Oxygénothérapie nasale à haut débit

Alain Mercat
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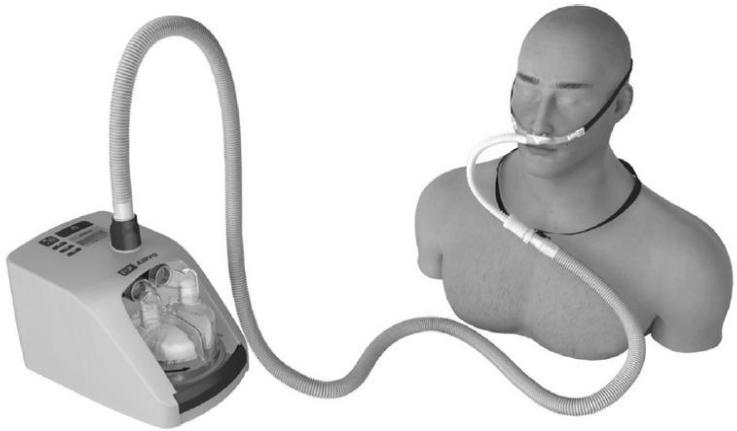
Liens d’intérêts

- Financement de travaux de recherche
  - Covidien (PAV+)
  - General Electric (CRF/SDRA)
  - Maquet (NAVA)
  - Fisher-Paykel (Optiflow)
- Brevet
  - General Electric (EELV/PEEP/recrutement)
- Exposés lors de congrès
  - Covidien
  - Alung technologies
- Activité d’expertise
  - Faron Pharmaceuticals
  - Air Liquide Medical Systems

Oxygénothérapie nasale à haut débit

- Débit élevé jusqu'à 60 L/min
- Humidification (37 °C, 100 % HR, 44 mg H_2O/L)



ONHD : Avantages potentiels

Débit O2 ≥ débit insp
(FiO2 stable)

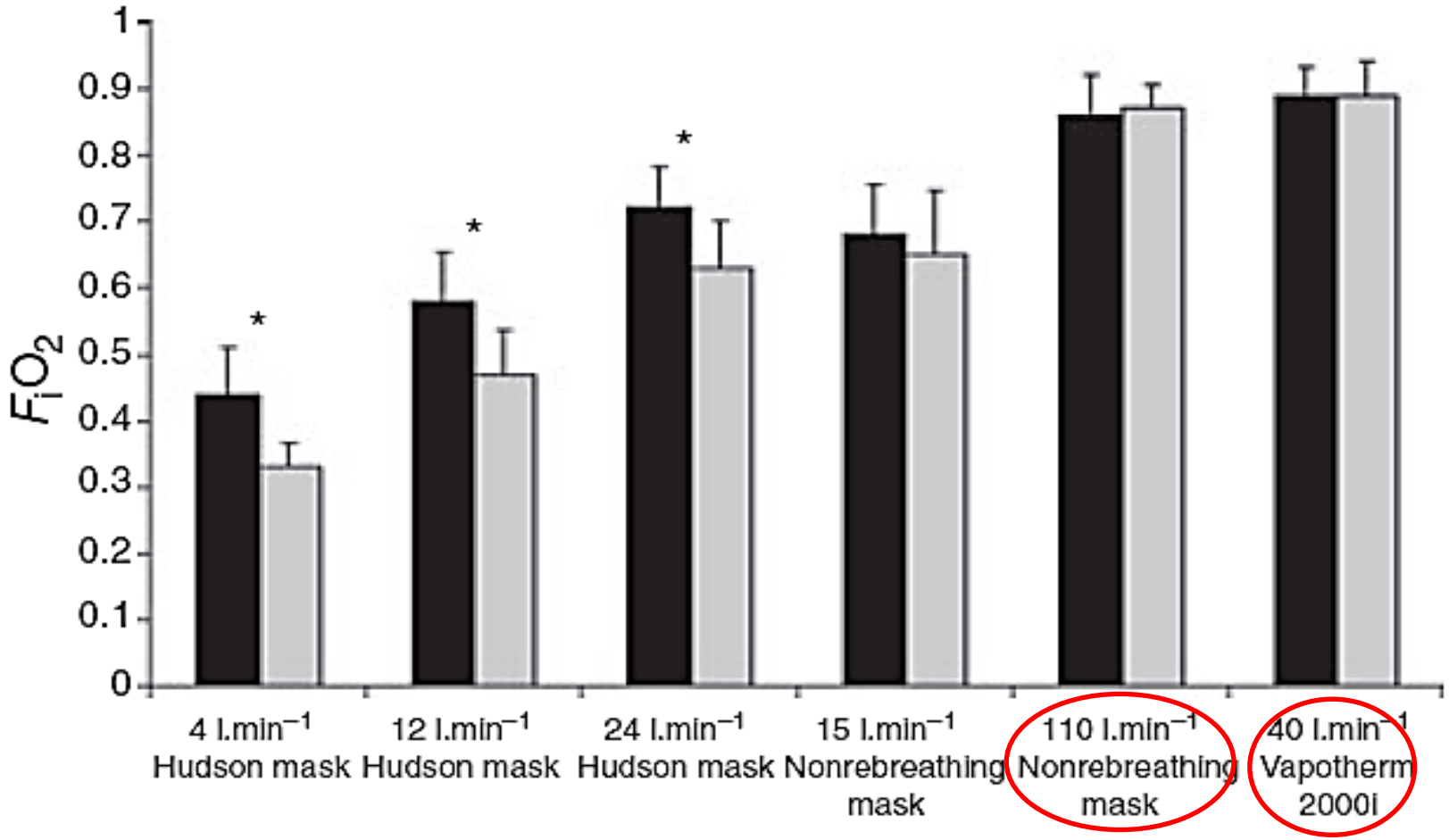
Effet “CPAP”
(recrutement)

Lavage de l’espace
mort des VAS
(diminution VD)

Bonne
humidification
Confort

ONHD : FiO2 élevée

- Sujet sains +/- simulation IRA (bandage thoracique)



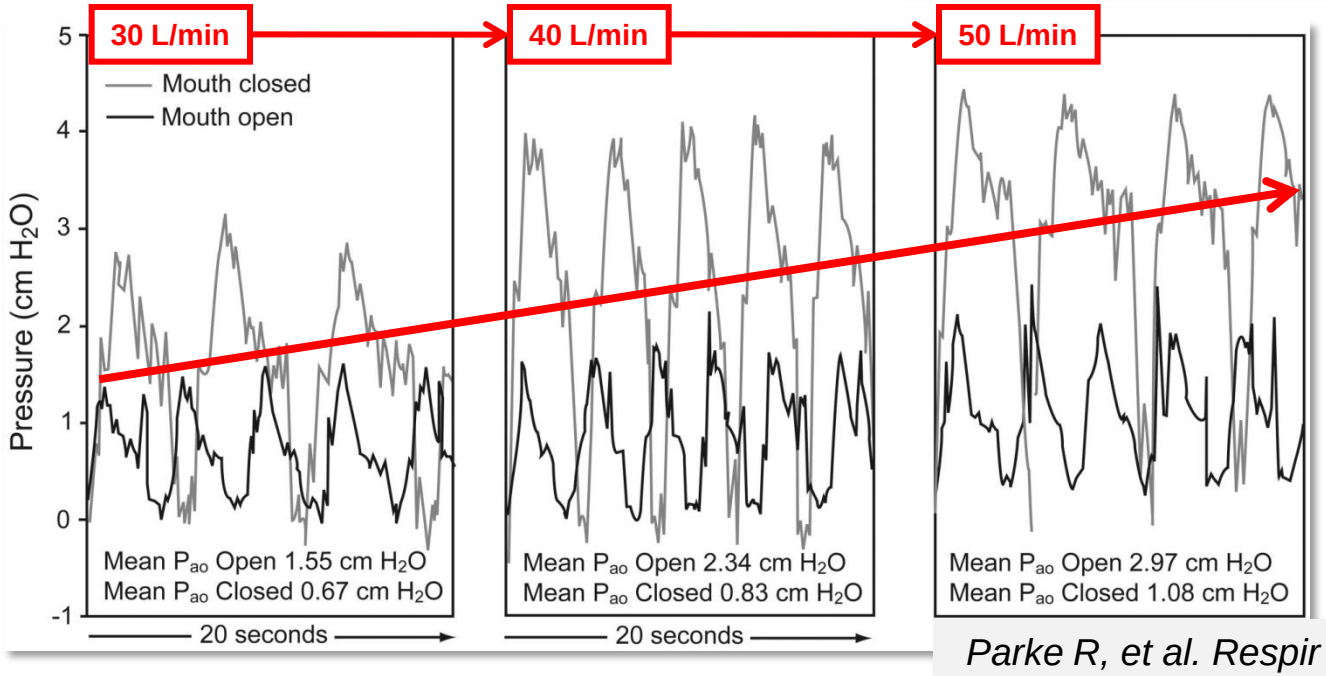
Sim. Anesthesia 2008; 63: 938-40

ONHD : Discret effet “PEP”, débit dépendant

Nasopharyngeal pressure (cmH_2O) [Flow 35 L/min]

	NHF Mouth Closed	NHF Mouth Open	FM Mouth Closed	FM Mouth Open
M	**2.7**	**1.2**	**0.2**	**0.1**
	±	±	±	±
SD	1.0	0.8	0.6	0.4

