Oxygénothérapie à haut débit (vs. VNI) en réanimation
Etat des connaissances

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Aucun conflit d'intérêt !

Dispositifs médicaux disponibles

Non Humidifié - Non Réchauffé
Contrôle FiO2 peu précis

Humidification - Réchauffement
Contrôle FiO2 précis


Sonde nasale
0.5 à 6 l/min


Canule nasale


Masque facial
Max 10 l/min


MHC
Max 15 l/min


OHD
35 à 60 l/min


VNI ou CPAP


Intubation

Plan

- Effets physiologiques – Tolérance
- HFNC dans l'IRA
- HFNC en post-extubation
  - En réanimation
  - En post-op
- HFNC en pré-intubation

HFNC (high-flow nasal cannula) = OHD (oxygène à haut débit)

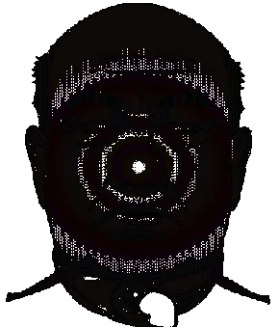
Effets physiologiques - Tolérance

OHD = Oxygénothérapie à Haut Débit
effets physiologiques

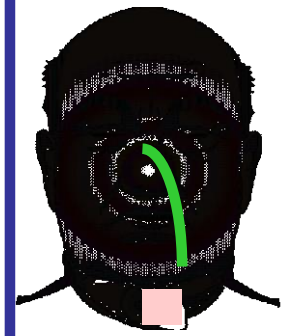
1. Effet de l'OHD sur la FiO2
2. Effet de l'OHD sur les pressions des voies aériennes (VA)
    - Amélioration des échanges gazeux
    - Amélioration du confort
    - Diminution du travail inspiratoire
3. Conditionnement des Gaz (humidification et réchauffement)
4. « Lavage » de l'espace mort naso-pharyngé

Systèmes d'oxygénothérapie

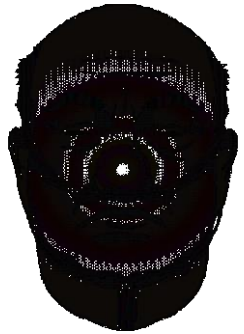
Trachéotomie



Sonde nasale



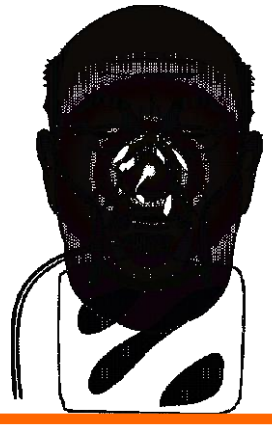
Lunettes nasales



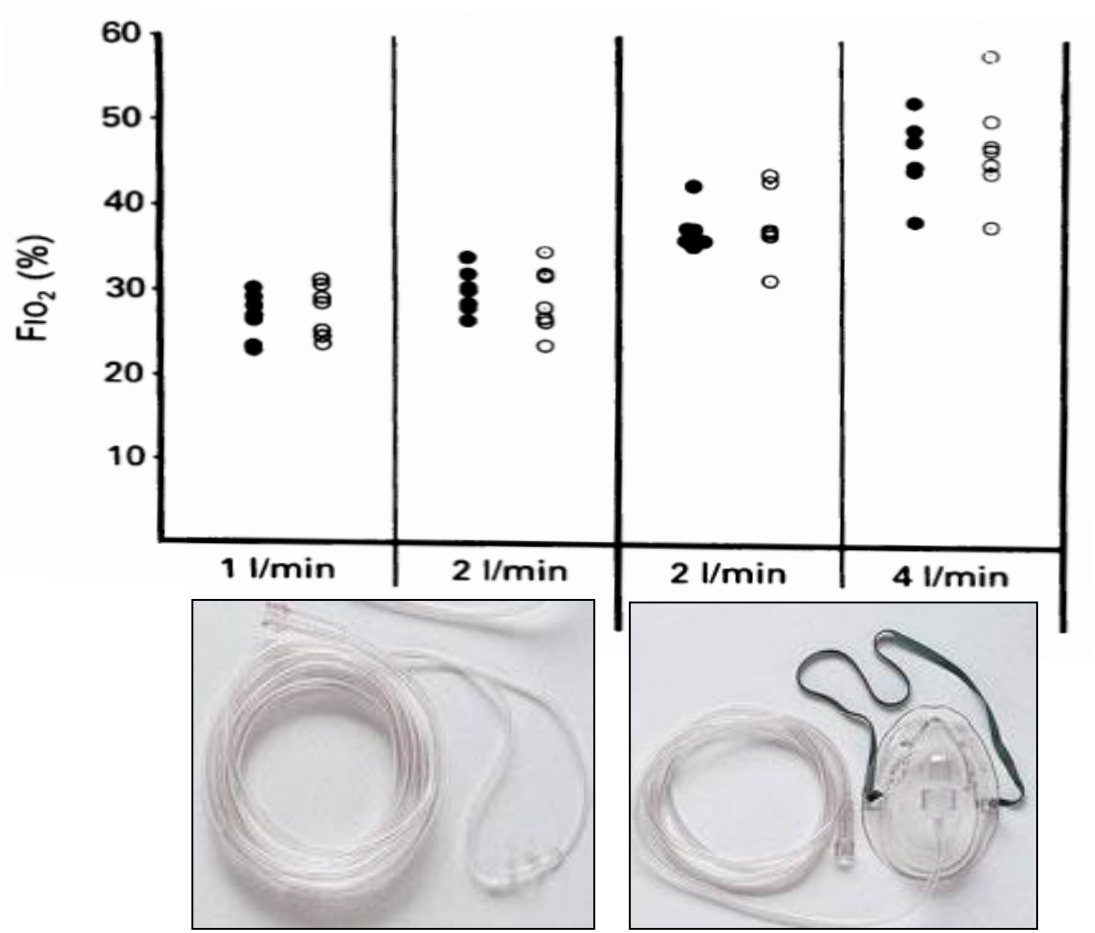
Masque O2

Masque à venturi

Masque à haute concentration



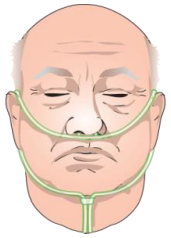
Canule nasale « classique » – Limites d'efficacité



Importante variabilité interindividuelle de la FiO_2 en fonction du débit avec les dispositifs usuels

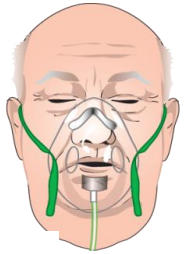
?

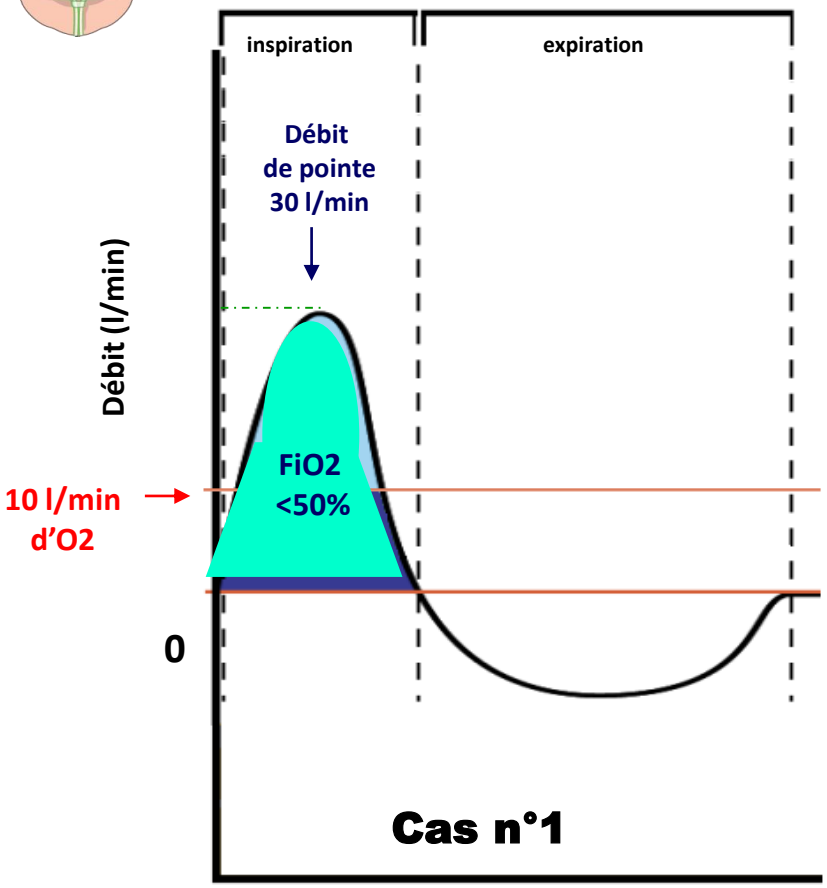
Bazuaye *et al.* Thorax 1992

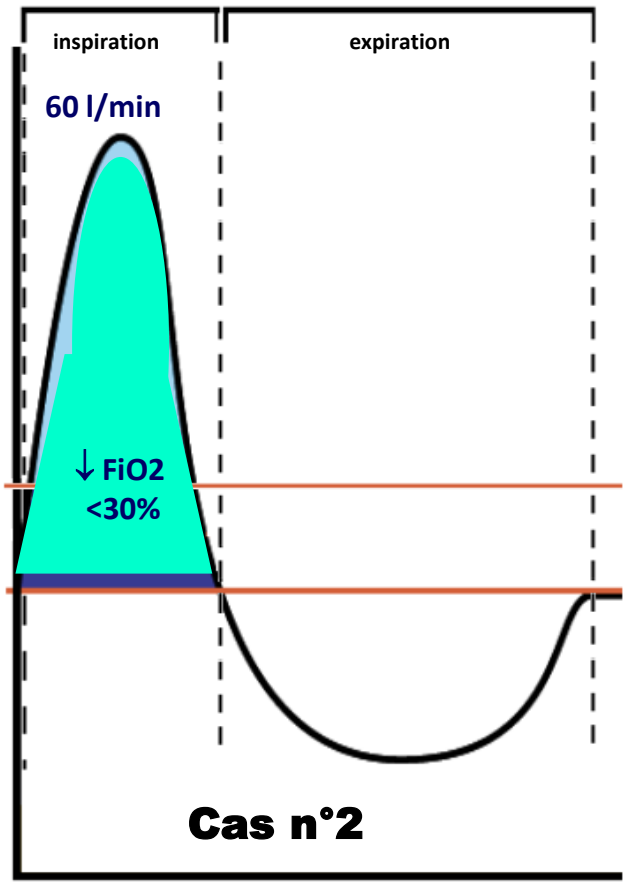


La « vraie » FiO2 dépend :

