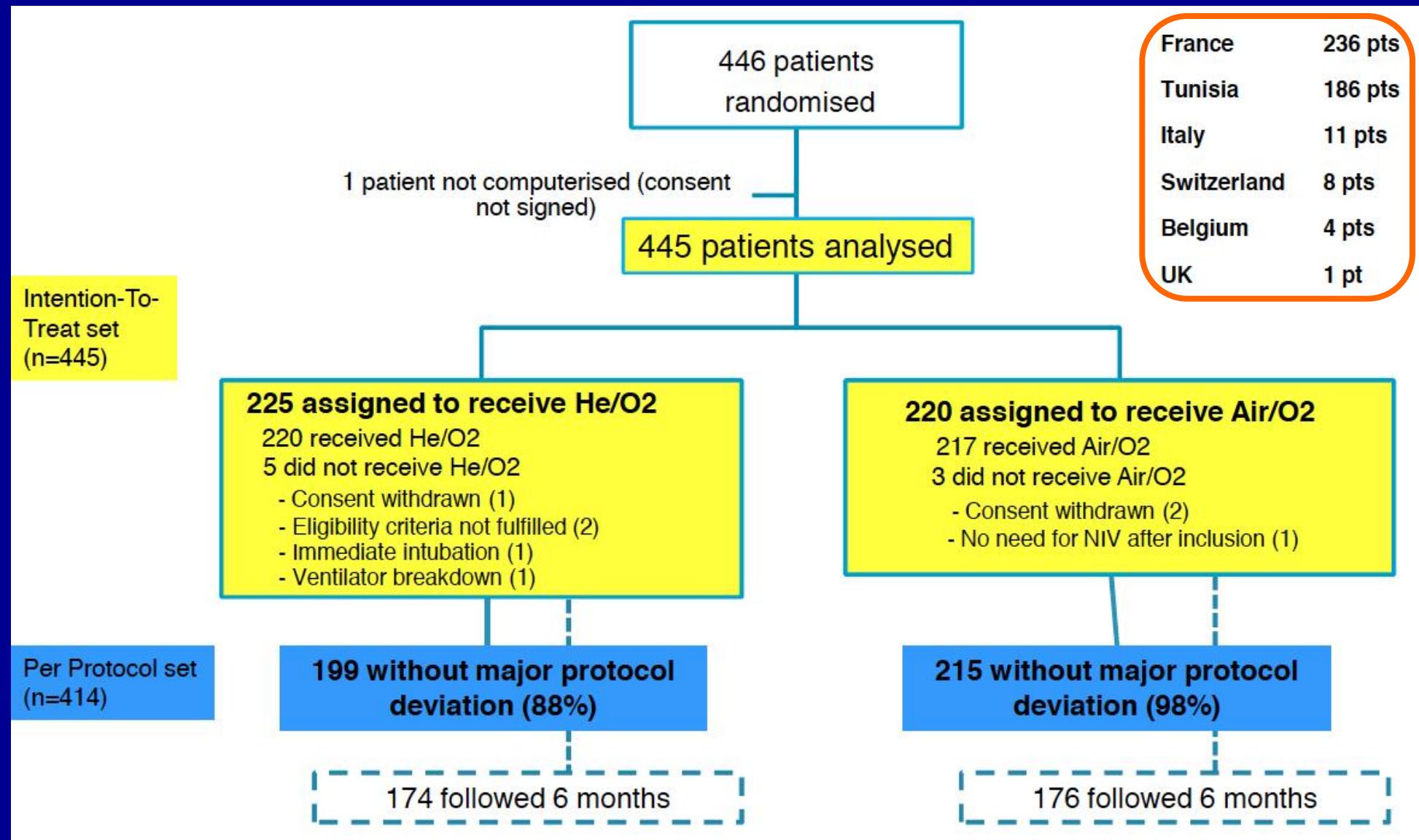


FlexiFit
Facemask

Study sample size estimation

- Based on a reduction in the NIV failure rate from 25% to 15%
- Total 670 patients
- Inclusions stopped prematurely due to low event rate (adjudication committee) / futility rule
- Total of 445 patients included