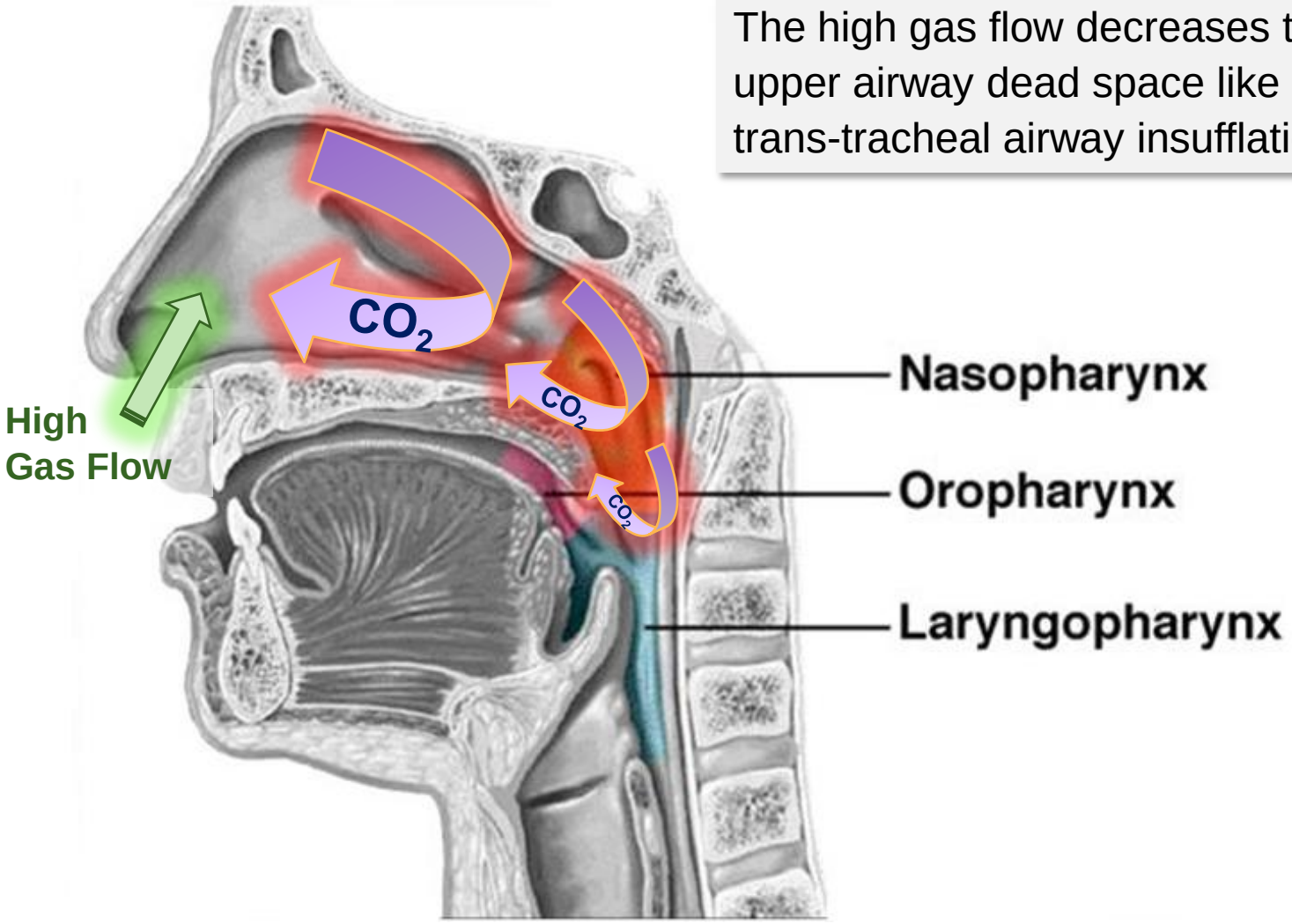
Parke R, et al. Br J Anaest 2009;103:886-890



Parke R, et al. Respir Care 2011;56:1151-5

Effet “lavage” de l’espace mort nasopharyngé

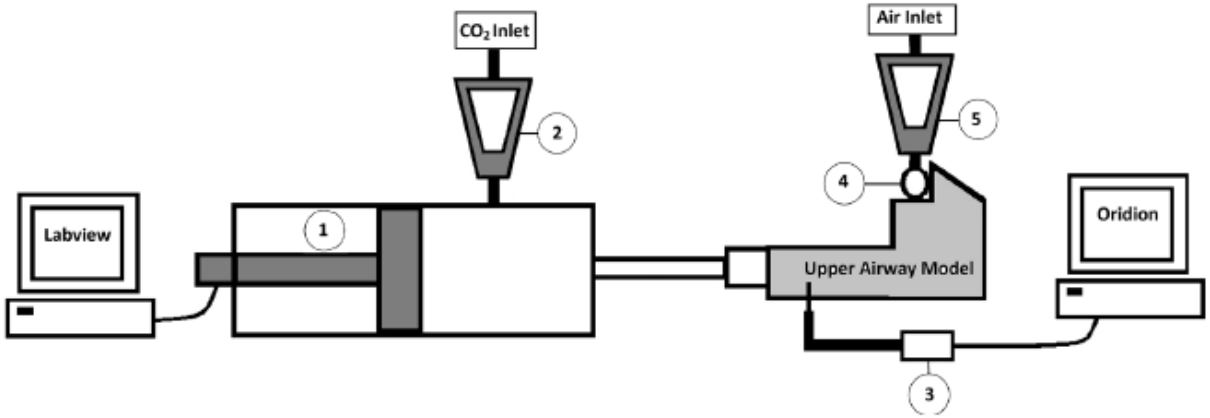
The high gas flow decreases the upper airway dead space like trans-tracheal airway insufflation

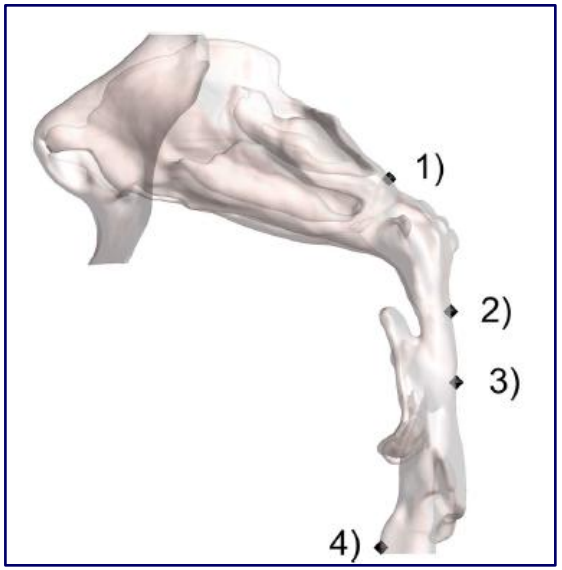


An Experimental and Numerical Investigation of CO_2 Distribution in the Upper Airways During Nasal High Flow Therapy

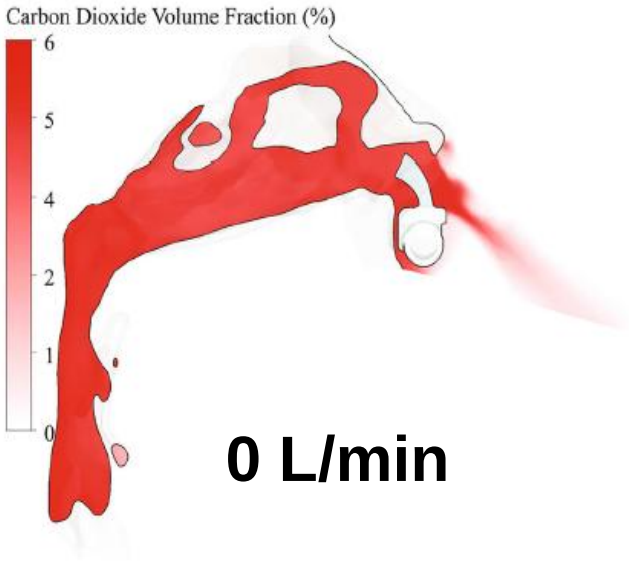
S. C. Van Hove,[1] J. Storey,[1] C. Adams,[2] K. Dey,[2] P. H. Geoghegan,[2] N. Kabaliuk,[2] S. D. Oldfield,[3] C. J. T. Spence,[3] M. C. Jermy,[2] V. Suresh,[1,4] and J. E. Cater[1]

[1]Department of Engineering Science, University of Auckland, Auckland 1142, New Zealand; [2]Department of Mechanical Engineering, University of Canterbury, Christchurch 8041, New Zealand; [3]Fisher and Paykel Healthcare Limited, 15 Maurice Paykel Place, Auckland 2013, New Zealand; and [4]Auckland Bioengineering Institute, University of Auckland, Auckland 1142, New Zealand

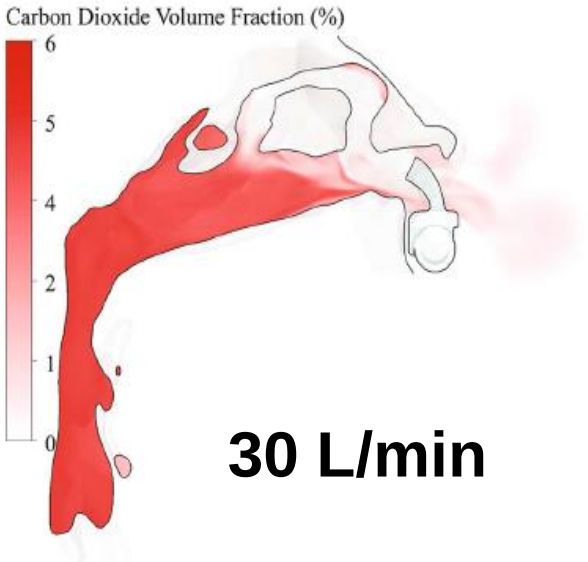




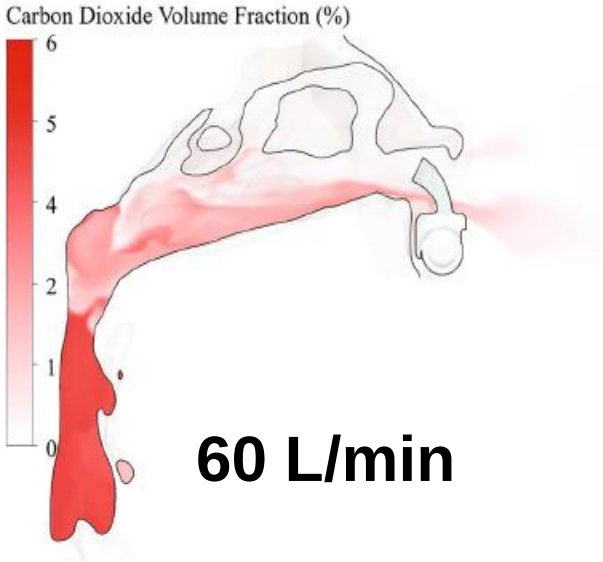
Annals of Biomedical Engineering (© 2016)
DOI: 10.1007/s10439-016-1604-8