1. débit d'O2 mural
2. des fuites autour de l'interface
3. ventilation minute du patient



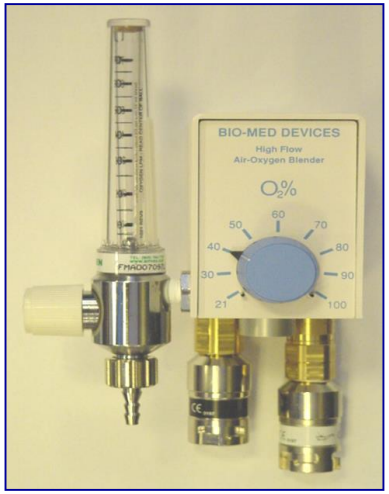




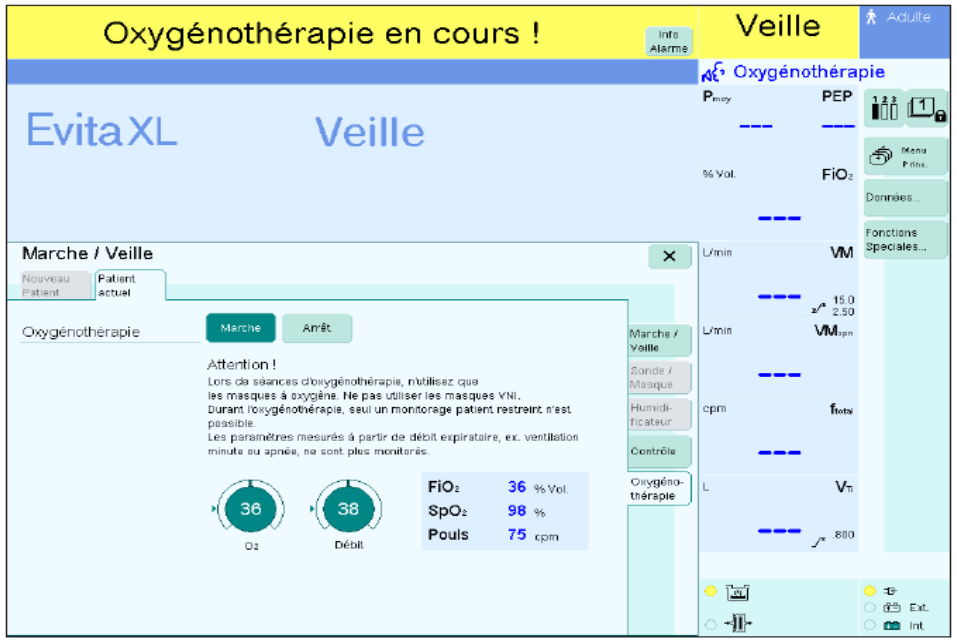
Un mélange à haut débit (→ 60 l/min)

30 l 15 L/min

Débitmètres Air/O2 ou un mélangeur à haut débit



Fonction oxygénothérapie sur certains ventilateurs



OHD = Oxygénothérapie à Haut Débit
effets physiologiques

1. Effet de l'OHD sur la FiO2

2. Effet de l'OHD sur les pressions des voies aériennes

   - Amélioration des échanges gazeux

   - Amélioration du confort

   - Diminution du travail inspiratoire

3. Conditionnement des Gaz (humidification et réchauffement)

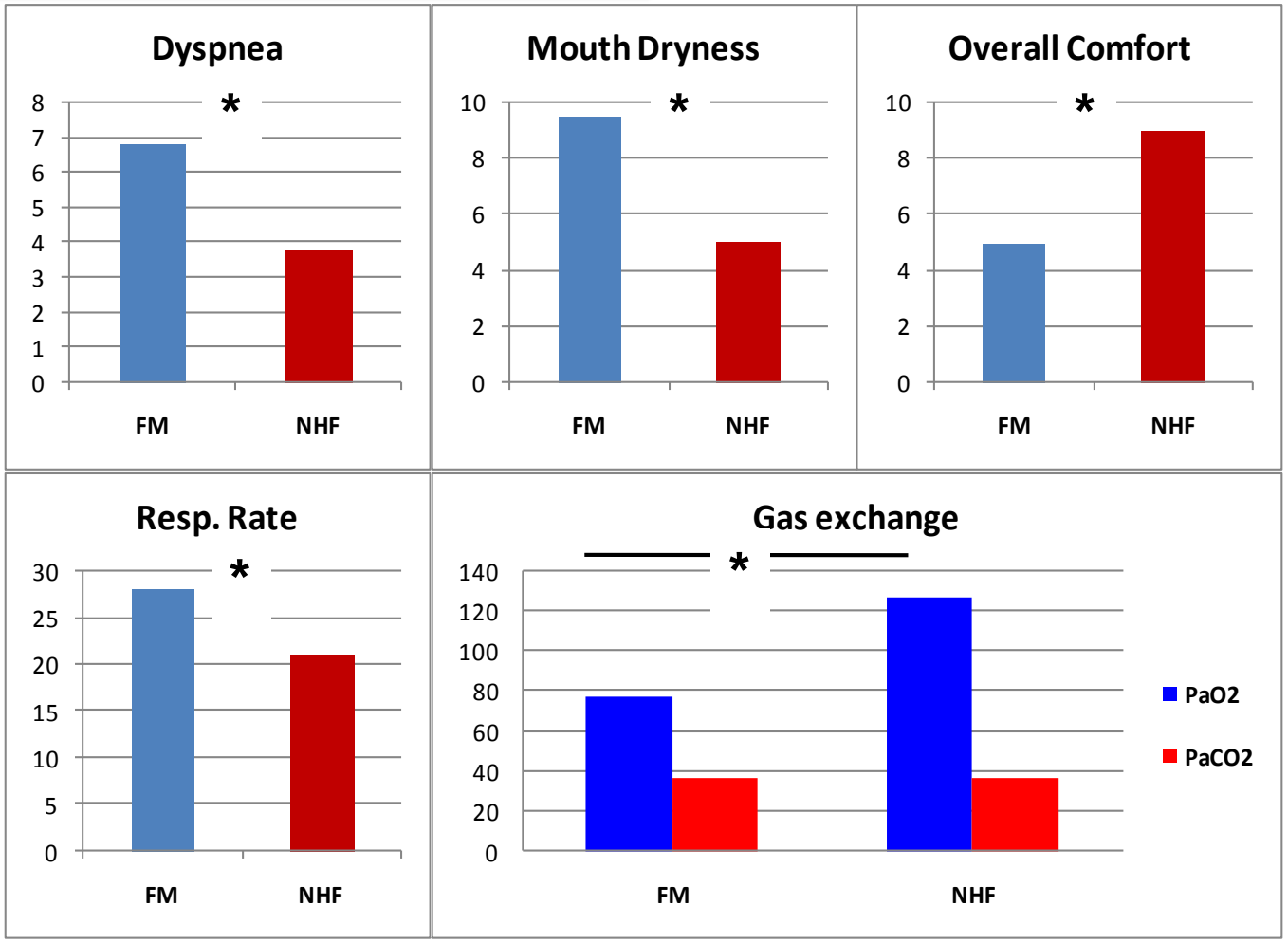
4. « Lavage » de l'espace mort naso-pharyngé