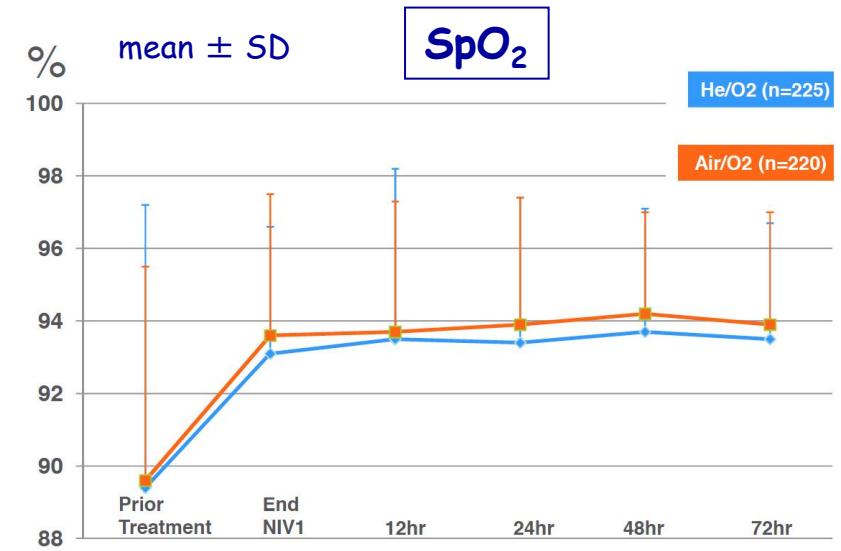
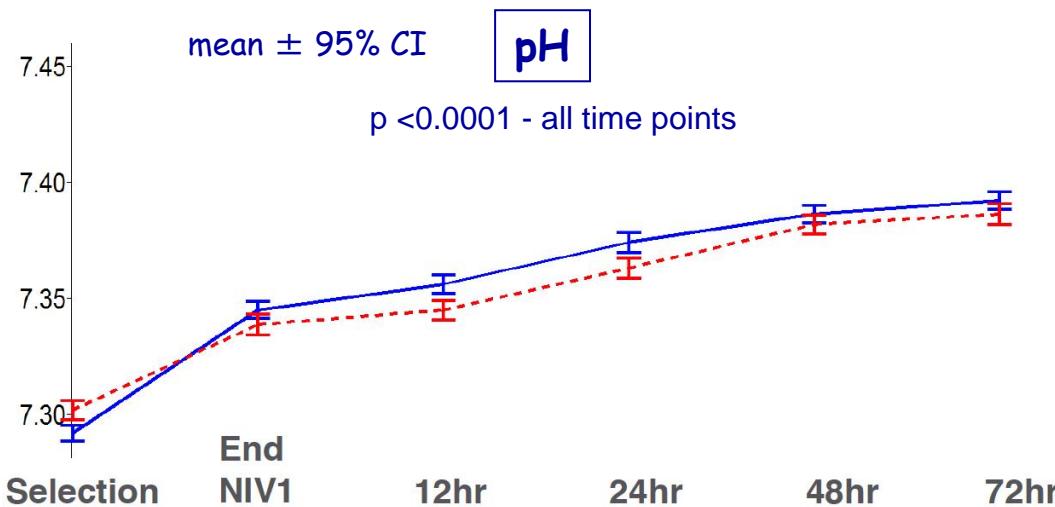