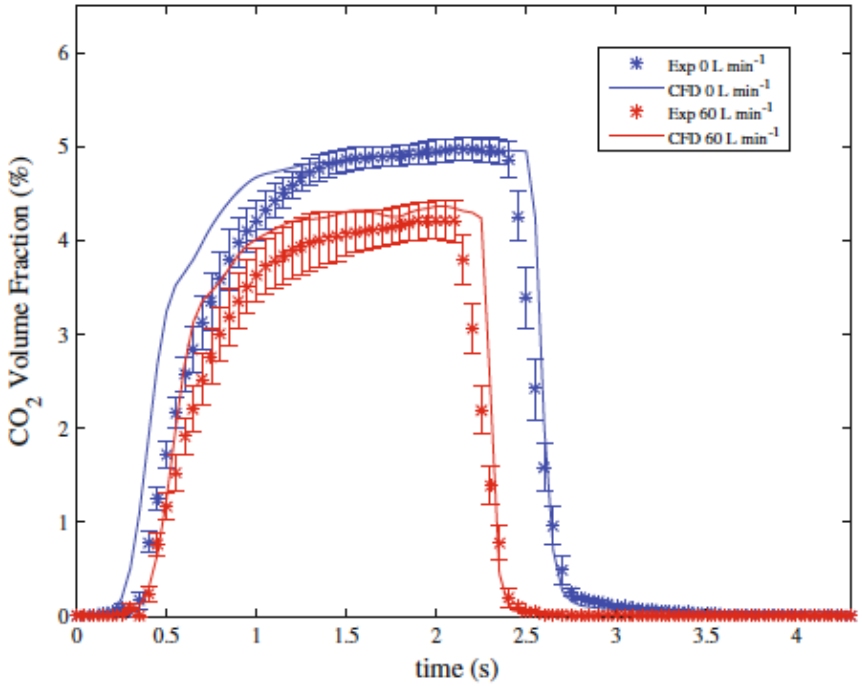
0 L/min

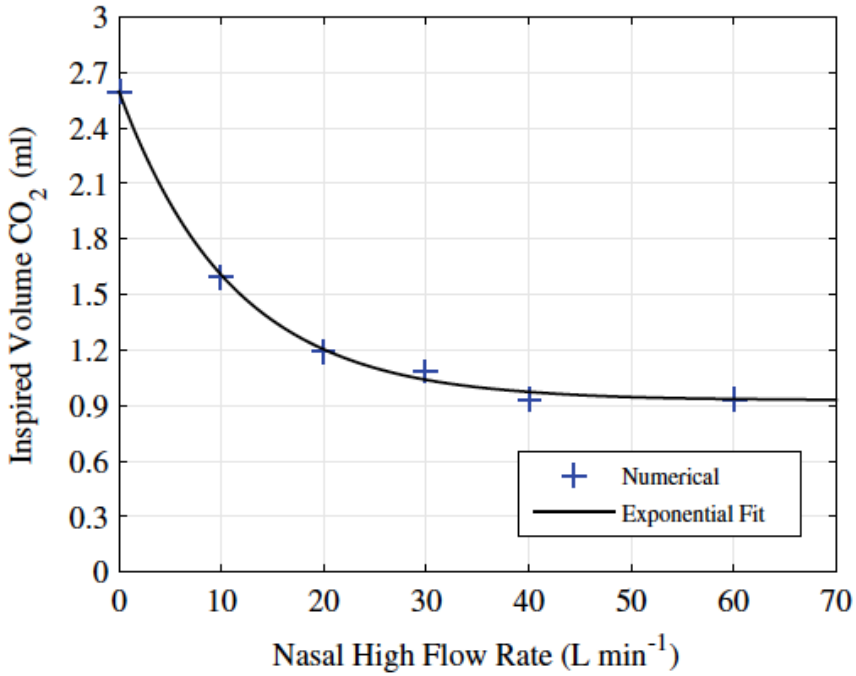


30 L/min



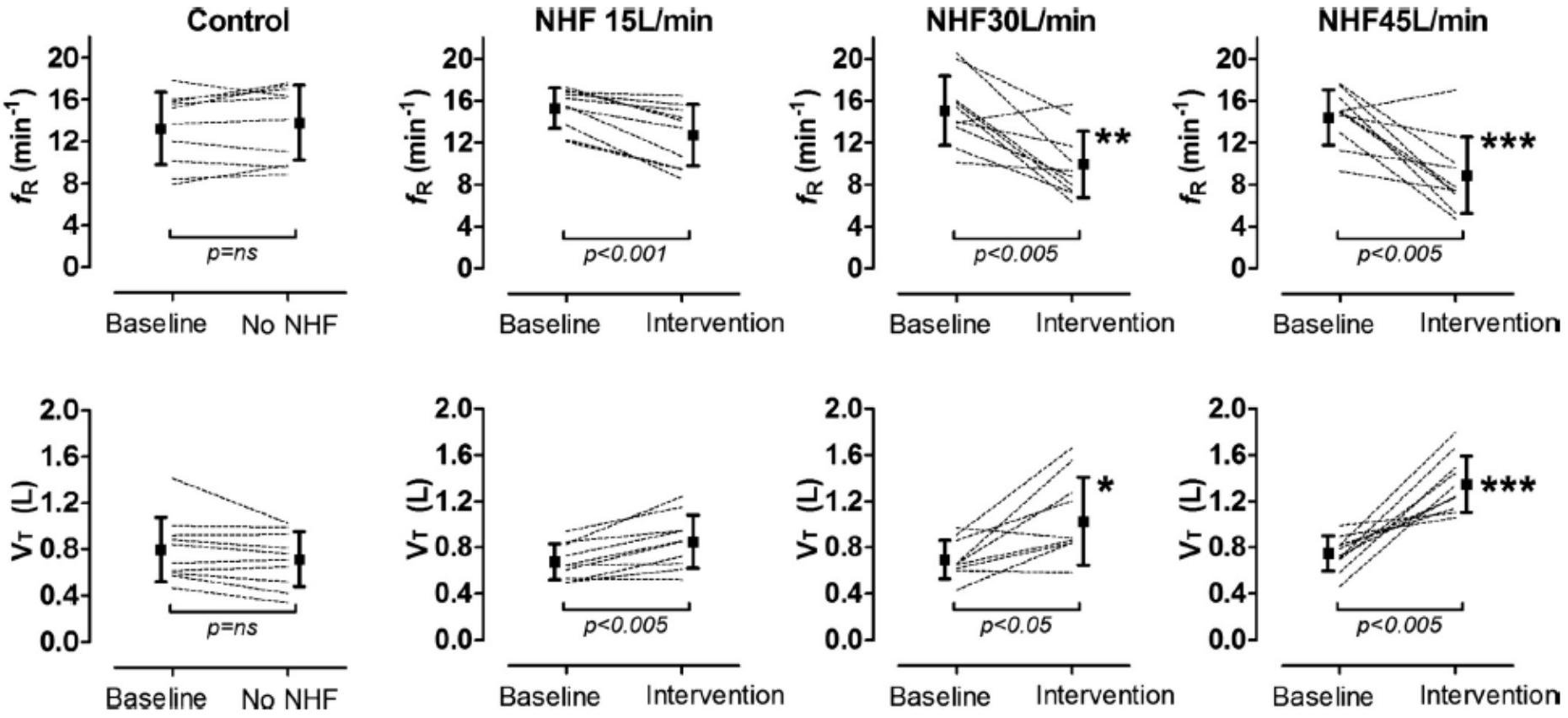
60 L/min





ONHD : Effets physiologiques

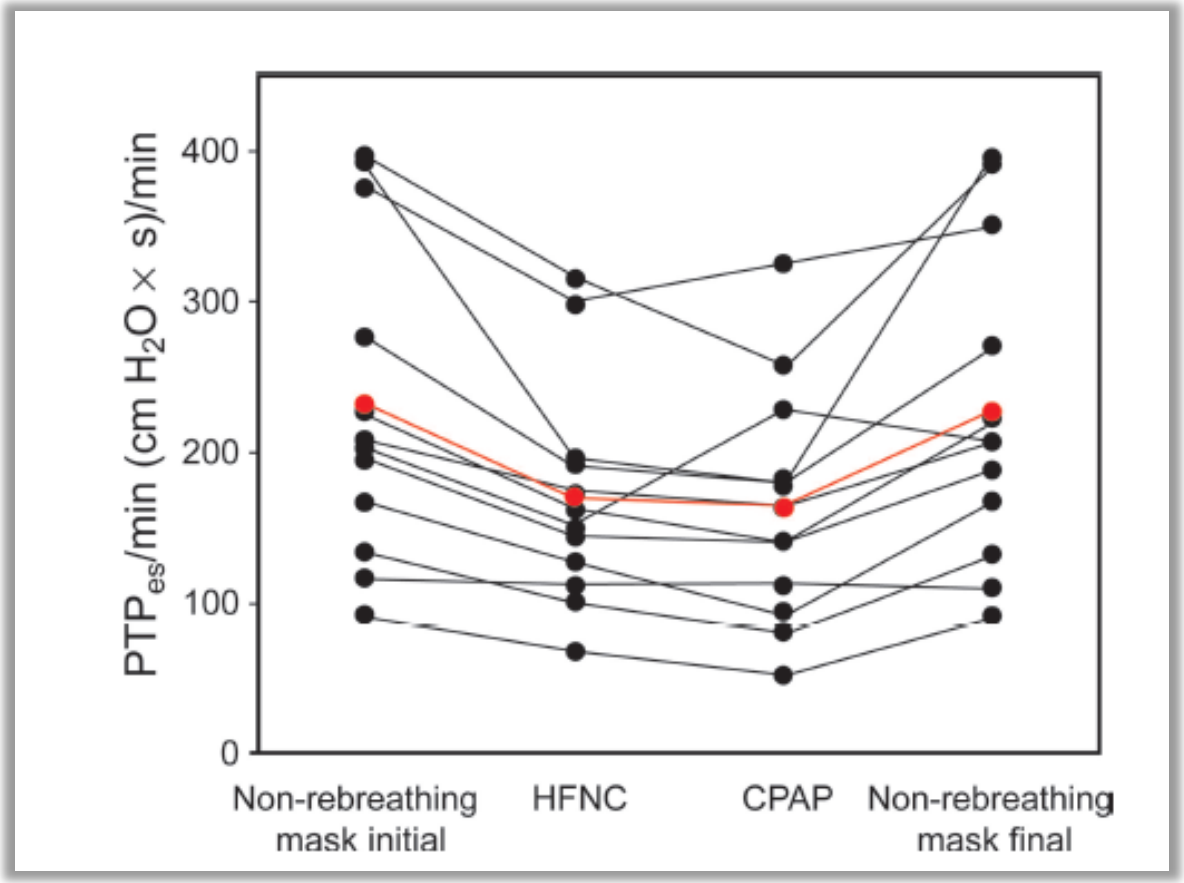
- Sujets sains, repos, éveillés, air (FiO2 21 %)



Mundel T et al. JAP 2013;114:1058-65

Physiologic Effects of High-Flow Nasal Cannula Oxygen in Critical Care Subjects

Frederic Vargas MD PhD, Mélanie Saint-Leger MD, Alexandre Boyer MD PhD, Nam H Bui MD, and Gilles Hilbert MD PhD