Amélioration oxygénation et confort

20 patients - SpO2<96% à FiO2 > 0.5

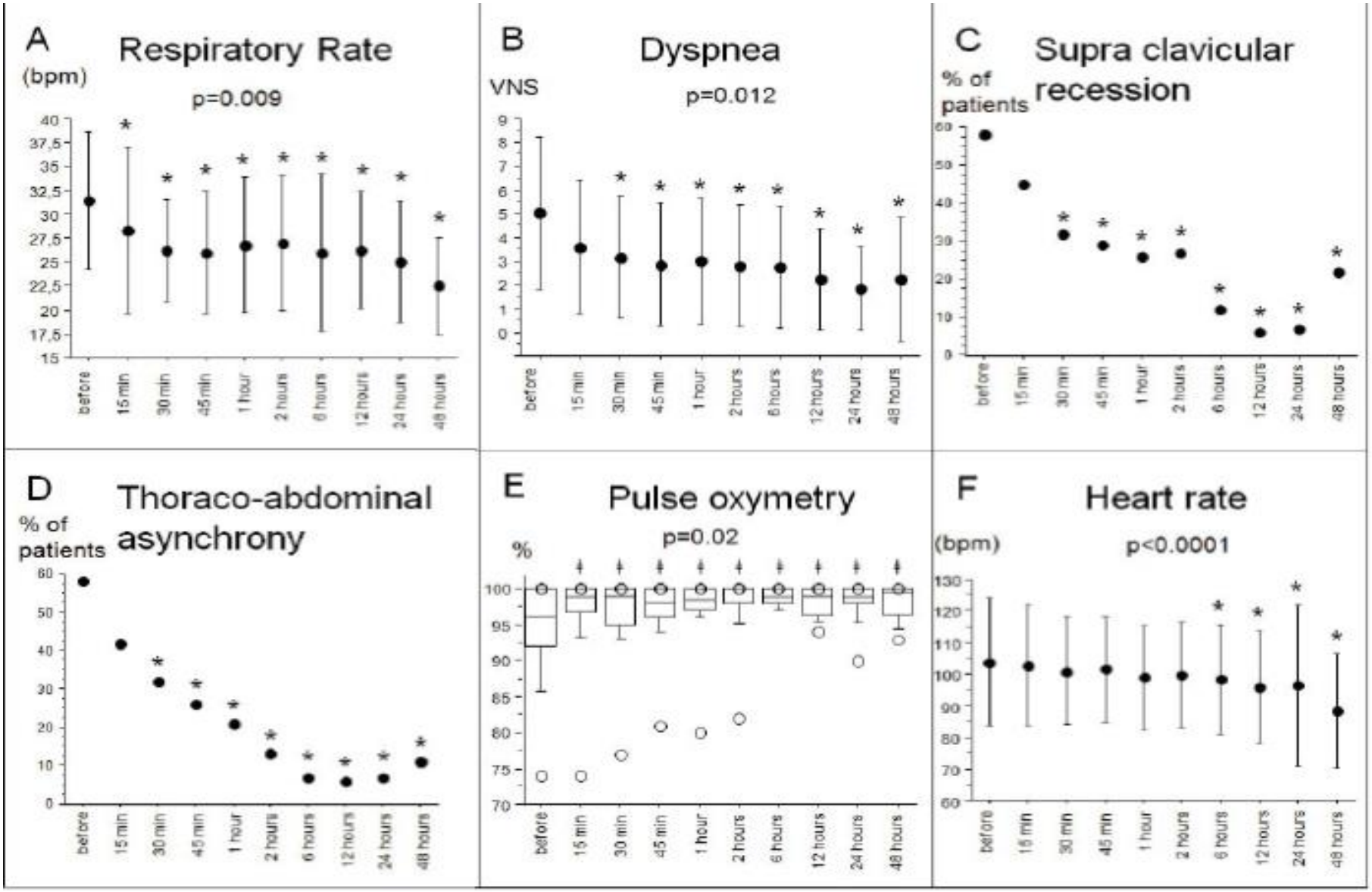
Venturi Mask vs NHF /30 min

Roca *et al.* Respir Care 2010



Sztrymf *et al.* Intensive Care Med 2011

ARF, N=38

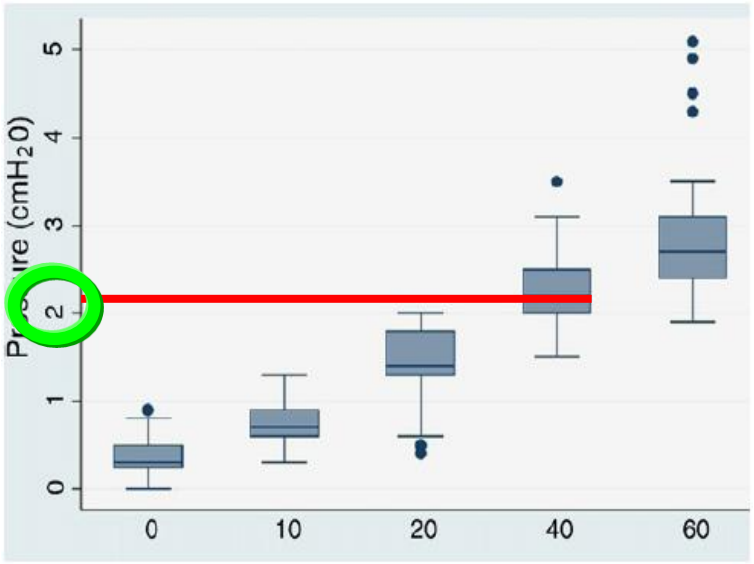


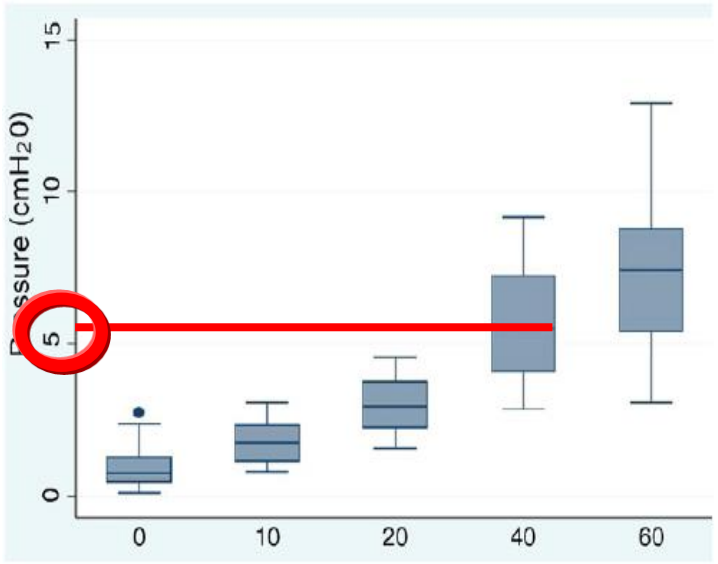
ǂ p<0.005 vs before value * p<0.05 vs before value

Australian Critical Care (2007) 20, 126–131

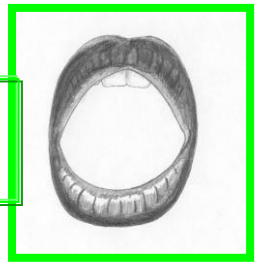
High flow nasal oxygen generates positive airway pressure in adult volunteers

Nicole Groves Bachelor of Nursing, Post-Graduate Diploma in Advanced Clinical Nursing (Critical Care)*,
Antony Tobin FRACP FJFICM