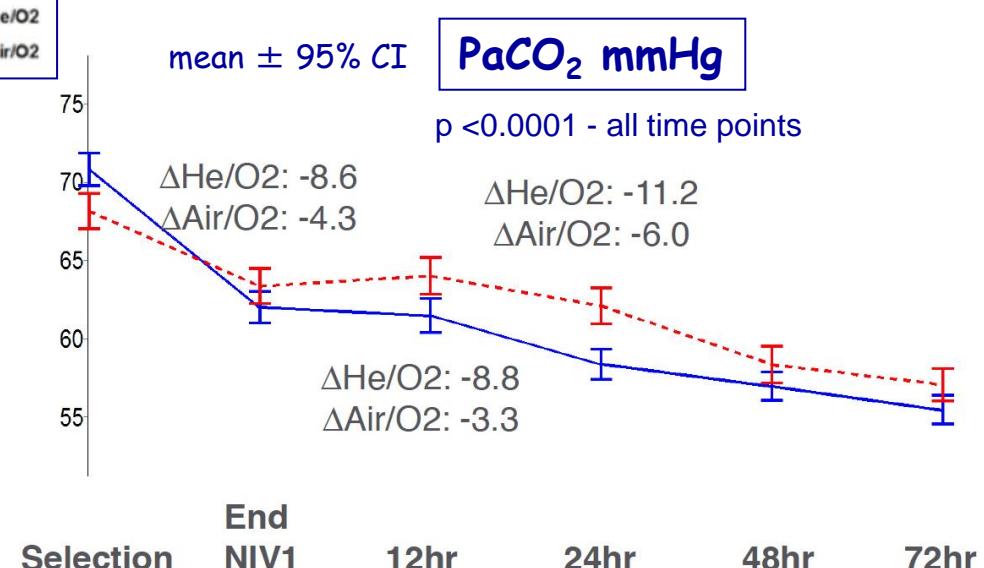
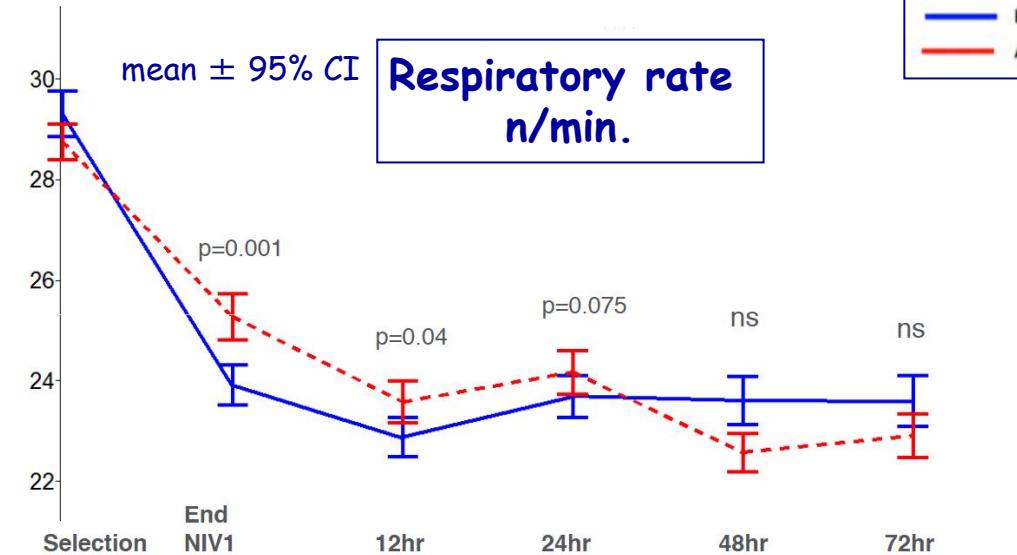
Results