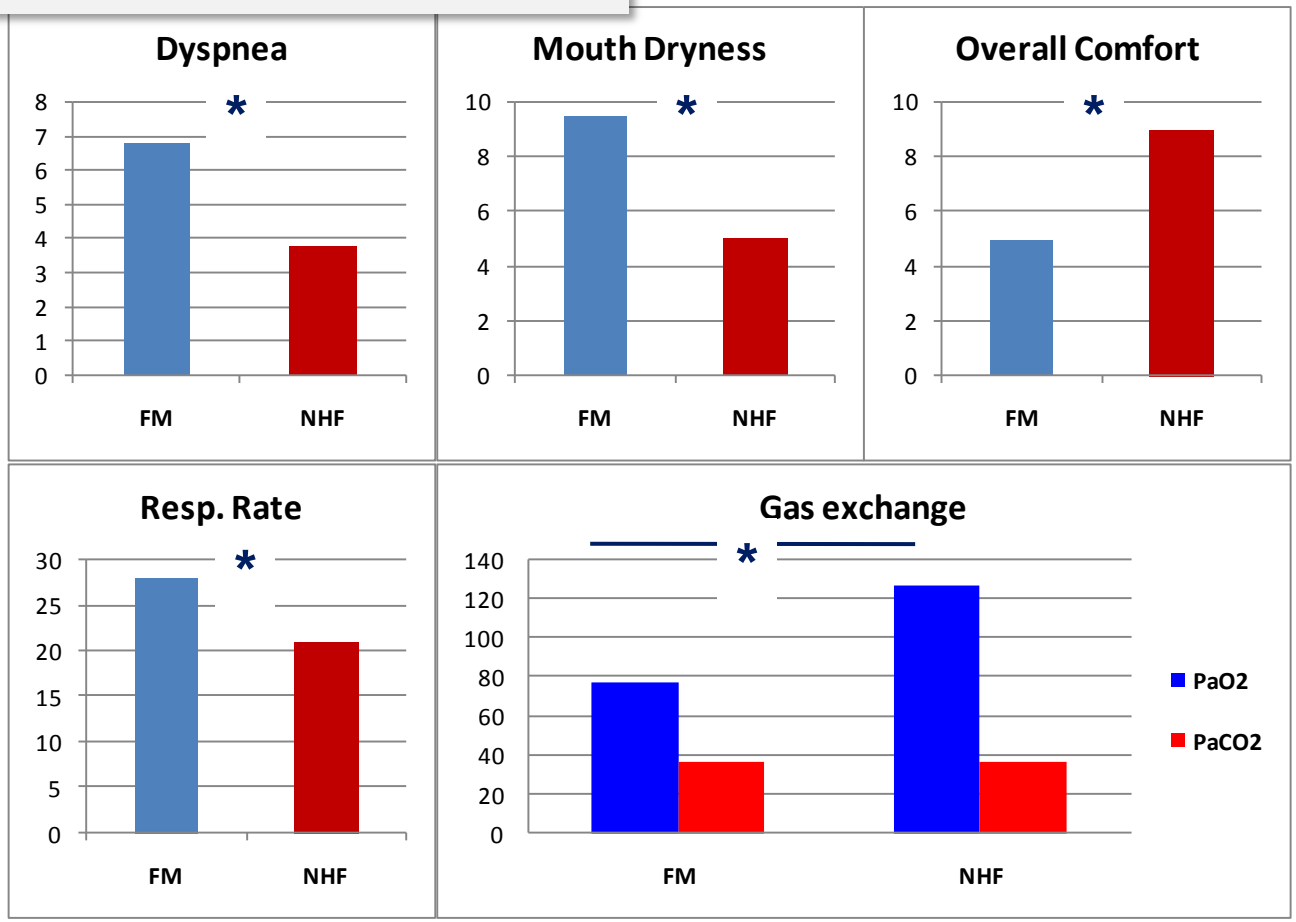
Diminution travail respiratoire

Respir Care 2015;60(10):1369–1376

ONHD vs O2 au masque : confort et oxygénation

20 hypoxemic pts (SpO2<96% with FiO2 50%)

Venturi Mask vs NHF for 30 min



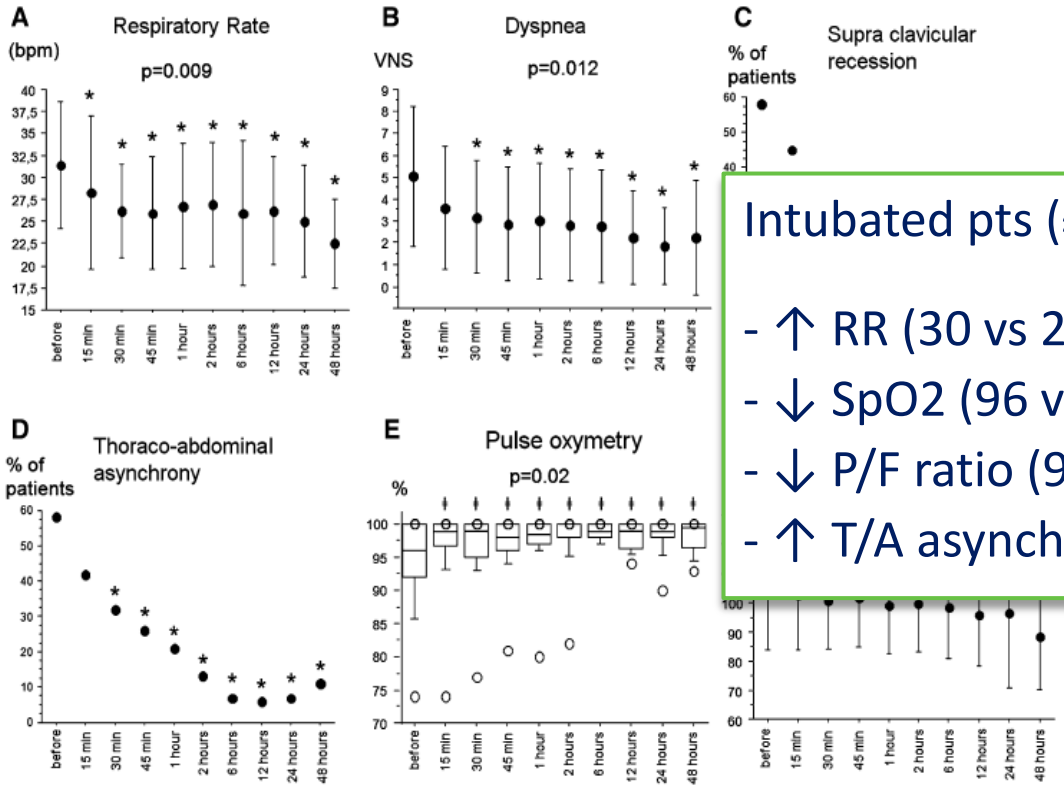
Roca O, et al. Respir Care 2010;55:408-413

ONHD au cours de l'IRA hypoxémique

Benjamin Sztrymf
Jonathan Messika
Fabrice Bertrand
Dominique Hurel
Rusel Leon
Didier Dreyfuss
Jean-Damien Ricard

Beneficial effects of humidified high flow nasal oxygen in critical care patients: a prospective pilot study

38 pts with ARF receiving NHF for 48h; 9 pts (24%) were intubated



Intubated pts (≈ at 1h):

- ↑ RR (30 vs 24 b/m)
- ↓ SpO2 (96 vs 98%)
- ↓ P/F ratio (91 vs 201)
- ↑ T/A asynchrony (75 vs 10% pts)

Sztrymf et al. Intensive Care Med 2011;37:1780–1786

ONHD aux urgences

Humidified High Flow Nasal Oxygen During Respiratory Failure in the Emergency Department: Feasibility and Efficacy

Hugo Lenglet MD, Benjamin Sztrymf MD, Christophe Leroy MD, Patrick Brun MD, Didier Dreyfuss MD, and Jean-Damien Ricard MD PhD

17 pts with hypoxemic ARF & dyspnea

	Before NHF	After 1h NHF
Borg scale	6	3 *
VAS dyspnea	7	3 *
RR, b/min	28	25 *
SpO2, %	90	97 *

NHF is feasible in the ED, and it alleviated dyspnea and improved respiratory parameters in subjects with hypoxemic ARF

Lenglet H et al. Respir Care 2012;57:1873–1878

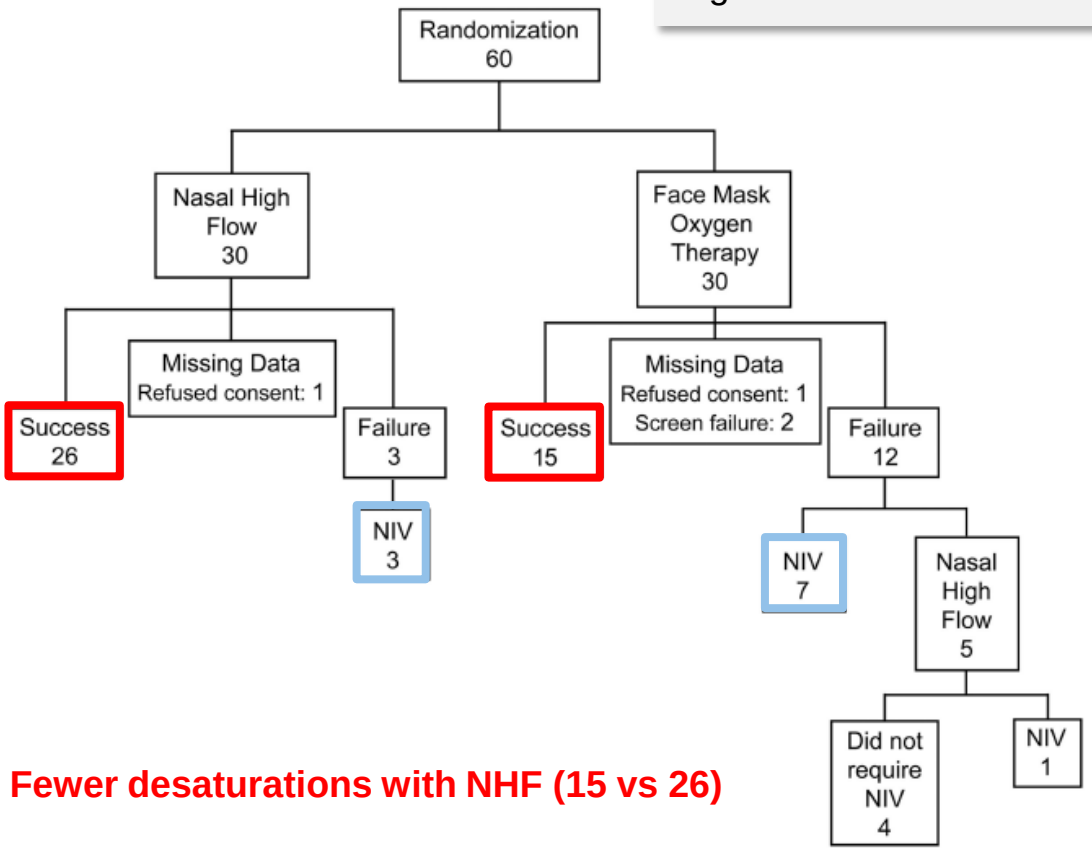
ONHD et IRA : taux de succès

A Preliminary Randomized Controlled Trial to Assess Effectiveness of Nasal High-Flow Oxygen in Intensive Care Patients

Rachael L Parke MHSc, Shay P McGuinness,

60 pts with mild to moderate hypoxemic ARF

High-flow face mask vs NHF for 24 h



Fewer desaturations with NHF (15 vs 26)