Bouche ouverte



cathéter nasopharyngé

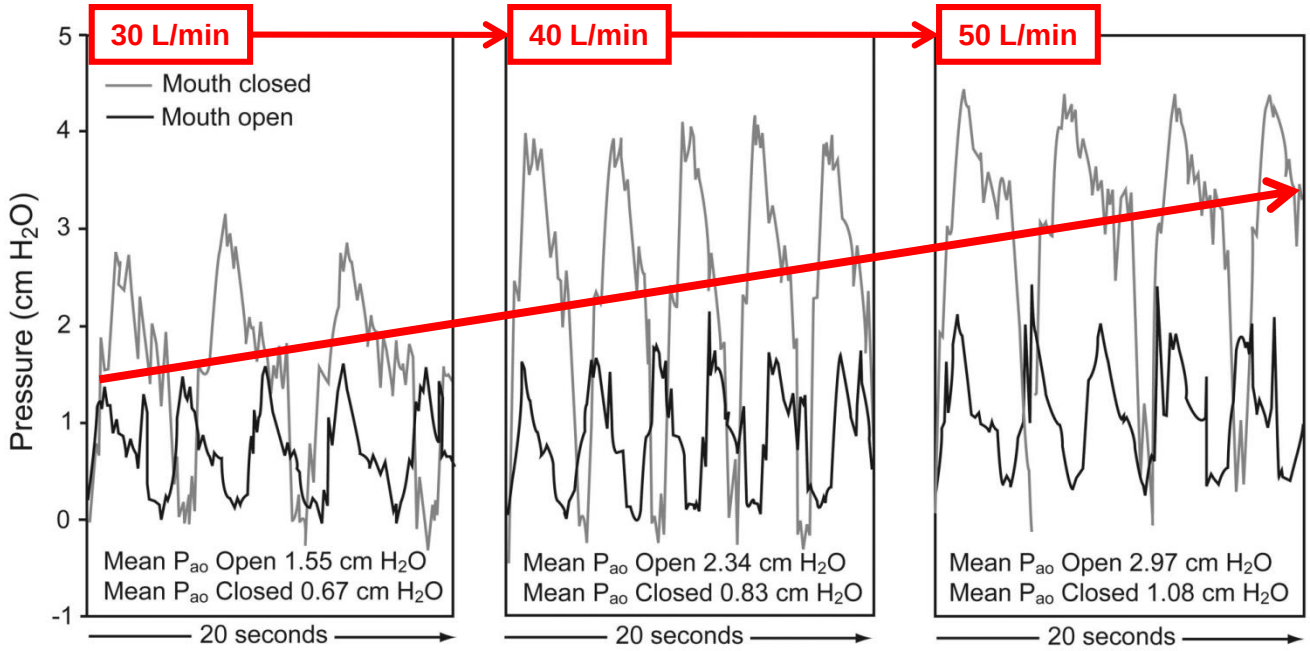
Bouche fermée

Pression positive proportionnelle au débit

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 *et al.* Br J Anaesth 2009

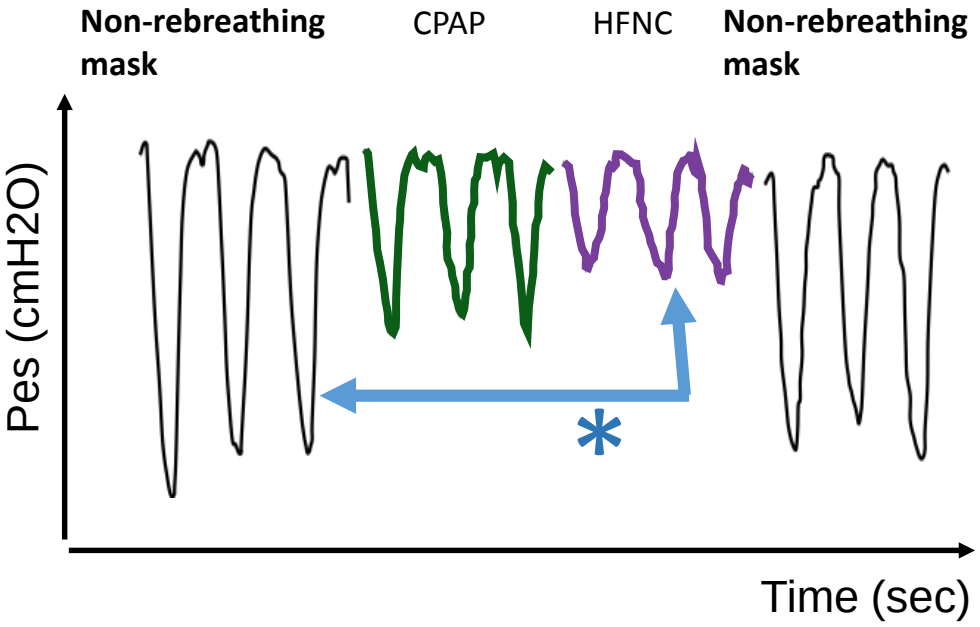


Parke *et al.* Respir Care 2011

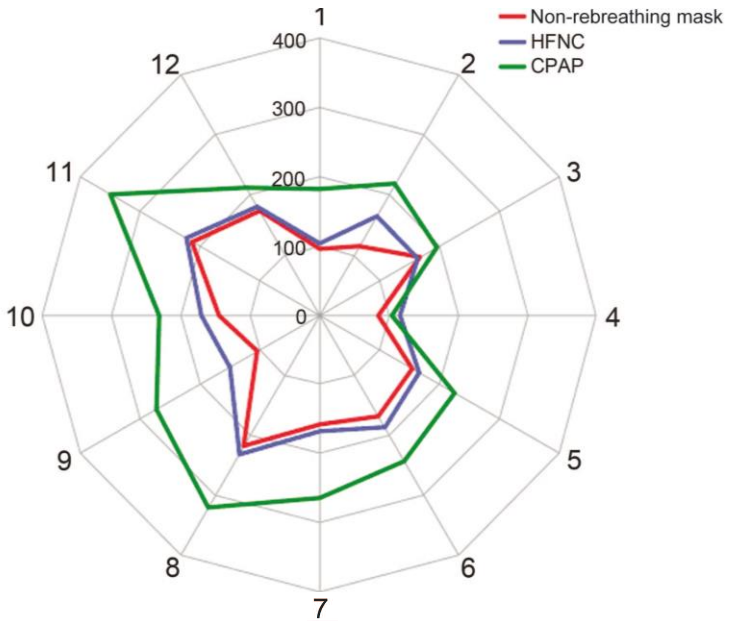
Diminution du travail inspiratoire

Mesure pression oesophagienne (N=12 ARF)

Inspiratory effort



Individual changes in PaO2/FiO2



Vargas *et al.* Respir Care 2015

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4. « Lavage » de l'espace mort naso-pharyngé