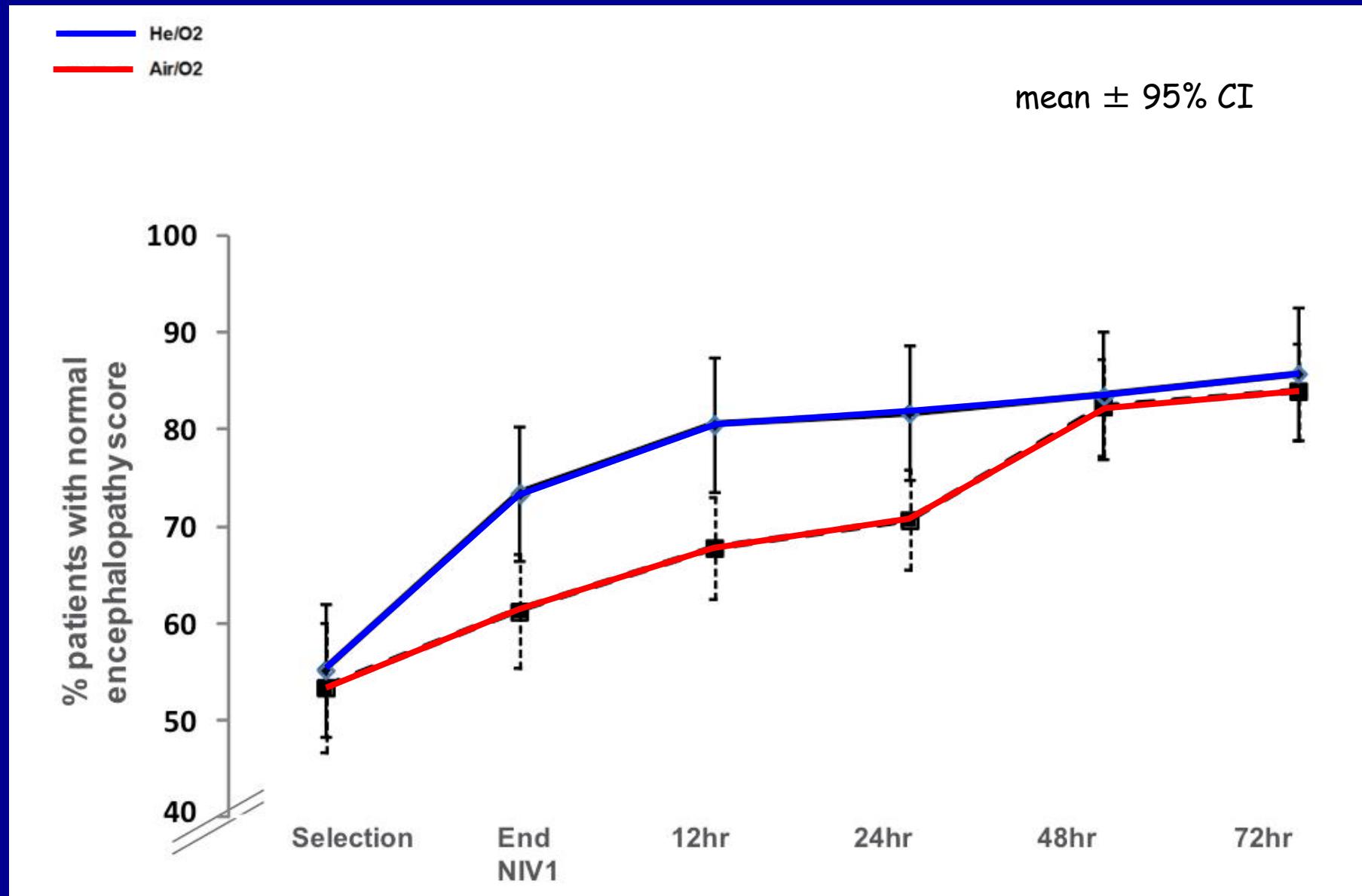
Patient characteristics

	He/O ₂ (n=225)	Air/O ₂ (n=220)
Age (years)	68.9 ± 11.4	66.9 ± 11.4
Gender (M/W) – n	149 / 76	158 / 62
BMI Kg/m ²	25.7 ± 5.5	25.9 ± 6.3
Current smokers, n (%)	85 (38%)	94 (43%)
Lung function		
Available PFTs, n (%)	124 (55%)	107 (49%)
FEV1, %predicted value	36 ± 14	35 ± 15
Admission in ICU in the last 12 months, n (%)	35 (16%)	27 (12%)
Main provenance		
Emergency room – n (%)	174 (77.3%)	168 (76.4%)
Medical ward – n (%)	23 (10.2%)	30 (13.6%)
Home – n (%)	22 (9.8%)	16 (7.3%)
SAPS III (0-217)	49.7 ± 7.9	48.8 ± 7.6
Main causes of COPD exacerbation		
Infection – n (%)	113 (50.2%)	115 (52.3%)
Undetermined – n (%)	55 (24.4%)	53 (24.1%)
Cardiac – n (%)	35 (15.6%)	30 (13.6%)