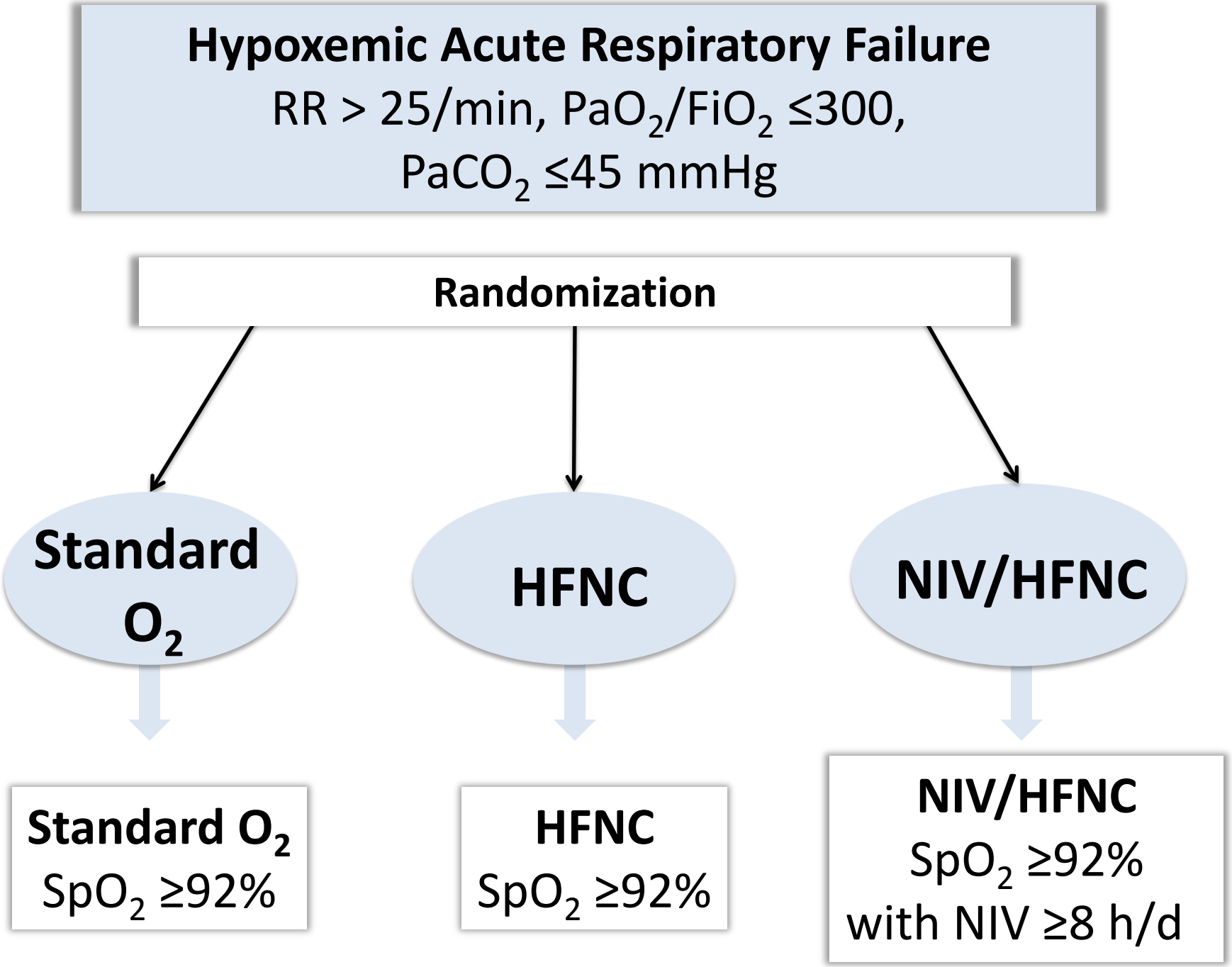
Parke R, et al. Respir Care 2011;56:265-70

ORIGINAL ARTICLE

High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure

Jean-Pierre Frat, M.D., Arnaud W. Thille, M.D., Ph.D., Alain Mercat, M.D., Ph.D., Christophe Girault, M.D., Ph.D., Stéphanie Ragot, Pharm.D., Ph.D., Sébastien Perbet, M.D., Gwénael Prat, M.D., Thierry Boulain, M.D., Elise Morawiec, M.D., Alice Cottereau, M.D., Jérôme Devaquet, M.D., Saad Nseir, M.D., Ph.D., Keyvan Razazi, M.D., Jean-Paul Mira, M.D., Ph.D., Laurent Argaud, M.D., Ph.D., Jean-Charles Chakarian, M.D., Jean-Damien Ricard, M.D., Ph.D., Xavier Wittebole, M.D., Stéphanie Chevalier, M.D., Alexandre Herbland, M.D., Muriel Fartoukh, M.D., Ph.D., Jean-Michel Constantin, M.D., Ph.D., Jean-Marie Tonnelier, M.D., Marc Pierrot, M.D., Armelle Mathonnet, M.D., Gaëtan Béduneau, M.D., Céline Delétage-Métreau, Ph.D., Jean-Christophe M. Richard, M.D., Ph.D., Laurent Brochard, M.D., and René Robert, M.D., Ph.D., for the FLORALI Study Group and the REVA Network*

DOI: 10.1056/NEJMoa1503326


Hypoxemic Acute Respiratory Failure
RR > 25/min, PaO_2/FiO_2 ≤300,
$PaCO_2$ ≤45 mmHg
Randomization
Standard O_2
HFNC
NIV/HFNC
Standard O_2
SpO_2 ≥92%
HFNC
SpO_2 ≥92%
NIV/HFNC
SpO_2 ≥92%
with NIV ≥8 h/d

FLORALI trial

Inclusion criteria:

Hypoxemic Acute Respiratory Failure

RR > 25/min ; PaO_2/FiO_2 ≤300 mmHg,

$PaCO_2$ ≤45 mmHg

inspired fraction of oxygen (FiO2) determined by a portable oxygen analyzer

FLORALI trial

Exclusion criteria:

- $PaCO_2$ > 45 mmHg
- NIV contraindications
- urgent need for intubation
- Exacerbation of chronic respiratory insufficiency
- cardiogenic pulmonary edema
- shock
- Glasgow coma score <12
- neutropenia (<500/mm^3)

FLORALI trial

Pre-determined criteria for intubation

Glasgow coma score <12

Hemodynamic instability

Respiratory failure*

≥2 criteria:

– RR > 40/min
– copious tracheal secretions
– acidosis with pH <7.35
– SpO_2 <90% for more than 5 min
– intolerance to NIV

FLORALI trial

Primary outcome:

intubation rate

Main secondary outcomes:

- **in-ICU and day-90 mortality**
- number of invasive ventilator-free days at D28
- length of ICU stay
- Complications

Characteristics of patients

Characteristics at inclusion	Oxygen Group (n=94)	HFNC Group (n=106)	NIV/HFNC Group (n=110)
Age – yr	59±17	61±16	61±17
Male sex – no. (%)	63 (67.0)	75 (70.7)	74 (67.3)
Body-mass index	26±5	25±5	26±6
SAPS II at inclusion	24±9	25±9	27±9
SOFA score at inclusion	3.6±1.8	3.7±2.0	4.2±2.1
Preexisting cardiac failure - no. (%)	4 (4.3)	8 (7.5)	8 (7.3)
Immunodeficiency – no. (%):	30 (31.9)	26 (24.5)	26 (23.6)
Liver cirrhosis – no. (%)	5 (5.3)	6 (5.7)	5 (4.5)
Smoker – no. (%)	36 (38.3)	34 (32.1)	40 (36.4)
Reason for acute respiratory failure, no. (%)			
Community-acquired pneumonia	57 (60.6)	71 (67.0)	69 (62.7)
Hospital acquired pneumonia	13 (13.8)	12 (11.3)	12 (10.9)
other	24 (25.5)	23 (21.7)	29 (26.4)
Bilateral pulmonary infiltrates – no. (%)	80 (85.1)	79 (74.5)	85 (77.3)

Characteristics of patients (2)

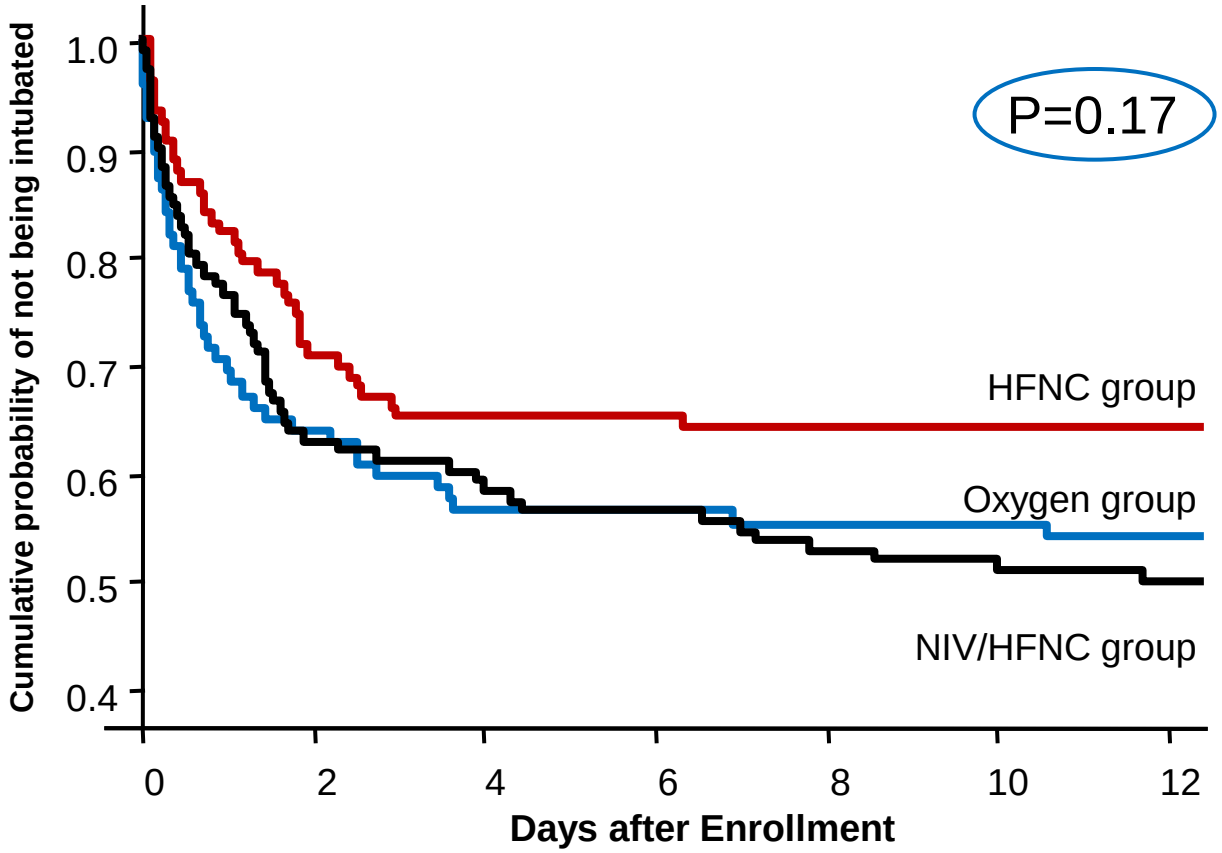
Characteristics at inclusion	Oxygen Group (n=94)	HFNC Group (n=106)	NIV/HFNC group (n=110)
Clinical parameters			
Respiratory rate - breath/min	32±6	33±6	33±7
Heart rate - beats/min	104±16	106±21	106±21
Systolic arterial pressure – mmHg	130±22	127±24	128±21
Mean arterial pressure – mmHg	89±15	87±17	86±16
Arterial blood gas			
pH	7.44±0.06	7.43±0.06	7.43±0.06
PaO_2 – mmHg	91±33	85±31	90±35
FiO_2	0.66±0.12	0.66±0.13	0.64±0.14
PaO_2:FiO_2 ratio– mmHg	146±53	137±56	150±62
$PaCO_2$ – mmHg	35±5	36±6	34±6