Importance du réchauffement

Masque facial > 5 L/min

Humidificateur Chauffant

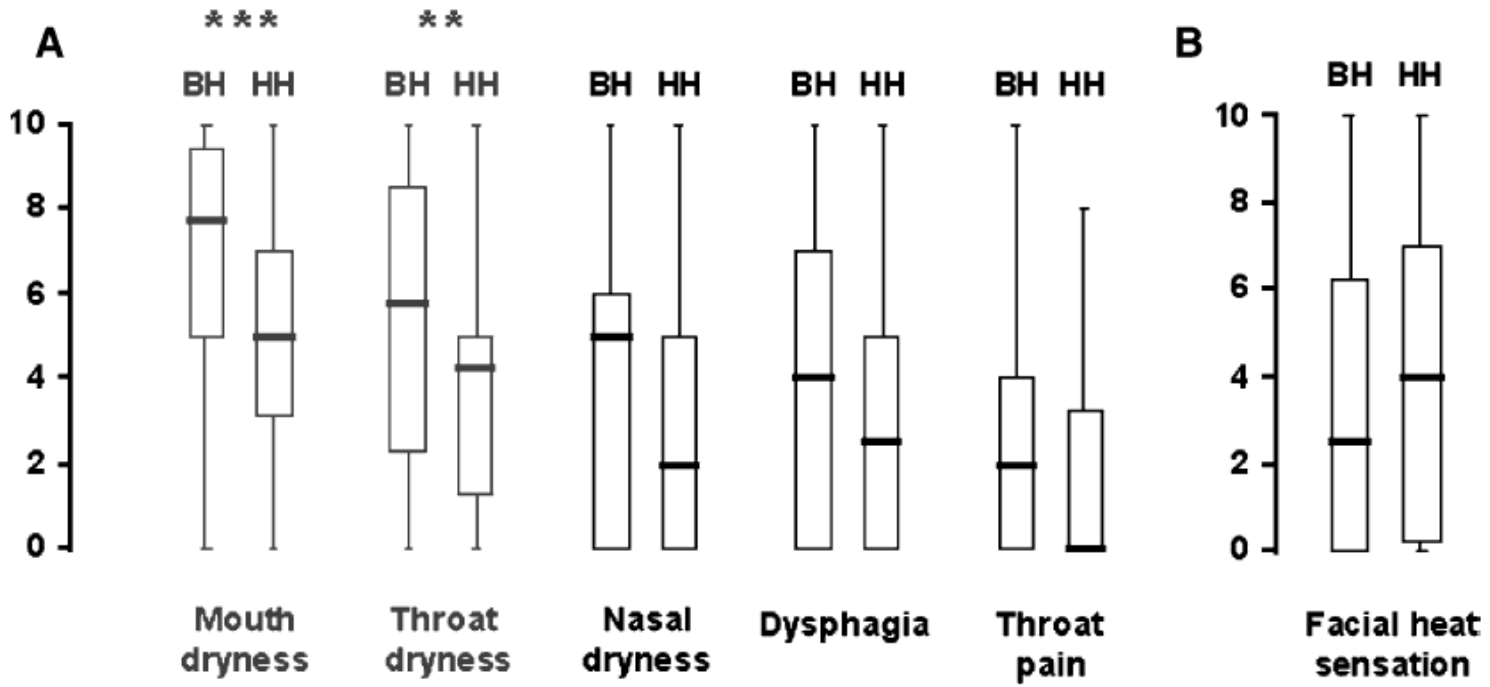
ACTIF

PASSIF

Chanques *et al.* Intensive Care Med 2009

Chanques *et al.* Intensive Care Med 2009

50% des patients ont un inconfort modéré à sévère



Intensité des symptômes pour chaque système

OHD = Oxygénothérapie à Haut Débit
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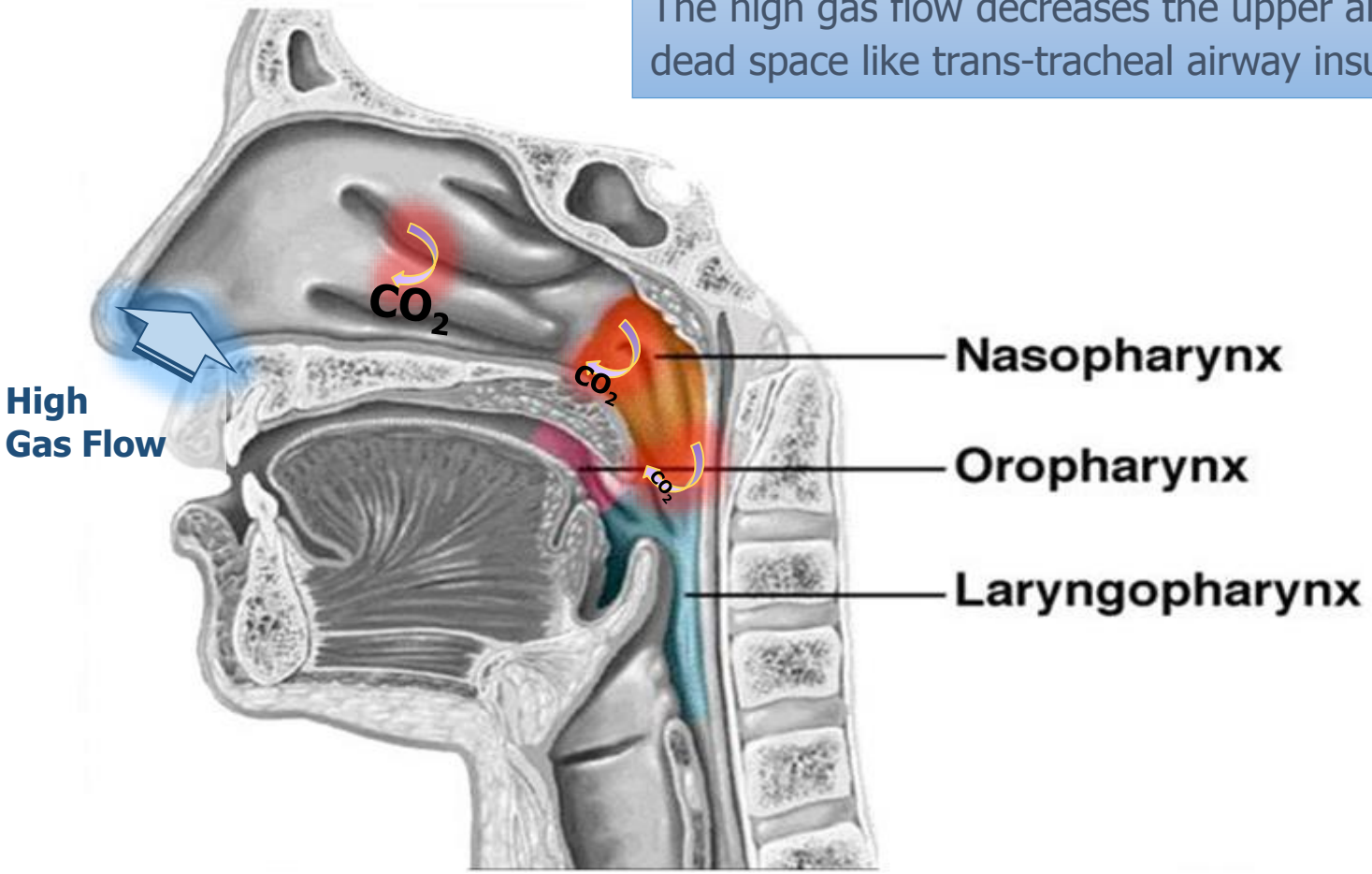
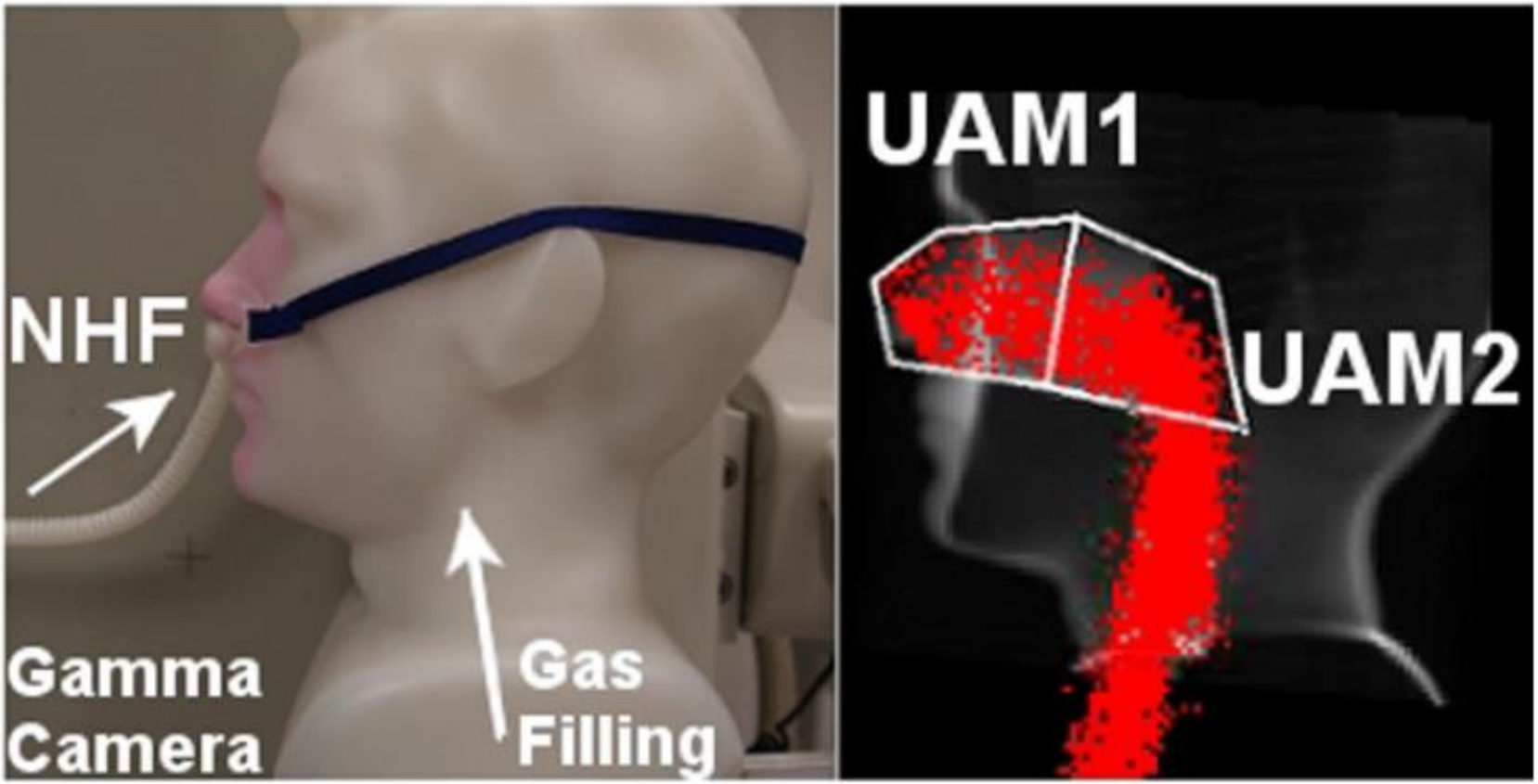
Lavage espace-mort

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

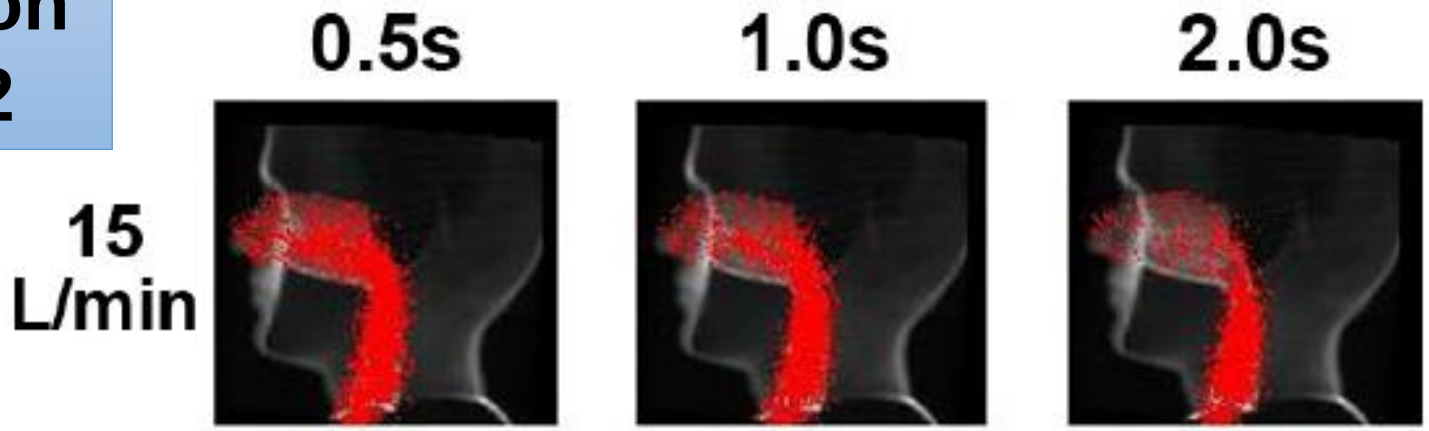


Möller *et al.* J Appl Physiol 2015

Lavage espace-mort



Elimination Du CO2



HFNC et IRA

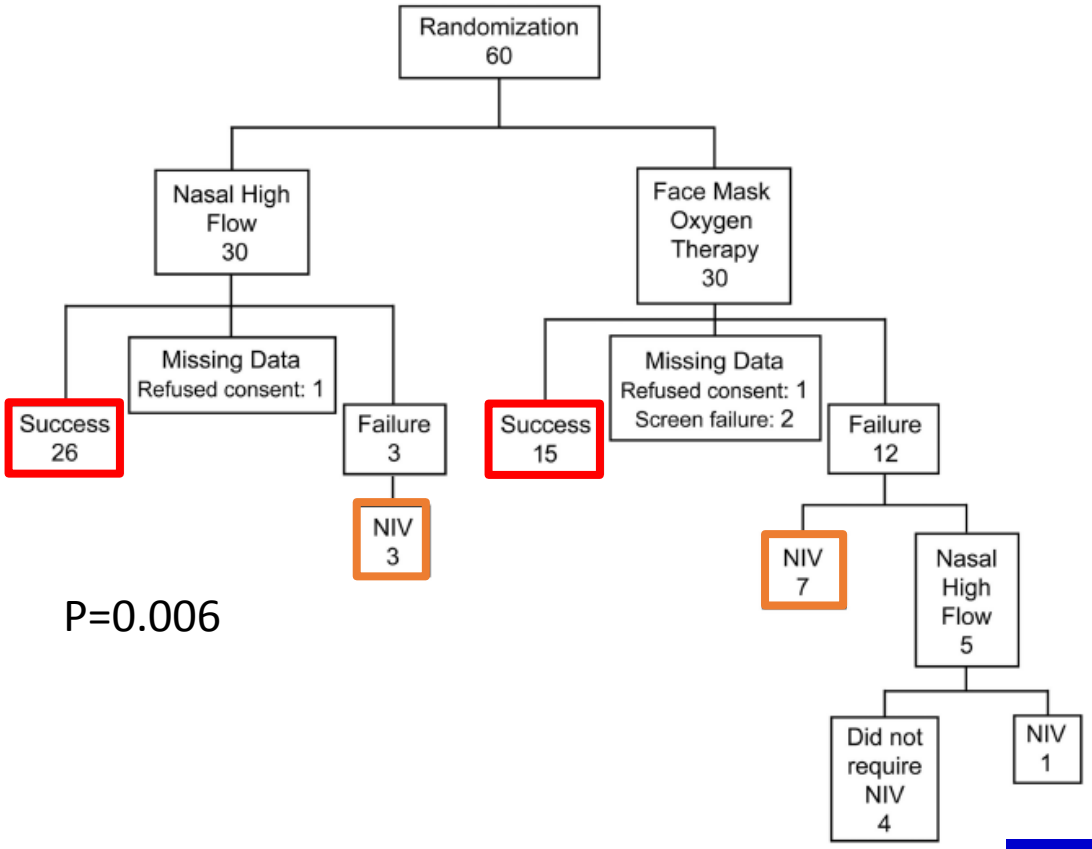
Reference	Study design	Population	N patients	Main results
Hypoxemic acute respiratory failure in the ICU				
Sztrymf ICM 2011	Cohort, unselected patients. HFNC 50 L/min vs. face mask oxygen	Hypoxemic ARF	38	Improved oxygenation Decreased respiratory rate
Sztrymf JCC 2012	Cohort, unselected patients. HFNC 20-30 L/min vs. face mask oxygen	Hypoxemic ARF	20	Improved oxygenation Decrease in respiratory/heart rates, dyspnoea, respiratory distress, and thoraco-abdominal asynchrony
Parke Respir Care 2011	HFNC vs. face mask oxygen	Hypoxemic ARF	60	Decreased treatment failure (defined as need for non-invasive ventilation) from 30% to 10%. Fewer desaturation episodes
Roca Respir Care 2010	Cohort study, HFNC 20-30 L/min vs. face mask oxygen	Hypoxemic ARF	20	Improved comfort; Improved oxygenation
Rello JCC 2012	Cohort study (post hoc)	Hypoxemic ARF (2009 A/H1N1v outbreak)	20	9/20 (45%) success (no intubation). All 8 patients on vasopressors required intubation within 24 hours. After 6 hours of HFNC, non-responders had lower PaO_2/FiO_2 values
Messika Respir Care 2015	Observational, single-centre study	ARDS	45	40% intubation rate. HFNC failure associated with higher SAPSII, development of additional organ failure, and trends toward lower PaO_2/FiO_2 values and higher respiratory rate
Frat NEJM 2015	Multicentre, open-label RCT with 3 groups: HFNC, usual oxygen therapy (face mask), or non-invasive ventilation.	Hypoxemic ARF, $PaO_2/FiO_2 \leq 300$	310	Intubation rate was 38% with HFNC, 47% with standard oxygen, and 50% with non-invasive ventilation. Decreased day-90 mortality with HFNC
Nagata Respir Care 2015	Retrospective before/after study of HFNC	Hypoxemic ARF	172	Reduced need for intubation (100% vs 63%, $P<0.01$)
Kang ICM 2015	Patients intubated after HFNC	Hypoxemic ARF	175	In patients intubated early, lower mortality (39.2 vs. 66.7 %), higher extubation success (37.7% vs. 15.6 %) and more ventilator-free days. Early intubation was associated with decreased ICU mortality.
Hypoxemic acute respiratory failure in the emergency department				
Lenglet Respir Care 2012	Patients with ARF (>9 L/min oxygen or clinical signs of respiratory distress)	Hypoxemic ARF	17	Decreased dyspnoea and respiratory rate and improved oxygenation
Rittayamai Respir Care 2015	RCT of HFNC vs. standard oxygen for 1 h	Hypoxemic ARF	40	Decreased dyspnoea and improved comfort