Physiological data during first 72 hours



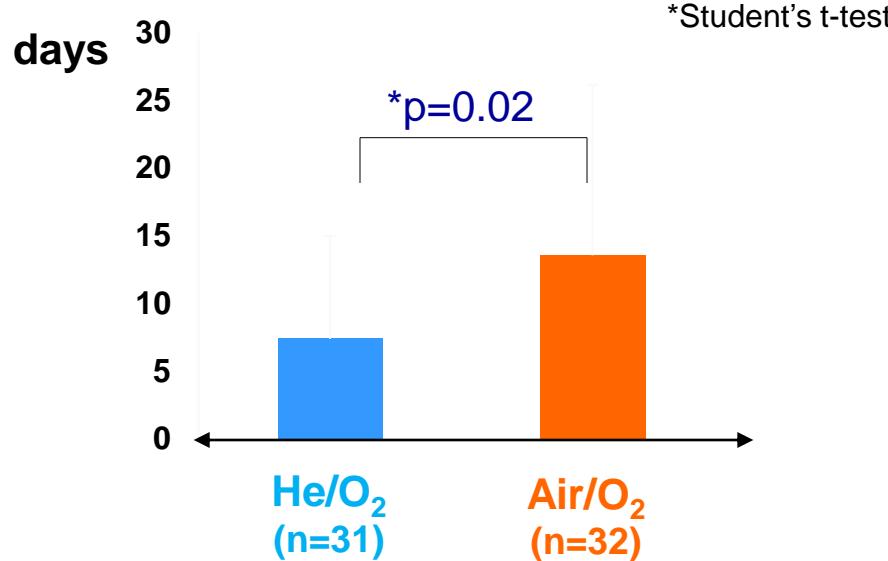
Encephalopathy score over first 72 hrs



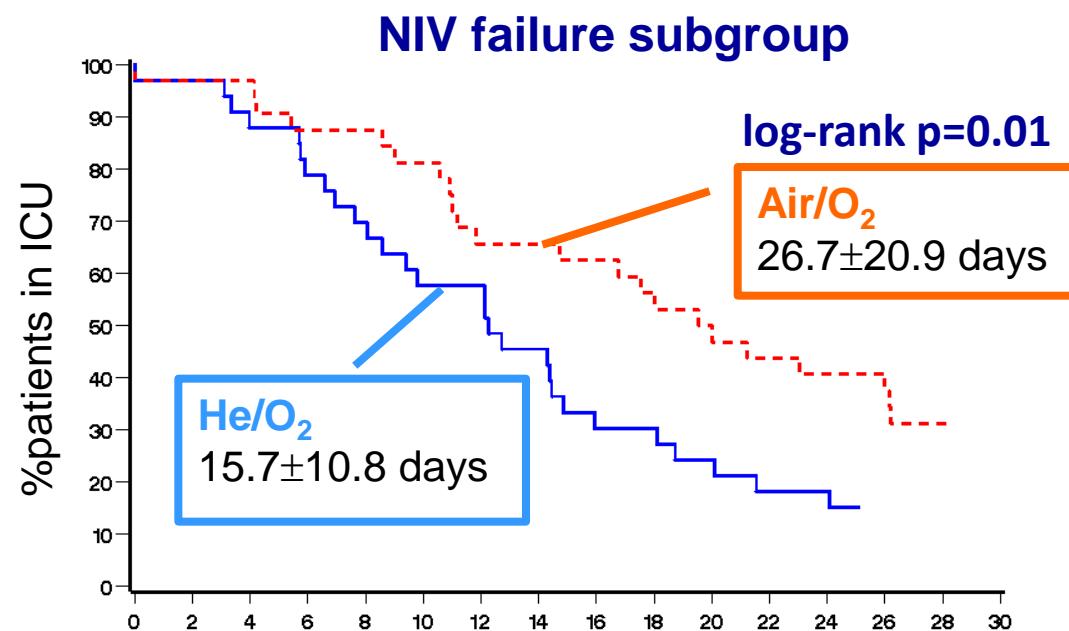
Main outcomes

ITT total population	He/O ₂ (n=225)	Air/O ₂ (n=220)	p
NIV failure	33 (14.7%)	32 (14.5%)	0.97
Intubation, n (%)	31 (13.8%)	32 (14.5%)	0.82
NIV duration, days	5.3 ± 4.2	5.1 ± 4.6	0.69
Length of stay, days			
ICU	8.7 ± 6.7	10.2 ± 11.6	0.29
Hospital	16.2 ± 11.6	17.0 ± 15.6	0.74
Mortality, n (%)			
ICU	12 (5.3%)	15 (6.8%)	
Hospital	8 (3.6%)	3 (1.4%)	
6-m	20 (8.9%)	17 (7.7%)	