Respiratory comfort and gas exchanges

	Oxygen group (n=74)	HFNC group (n=86)	NIV/HFNC group (n=91)	P Value
Respiratory patient-discomfort at inclusion – mm	44±29	38±31	46±30	0.20
Respiratory patient-discomfort at H1– mm	40±29	29±26	43±29	<0.01
Grade of dyspnea at H1				<0.001
Marked improvement – no. (%)	5 (6.8)	19 (22.1)	13 (14.3)	
Slight improvement– no. (%)	26 (35.1)	46 (53.5)	40 (44.0)	
No change– no. (%)	33 (44.6)	18 (20.9)	23 (25.3)	
Slight deterioration – no. (%)	9 (12.2)	3 (3.5)	8 (8.8)	
Marked deterioration – no. (%)	1 (1.3))	0 (0.0)	7 (7.7)	
Respiratory rate at H1 – cycles/min	31±7	28±7	31±8	<0.01
PaO_2 at H1– mm Hg	91±32	106±66	118±72	<0.05
PaO_2:FiO_2ratio at H1 – mm Hg	146±69	133±73	183±83	<0.001

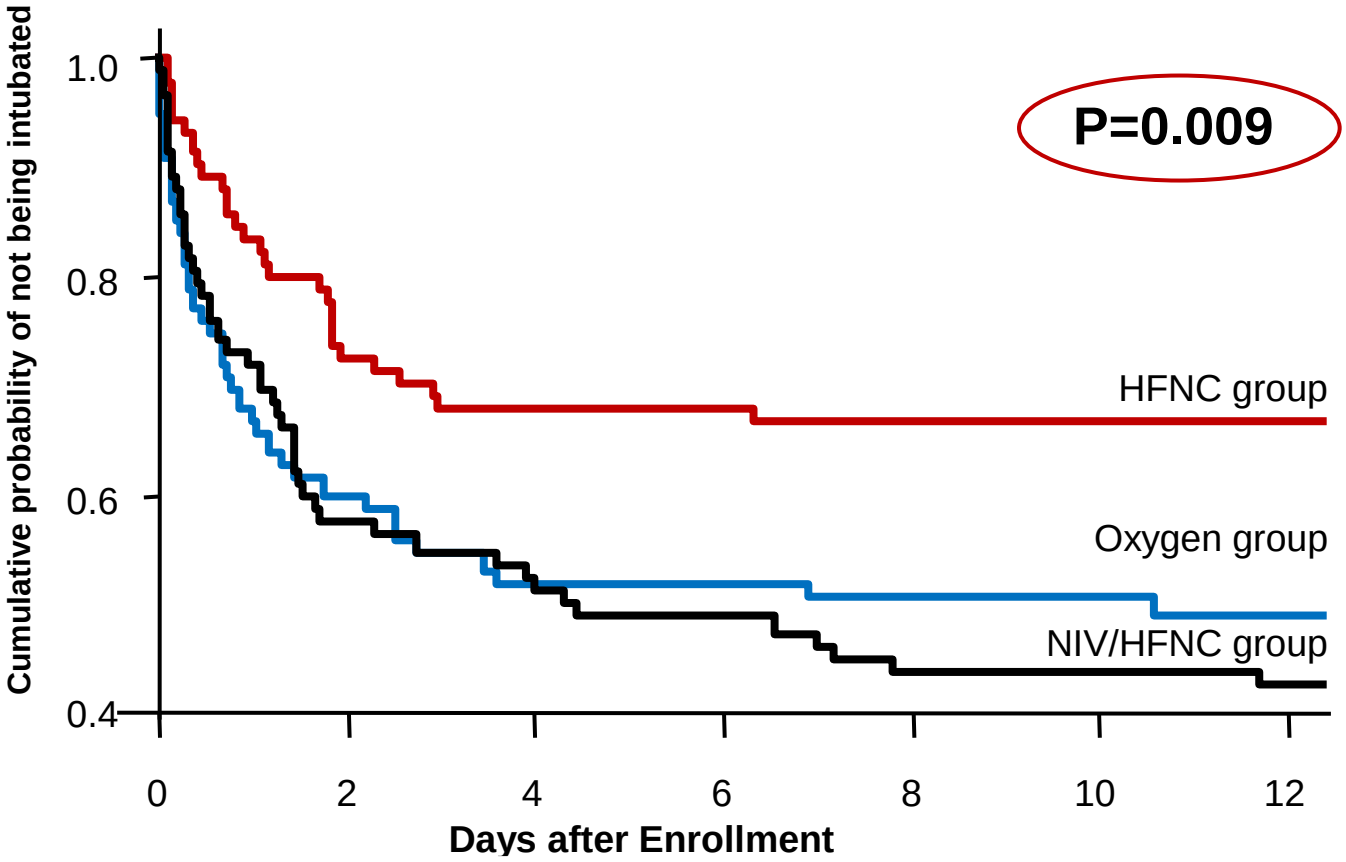
Primary outcome: Intubation rate

	Oxygen group (n=94)	HFNC group (n=106)	NIV/HFNC group (n=110)	P Value
Intubation – no. (%)	44 (46.8)	40 (37.7)	55 (50.0)	0.17
Interval between baseline and intubation – hours	15 [5-39]	27 [8-46]	27 [8-53]	0.27



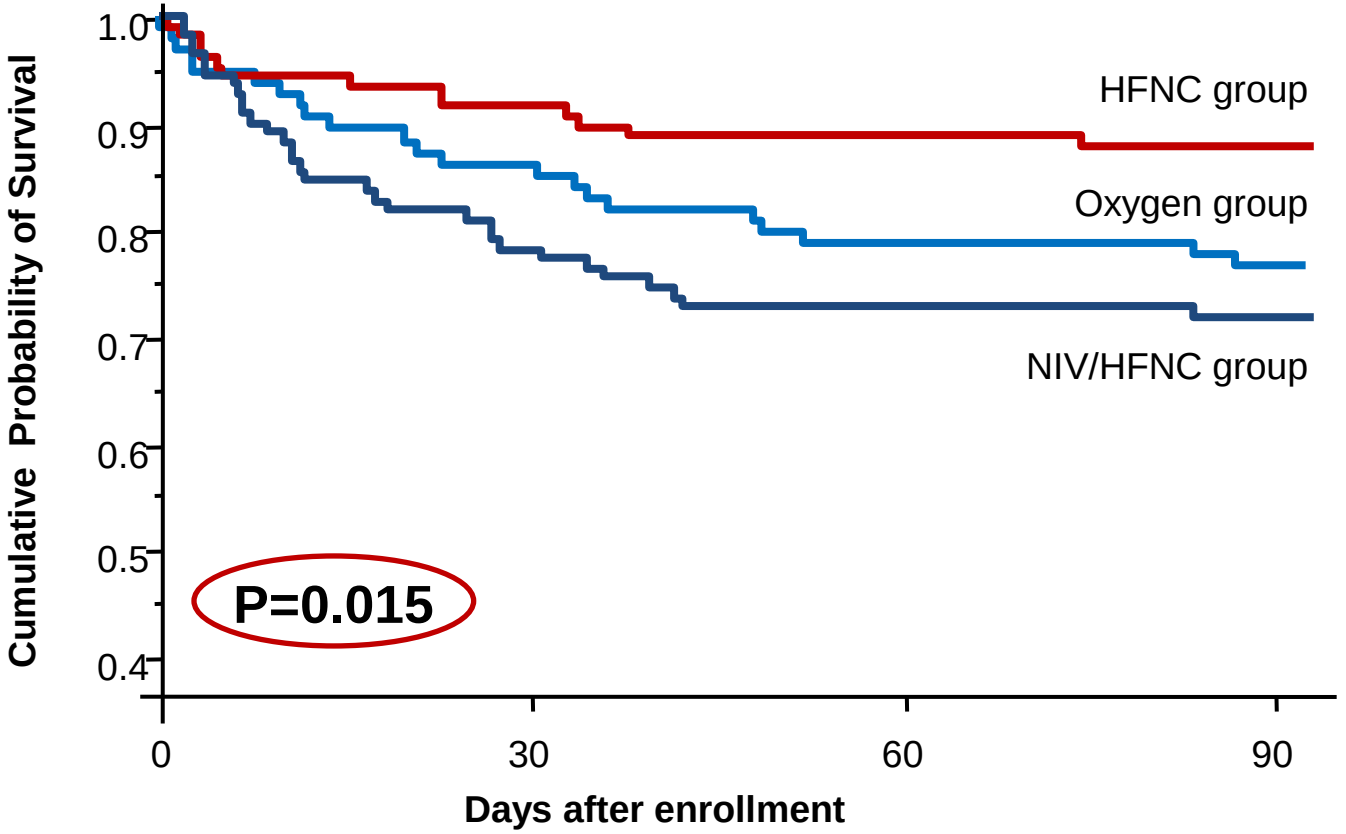
Intubation rate in patients with P/F ≤200 (n=238)

	Oxygen group (n=74)	HFNC group (n=83)	NIV/HFNC group (n=81)	P Value
Intubation – no. (%)	39 (52.7)	29 (34.9)	47 (58.0)	<0.01



Secondary outcomes:
in-ICU mortality, day 90 mortality, Day 28 VFD

	Oxygen group (n=94)	HFNC group (n=106)	NIV/HFNC group (n=110)	P Value
ICU mortality – no. (%)	18 (19.1)	12 (11.3)	27 (24.5)	<0.05
Mortality at day 90– no. (%)	22 (23.4)	13 (12.3)	31 (28.2)	<0.05
Ventilator-free days at day 28 – day	22±10	24±8	19±12	<0.05



Effet délétère de la VNI : Vt ?

	a-OR for Intubation	a-OR for ICU mortality	a-HR for 90-day mortality
Age, per year	1•1 [1•0-1•1], P=0•008	1•1 [1•0-1•1], P=0•002	1•0 [1•0-1•1], P=0•003
Use of NIV	4.4 •4 [1•4-14], P=0•013	4.2 2 [1•3-13•5], P=0•016	3.3 3 [1•2-5•0], P=0•01