RCT

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

60 pts (54 cardiac/vacular surgery) with mild to moderate hypoxemic ARF

High-flow face mask vs NHF for 24 h



P=0.006

Parke *et al.* Respir Care 2011

The NEW ENGLAND JOURNAL of MEDICINE

FLORALI

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*

Objectif: déterminer si HFNC ± la VNI comparées à l'O2 standard (masque haute concentration) permettent de diminuer le risque d'intubation (J28) et d'améliorer le pronostic des patients admis en réanimation pour IRA

Etude prospective, randomisée, multicentrique

Inclusion : patients avec une IRA

- FR > 25
- P/F < 300 (débit ≥ 10 lpm)
- $PaCO_2$ < 46 mmHg
- Sans pathologie pulmonaire chronique

N= 310

Exclusion dont OAP, neutropénie, vasopresseurs, LATA…

O2 Standard	VS	HFNC Optiflow®	VS	Optiflow® + VNI
Masque haute concentration Débit O_2 ≥ 10 lpm pour SpO_2 ≥ 92%		Canules nasales Débit 50L/min FiO_2 pour SpO_2 ≥ 92% Relais O2 standard		AI pour Vte = 7-10 ml/kg et PEEP = 2-10 cmH_2O FiO_2 pour SpO_2 ≥ 92% Au moins 8h par jour durant les deux premiers jours

Critères d'intubation

- hemodynamic instability
- deterioration of neurologic status
- signs of persisting or worsening respiratory failure as defined by at least two of the following criteria:
  - a respiratory rate of more than 40 breaths per minute
  - a lack of improvement in signs of high respiratory-muscle workload
  - the development of copious tracheal secretions
  - acidosis with a pH of less than 7.35
  - an SpO2 of less than 90% for more than 5 minutes without technical dysfunction
  - a poor response to oxygenation techniques
- VNI pré-intubation possible dans les 3 groupes

Characteristic	High-Flow Oxygen (N = 106)	Standard Oxygen (N = 94)	Noninvasive Ventilation (N = 110)
Age — yr	61±16	59±17	61±17
Male sex — no. (%)	75 (71)	63 (67)	74 (67)
Body-mass index†	25±5	26±5	26±6
SAPS II‡	25±9	24±9	27±9
Current or past smoking — no. (%)	34 (32)	36 (38)	40 (36)
Reason for acute respiratory failure — no. (%)			
Community-acquired pneumonia	71 (67)	57 (61)	69 (63)
Hospital-acquired pneumonia	12 (11)	13 (14)	12 (11)
Extrapulmonary sepsis	4 (4)	5 (5)	7 (6)
Aspiration or drowning	3 (3)	1 (1)	2 (2)
Pneumonia related to immunosuppression	6 (6)	4 (4)	10 (9)
Other	10 (9)	14 (15)	10 (9)
Arterial blood gas			
pH	7.43±0.05	7.44±0.06	7.43±0.06
Pao_2 — mm Hg	85±31	92±32	90±36
FIO_2 §	0.62±0.19	0.63±0.17	0.65±0.15
Pao_2:FIO_2 — mm Hg	157±89	161±73	149±72
$Paco_2$ — mm Hg	36±6	35±5	34±6

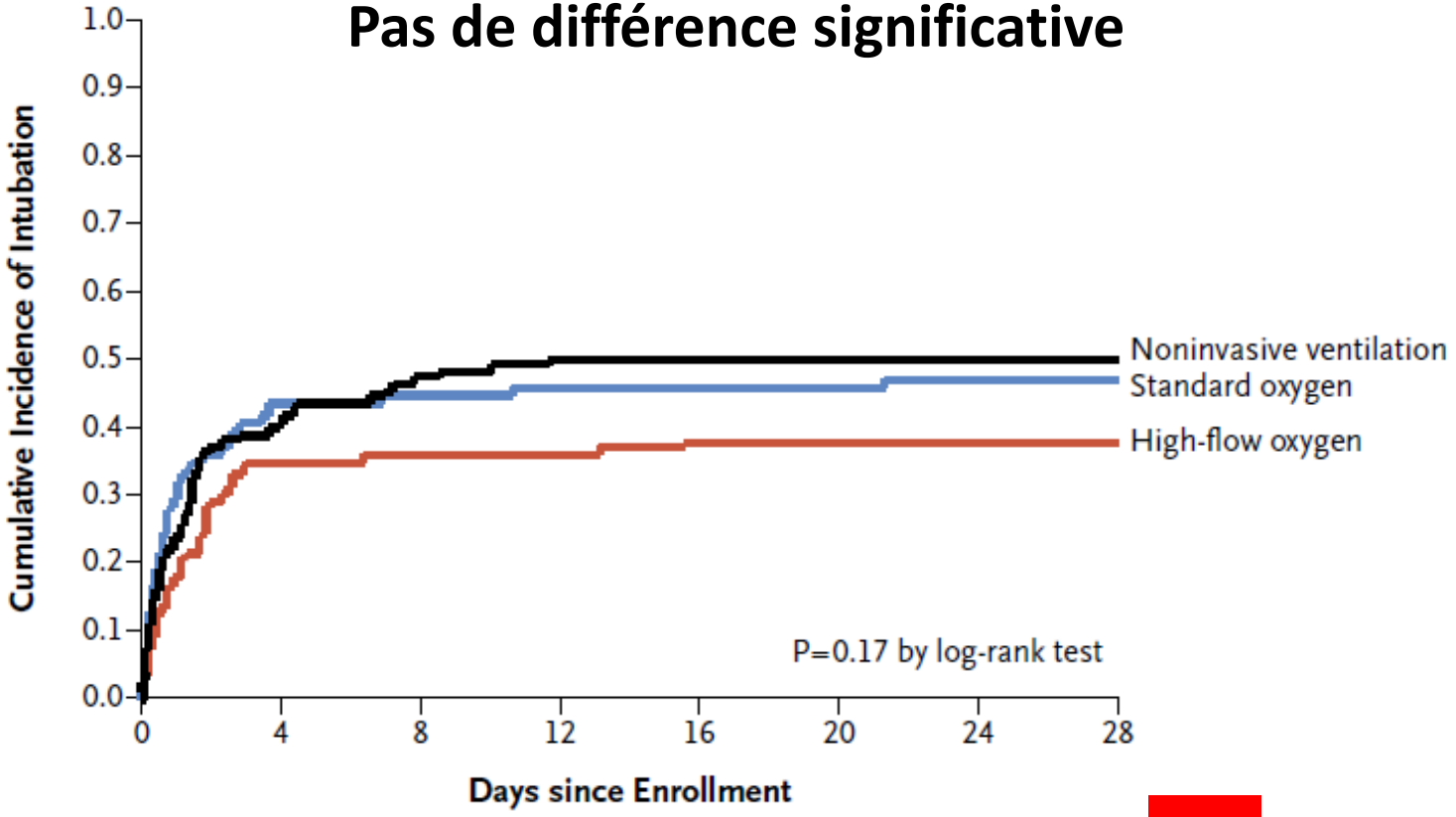
Résultats

- Réglages initiaux
  - standard-oxygen group 13±5 lpm
  - HFNC 48±11 lpm (FiO2: 0,82±0,21)
  - VNI
    - AI 8±3 cmH2O
    - PEEP 5±1 cmH2O
    - FiO2: 0,67±0,24
    - Vt 9,2±3 ml/kg
- Durée VNI
  - 8h (IQR 4-12) à J1
  - 8h (IQR 4-13) à J2