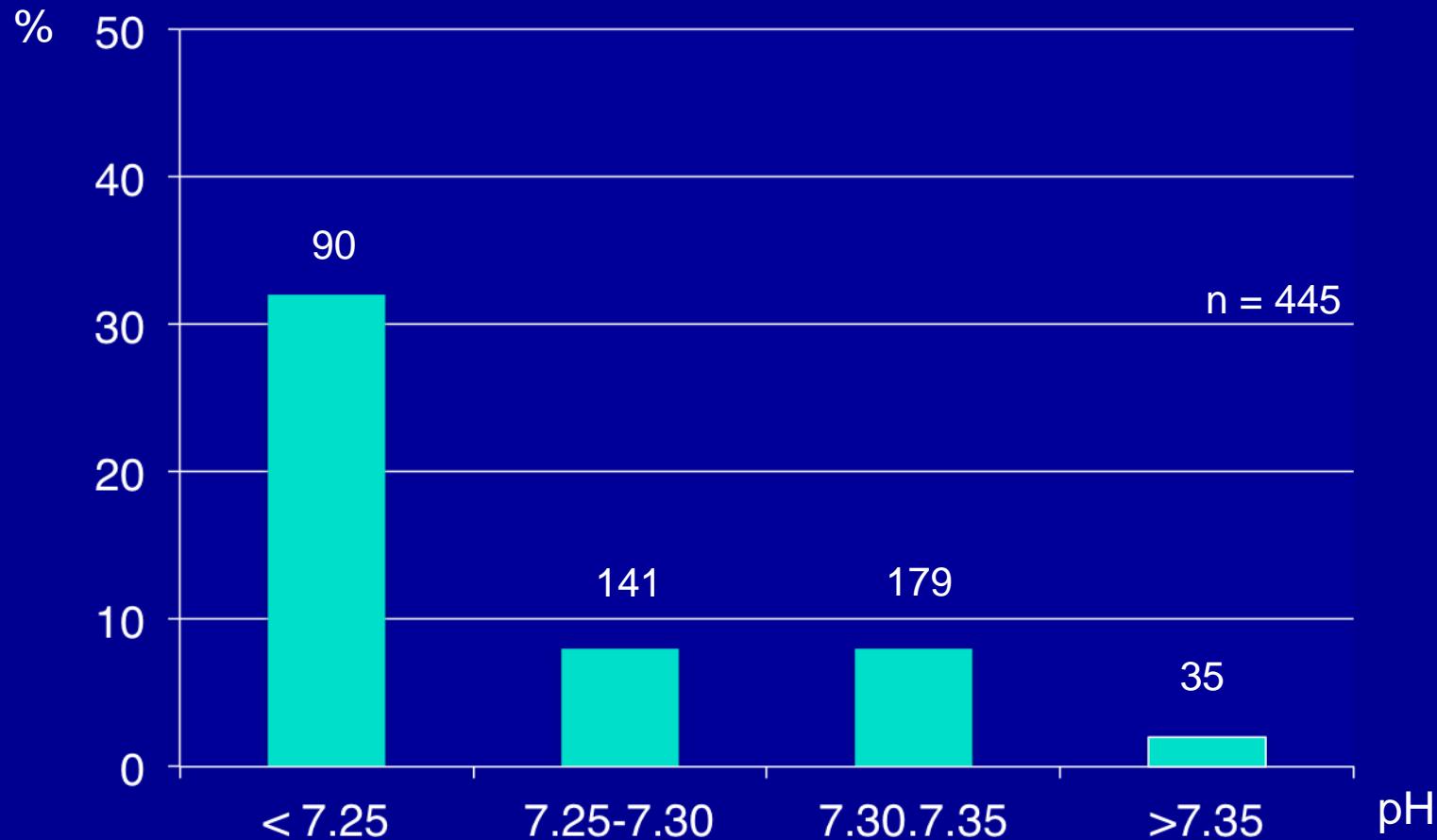
Cumulative invasive MV duration (ITT)



Duration of index ICU stay



NIV failure rate (%): pH at baseline



pH was the only predictor of NIV failure ($p<0.0001$)

Conclusion

- Largest study to date on severe hypercapnic COPD decompensation requiring NIV + 6 mo. follow-up.
- Largest study on the medical use of He/O₂ and first to assess its continuous administration for 72 h with specific delivery devices.

Conclusion (2)

- The study confirmed the beneficial physiological effects and safety of He/O₂.
- No reduction in NIV failure rate, but overall intubation very low.
- Significant reduction in duration of invasive MV and ICU LOS in patients in whom NIV failed.

Many Thanks to...

The 16 ECHO^{ICU} Investigational teams

Endpoint Validation & Safety Committee

Prof E. Vicaut (Chairman) (methodologist, Paris)

Prof S. Nava (intensivist, Bologna)

Prof J. Mancebo (intensivist, Barcelona)

Air Liquide medical R&D

H. Taupin

M. Labart

L. Monnier

H. Pasche

Les Loges en Josas, France

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