Vt patients intubé : **11.1** ml/kg

Vt patients non intubés : 7.6 ml/kg

ONHD au cours de l'intubation

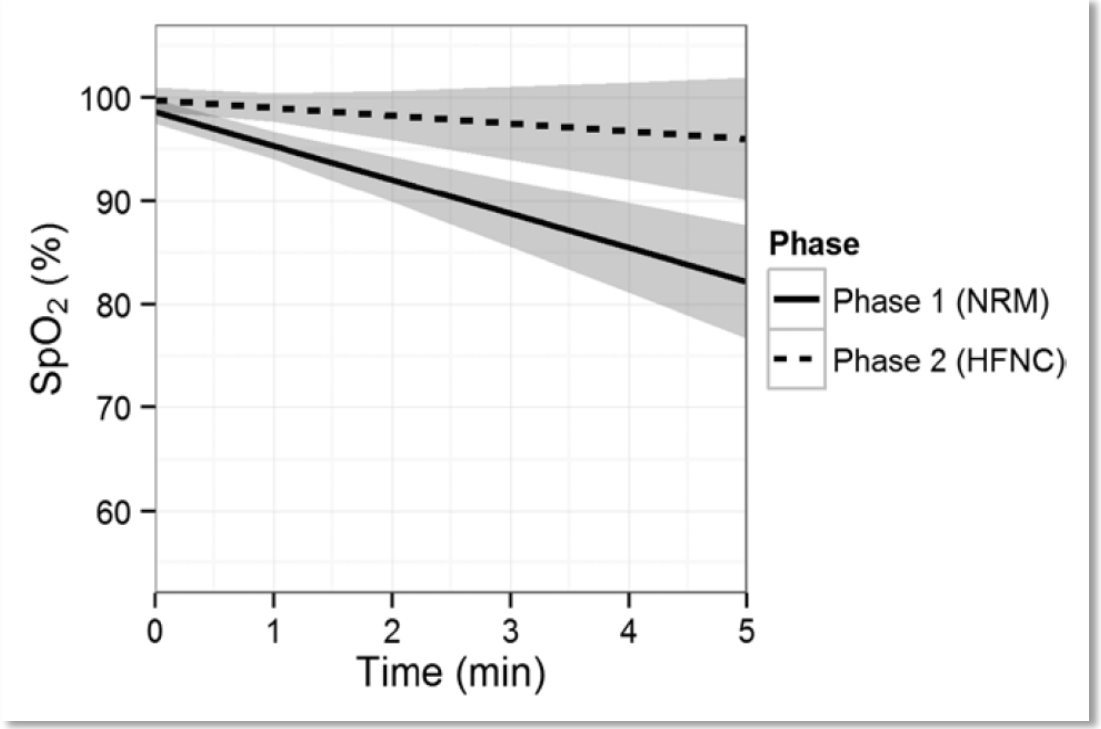
Use of High-Flow Nasal Cannula Oxygen Therapy to Prevent Desaturation During Tracheal Intubation of Intensive Care Patients With Mild-to-Moderate Hypoxemia*

Romain Miguel-Montanes, MD[1]; David Ha
Stéphane Gaudry, MD[1,3,4]; Cédric Rafat, M
Sylvain Jean-Baptiste, MD[1]; Alexandre Be
Jean-Damien Ricard, MD, PhD[1,3,4]

- Before-after study
- 101 ICU pts needing intubation: 50 NRM, 51 NHF

Severe desaturation (<80%):

- 14% NRM vs 2% NHF



Miguel-Montanes et al. Crit Care Med 2015;43:574–583

ONHD au cours de l'intubation

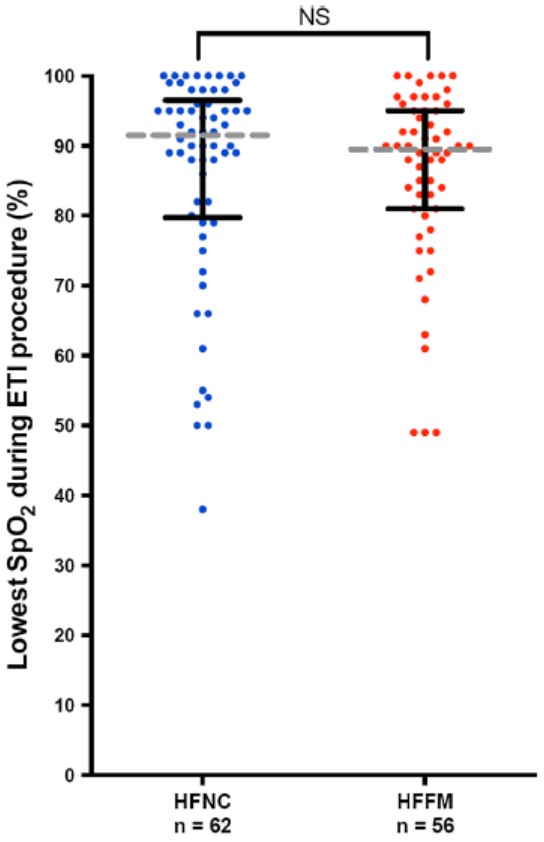
Mickaël Vourc'h
Pierre Asfar
Christelle Volteau
Konstantinos Bachoumas
Noëmie Clavieras
Pierre-Yves Egreteau
Karim Asehnoune
Alain Mercat
Jean Reignier
Samir Jaber
Gwenaël Prat
Antoine Roquilly
Noëlle Brule
Daniel Villers
Cédric Bretonniere
Christophe Guitton

High-flow nasal cannula oxygen during endotracheal intubation in hypoxemic patients: a randomized controlled clinical trial

- RCT : NHF vs O2 mask, hypoxemic ARF (P/F < 300, RR > 30)
- 119 pts (62 / 57)

Severe complications related to ETI :

- 58 % HFNC vs 67 % HFFM (p = 0.33)

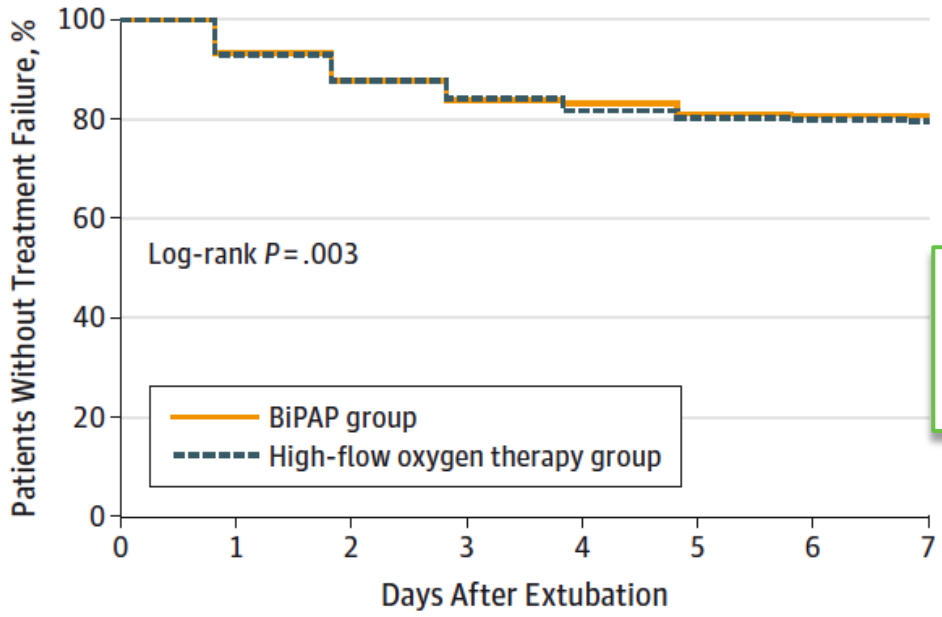


Intensive Care Med 2015;41:1538-48

ONHD et IRA post chirurgie cardiothoracique

High-Flow Nasal Oxygen vs Noninvasive Positive Airway Pressure in Hypoxemic Patients After Cardiothoracic Surgery
A Randomized Clinical Trial

François Stéphan, MD, PhD; Benoit Barrucand, MD; Pascal Petit, MD; Saida Rézaiguia-Delclaux, MD; Anne Médard, MD; Bertrand Delannoy, MD; Bernard Cosserant, MD; Guillaume Flicoteaux, MD; Audrey Imbert, MD; Catherine Pilorge, MD; Laurence Bérard, MD; for the BiPOP Study Group



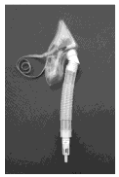
No. at risk								
BiPAP	416	385	363	348	339	333	331	329
High-flow oxygen therapy	414	385	361	346	342	334	333	331

In ICU mortality :

- 6.8 % % HFNO vs 5.5 % NIV (p = 0.66)

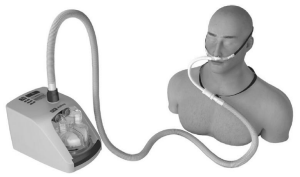
Stephan et al. JAMA 2015;313:2331-39

ONHD post-extubation



Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation

Effects on Oxygenation, Comfort, and Clinical Outcome



Salvatore Maurizio Maggiore[1], Francesco Antonio Idone[1], Rosanna Vaschetto[2], Rossano Festa[1], Andrea Cataldo[1], Federica Antonicelli[1], Luca Montini[1], Andrea De Gaetano[3], Paolo Navalesi[4,5,6], and Massimo Antonelli[1]

With NHF:

- Fewer pts with interface displacements (32% vs 56%, p=0.01)
- Fewer pts with oxygen desaturations (40% vs 75%, p<0.01)

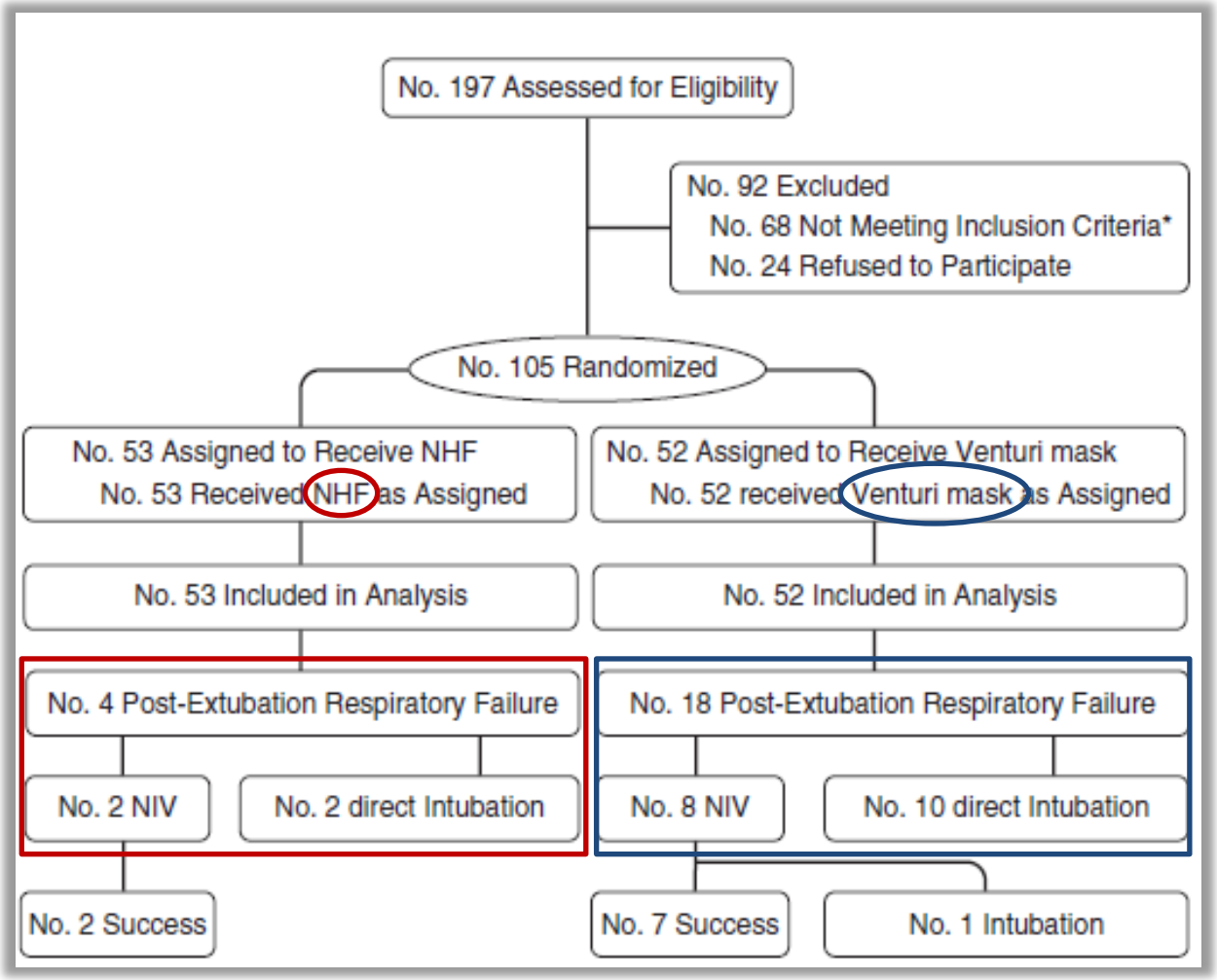
	Control Group (*n* = 52)	NHF (*n* = 53)	*P* Value
Noninvasive ventilation, n (%)	8 (15.4)	2 (3.8)	0.042
Endotracheal intubation, n (%)	11 (21.2)	2 (3.8)	0.005
Cause of endotracheal intubation			
Hypercapnia with respiratory acidosis, n (%)	0	0	N/A
Changes in mental status, n (%)	1 (1.9)	1 (1.9)	0.989
→ Oxygen desaturation or hypoxia, n (%)	6 (11.5)	1 (1.9)	0.047
Unbearable dyspnea with respiratory muscle failure, n (%)	4 (7.7)	1 (1.9)	0.162
Persistent hypotension, n (%)	2 (3.8)	0	0.149
→ Inability to clear secretions, n (%)	6 (11.5)	1 (1.9)	0.047