Critère de jugement principal = intubation à J28

A Overall Population

Pas de différence significative



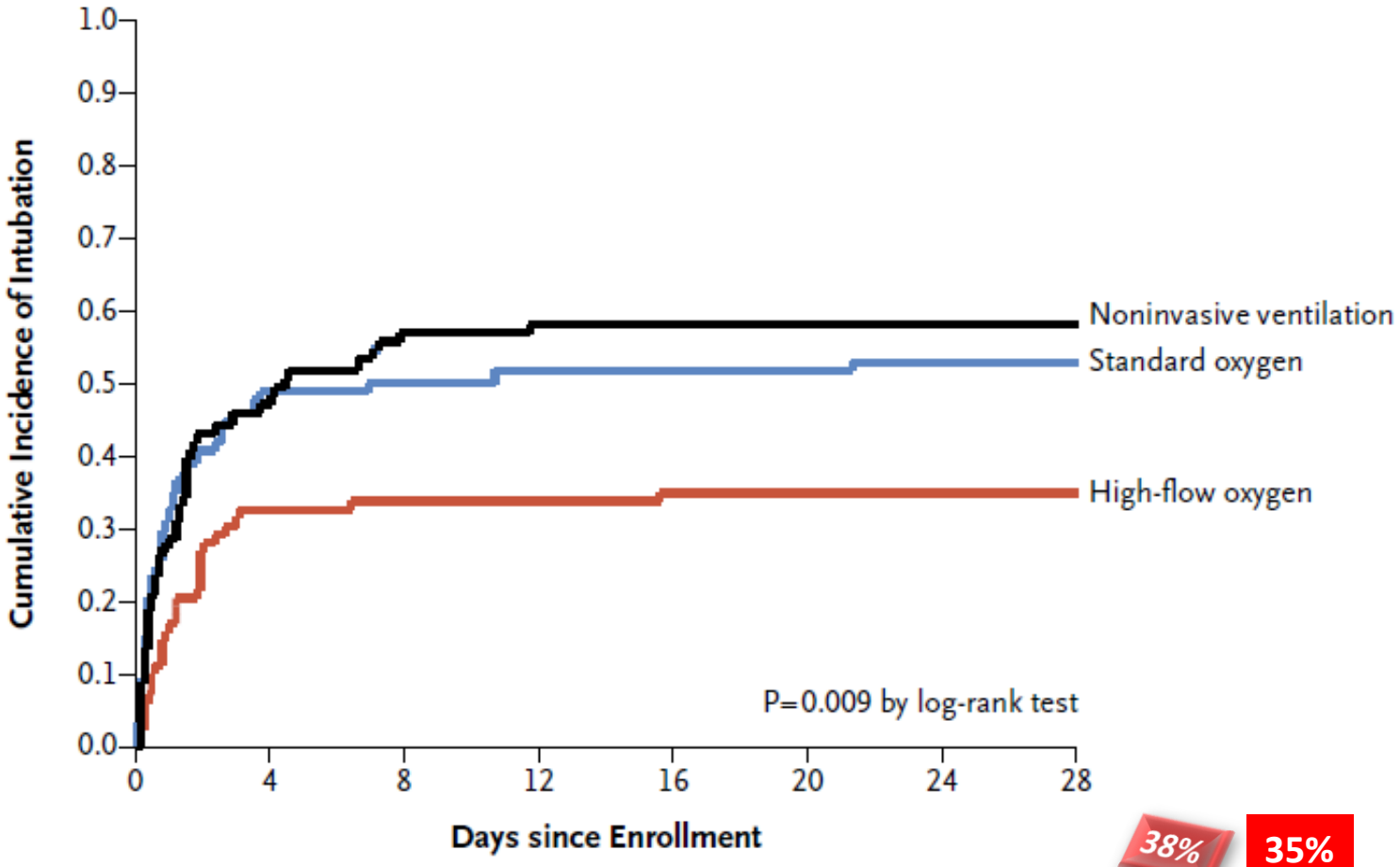
No. at Risk								
High-flow oxygen	106	68	67	67	65	65	65	65
Standard oxygen	94	52	50	49	49	49	48	48
Noninvasive ventilation	110	64	57	53	53	53	53	52

38%

47%

50%

P/F < 200



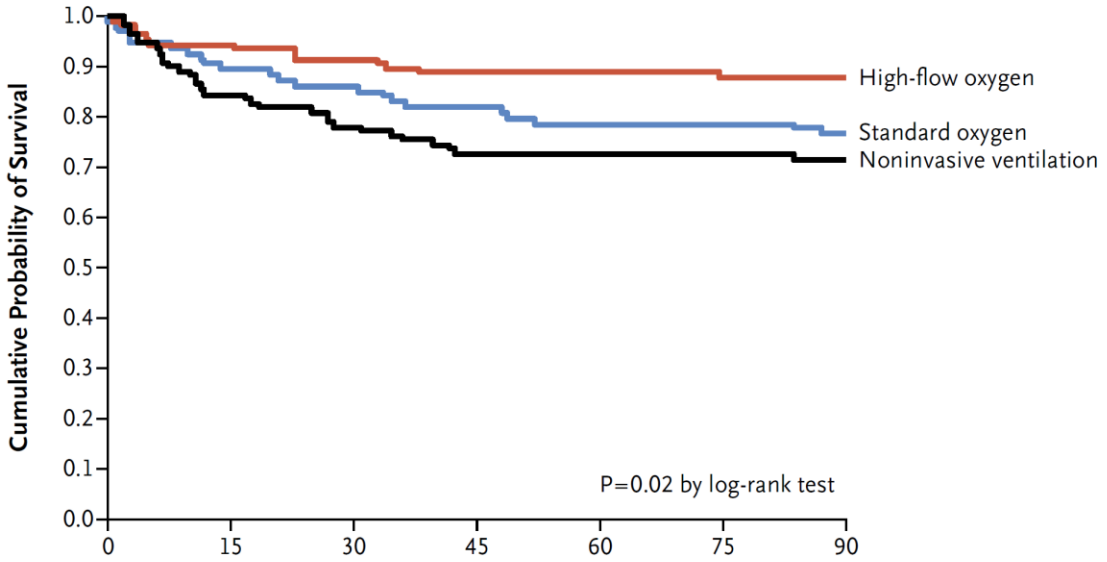
No. at Risk								
High-flow oxygen	83	55	54	54	53	53	53	53
Standard oxygen	74	37	35	34	34	34	33	33
Noninvasive ventilation	81	41	34	32	32	32	32	32

38% 35%

47% 53%

50% 58%

Mortalité



Outcome	Study Group			P Value†	Odds Ratio or Hazard Ratio (95% CI)	
	High-Flow Oxygen (N=106)	Standard Oxygen (N=94)	Noninvasive Ventilation (N=110)		Standard Oxygen vs. High-Flow Oxygen	Noninvasive Ventilation vs. High-Flow Oxygen
Death						
In ICU						
Unadjusted analysis				0.047	1.85 (0.84–4.09)	2.55 (1.21–5.35)
No. of patients	12	18	27			
% of patients (95% CI)	11 (6–19)	19 (12–28)	25 (17–33)			
Adjusted analysis**	—	—	—	—	2.55 (1.07–6.08)	2.60 (1.20–5.63)
At day 90						
Overall population						
Unadjusted analysis				0.02	2.01 (1.01–3.99)	2.50 (1.31–4.78)
No. of patients	13	22	31			
% of patients (95% CI)	12 (7–20)	23 (16–33)	28 (21–37)			
Adjusted analysis**	—	—	—	—	2.36 (1.18–4.70)	2.33 (1.22–4.47)

	Study Group			P Value
	High-Flow Oxygen (N=106)	Standard Oxygen (N=94)	Noninvasive Ventilation (N=110)	
Interval between enrollment and intubation — hr¶				
Overall population				0.27
Median	27	15	27	
Interquartile range	8–46	5–39	8–53	
Patients with Pao_2:FIO_2 ≤200 mm Hg				0.32
Median	26	17	27	
Interquartile range	11–46	5–41	7–52	
Death				
Intubated patients				0.16
No. of patients/total. no.	12/40	20/44	27/55	
% of patients (95% CI)	30 (18–46)	45 (32–60)	49 (36–62)	

Ce que l'on peut dire

Conclusion : pas de différence du taux d'intubation mais

- **Moins d'intubation qd P/F < 200**
- **Mortalité diminuée**

- **Patients sélectionnés : IRA *sans* hypercapnie et *sans* pathologie pulmonaire chronique**
- **Surmortalité dans groupe VNI (associé à HFNC)**
  - **Retard à l'intubation ?**
  - **↗ VILI (Vt = 9ml/kg) ?**

Intensive Care Med (2015) 41:623–632
DOI 10.1007/s00134-015-3693-5

ORIGINAL

Byung Ju Kang
Younsuck Koh
Chae-Man Lim
Jin Won Huh
Seunghee Baek
Myongja Han
Hyun-Suk Seo
Hee Jung Suh
Ga Jin Seo
Eun Young Kim
Sang-Bum Hong

Failure of high-flow nasal cannula therapy may delay intubation and increase mortality