Maggiore SM et al. AJRCCM 2014;190:282-288

Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation

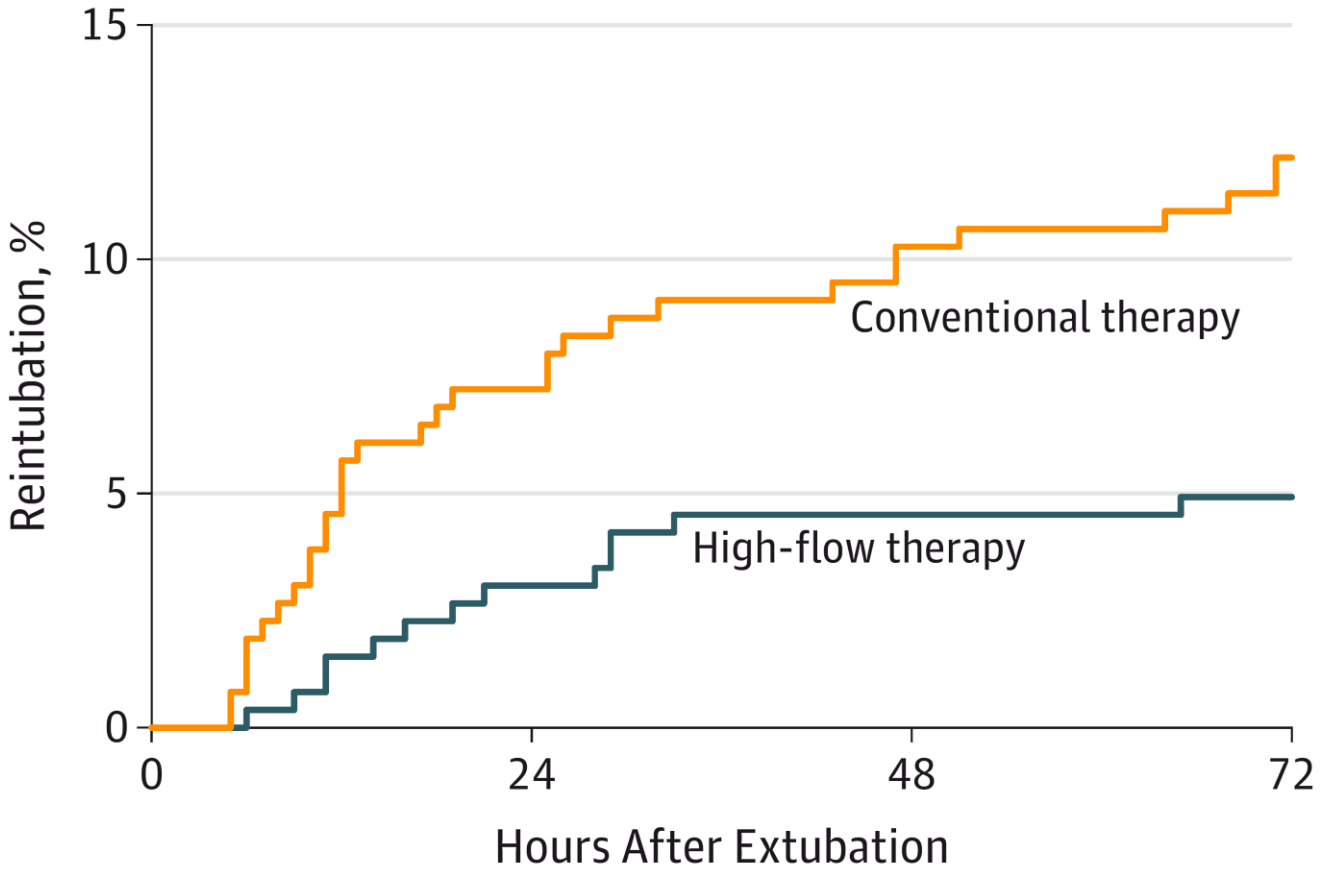
Effects on Oxygenation, Comfort, and Clinical Outcome

Salvatore Maurizio Maggiore[1], Francesco Antonio Idone[1], Rosanna Vaschetto[2], Rossano Festa[1], Andrea Cataldo[1], Federica Antonicelli[1], Luca Montini[1], Andrea De Gaetano[3], Paolo Navalesi[4,5,6], and Massimo Antonelli[1]



Effect of Postextubation High-Flow Nasal Cannula vs Conventional Oxygen Therapy on Reintubation in Low-Risk Patients

A Randomized Clinical Trial



Hernandez. JAMA. 2016 Apr 5;315:1354-61

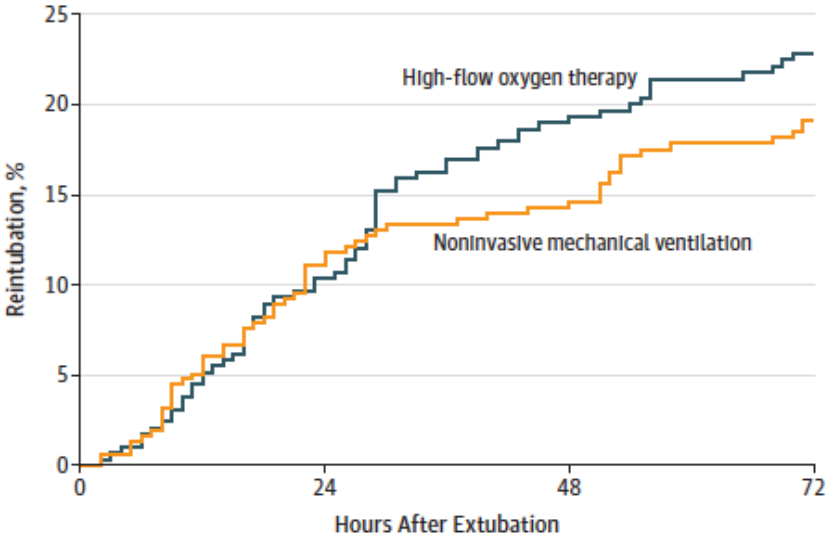
JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

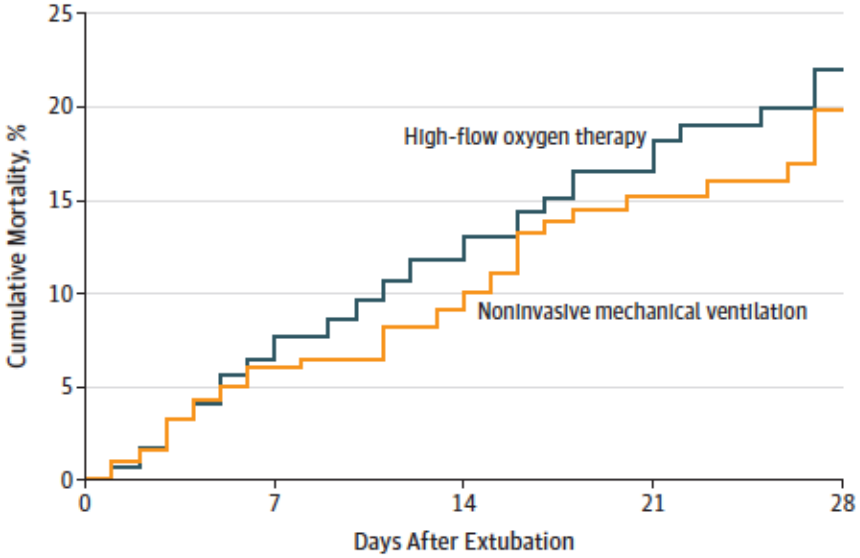
Effect of Postextubation High-Flow Nasal Cannula vs Noninvasive Ventilation on Reintubation and Postextubation Respiratory Failure in High-Risk Patients

A Randomized Clinical Trial

Gonzalo Hernández, MD, PhD; Concepción Vaquero, MD; Laura Colinas, MD; Rafael Cuena, MD; Paloma González, MD; Alfonso Canabal, MD, PhD; Susana Sanchez, MD; Maria Luisa Rodriguez, MD; Ana Villasclaras, MD; Rafael Fernández, MD, PhD

	No. (%)		
	Noninvasive Mechanical Ventilation (n = 314)	High-Flow Conditioned Oxygen Therapy (n = 290)	Difference Between Groups (95% CI)[a]
Primary outcome			
All-cause reintubation[b]	60 (19.1)	66 (22.8)	−3.7 (−9.1 to ∞)[c]
Postextubation respiratory failure[b]	125 (39.8)	78 (26.9)	12.9 (6.6 to ∞)[c]





JAMA. 2016;316(15):1565-1574.

Oxygénothérapie nasale à haut débit

- Technique d'oxygénation performante d'utilisation simple
- Plusieurs effets physiologiques potentiellement bénéfiques mais individuellement d'ampleur assez modeste
- Bénéfice indiscutable en termes de confort
- Méthode intéressante d'oxygénothérapie dans IRA hypoxémiques
- Possible supériorité par rapport à la VNI dans l'IRA hypoxémique
- Intérêt probablesdans les suites de l'extubation