Primary objective

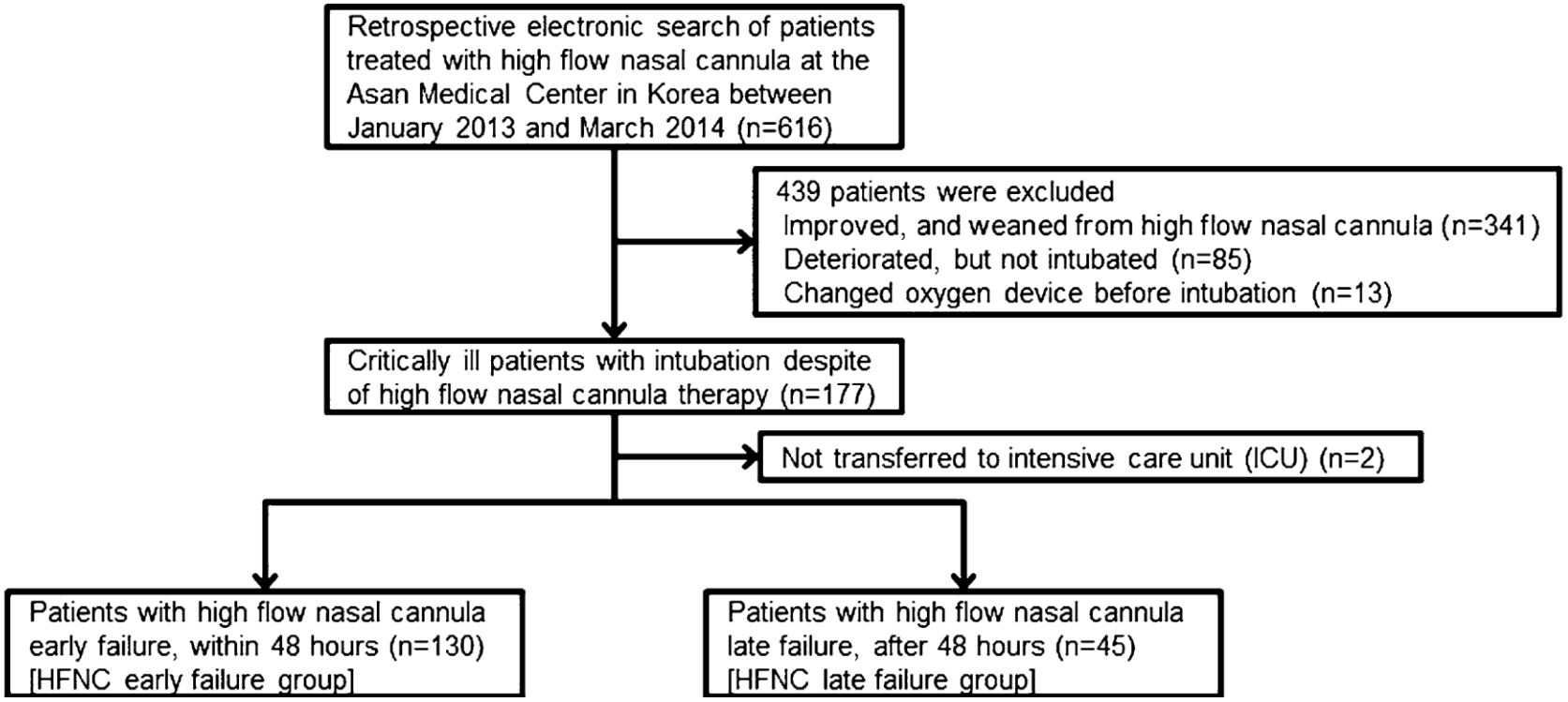
ICU mortality according to the intubation timing in respiratory failure patients who received HFNC that failed

Retrospective, single-center

Indications HFNC

- O2 standard > 9 lpm pour SpO2 > 92%
- Signes cliniques de DR
  - RR > 24, mise en jeu muscles resp accessoires, balancement tho-abdo
- Patients à risque après extubation

Kang *et al.* Intensive Care Med 2015



Kang *et al.* Intensive Care Med 2015

Characteristics	Early HFNC failure group ($n = 130$)	Late HFNC failure group ($n = 45$)	P value[a]
Age, years[b]	66 (56–73)	68 (57–75.5)	0.354
Male sex, n (%)	85 (65.4)	35 (77.8)	0.123
Body mass index, kg/m^2 [b]	22.2 (19.8–24.3)	21.1 (18.9–24.0)	0.326
HFNC treatment time, h[b]	10.1 (4.8–22.4)	126.1 (64.9–178.6)	<0.001
Underlying disease			
Diabetes mellitus, n (%)	44 (33.9)	7 (15.6)	0.020
Hypertension, n (%)	53 (40.8)	18 (40.0)	0.928
Solid malignancies, n (%)	34 (26.2)	9 (20.0)	0.409
Hematological malignancies, n (%)	40 (30.8)	15 (33.3)	0.749
Chronic kidney disease/dialysis, n (%)	18 (13.9)	4 (8.9)	0.387
Liver disease, n (%)	24 (18.5)	7 (15.6)	0.660
Use of immunosuppressive agents, n (%)	48 (36.9)	22 (48.9)	0.158
Coronary artery disease, n (%)	13 (10.0)	7 (15.6)	0.313
Heart failure, n (%)	22 (16.9)	8 (17.8)	0.896
Chronic obstructive pulmonary disease, n (%)	15 (11.5)	6 (13.3)	0.749
Tuberculosis-destroyed lung, n (%)	19 (14.6)	12 (26.7)	0.068
PaO_2/FiO_2 before HFNC, mmHg[b]	158.6 (112.7–222.8) ($n = 129$)	180.0 (138.4–292.0) ($n = 43$)	0.061
PaO_2/FiO_2 before intubation, mmHg[b]	90.6 (69.7–149.0)	86.3 (64.3–156.7)	0.594
APACHE II score[b]	25.0 (21.0–28.0)	25.0 (21.0–28.5)	0.832
SOFA score[b]	10.0 (7.0–13.0)	7.0 (5.0–11.0)	0.007

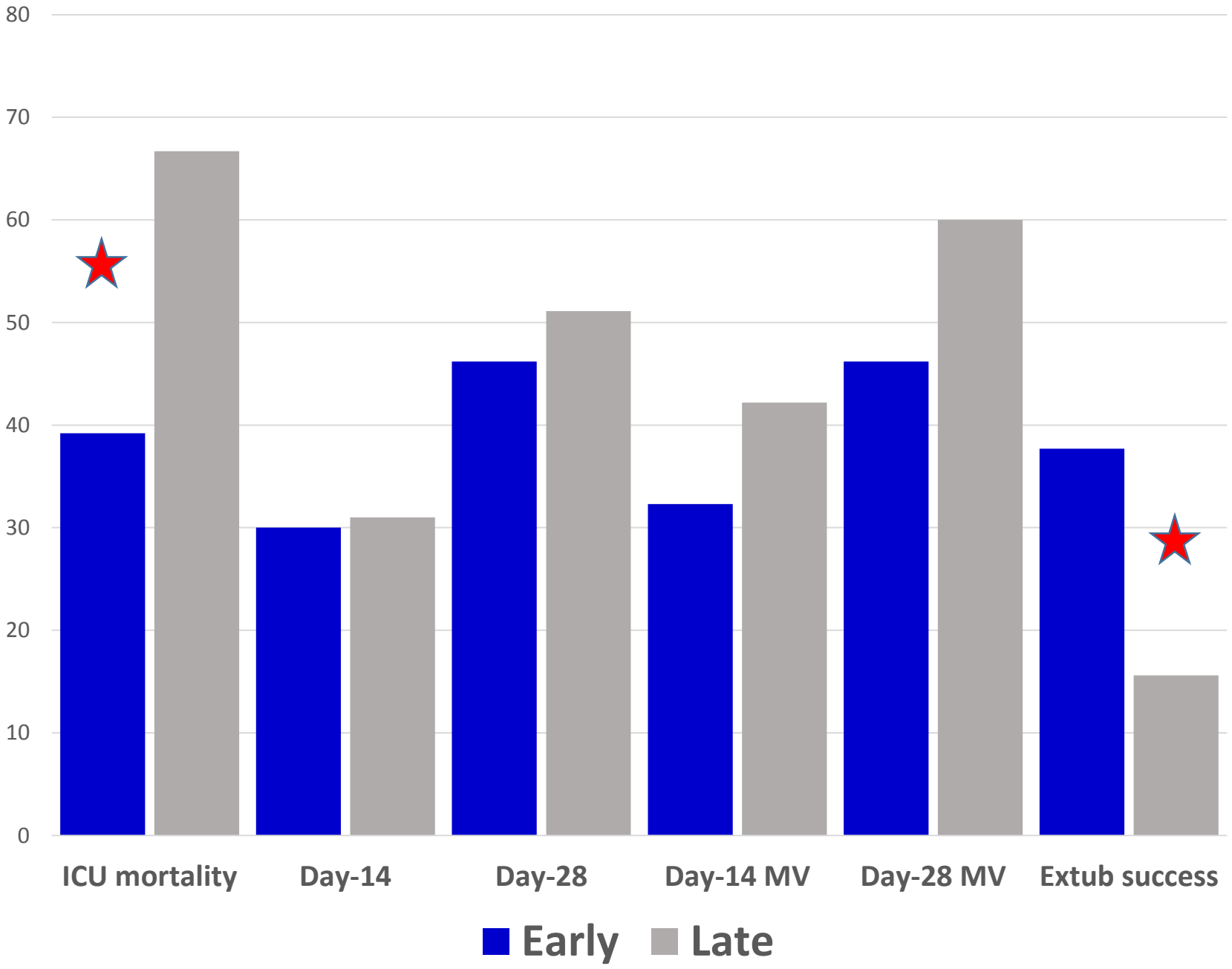
Kang *et al.* Intensive Care Med 2015

Etiologie DR

	Early HFNC failure group ($n = 130$)	Late HFNC failure group ($n = 45$)	P value
Etiology of respiratory failure before HFNC application			
Acute de novo respiratory failure, n (%)	43 (33.1)	15 (33.3)	0.975
Acute-on-chronic lung disease, n (%)	37 (28.5)	16 (35.6)	0.372
Cariogenic pulmonary edema, n (%)	11 (8.5)	3 (6.7)	>0.999
Pulmonary edema due to renal failure, n (%)	5 (3.8)	1 (2.2)	>0.999
Septic shock other than respiratory infection, n (%)	12 (9.2)	3 (6.7)	0.763
After extubation, n (%)	22 (16.9)	7 (15.6)	0.832

Kang *et al.* Intensive Care Med 2015

Kang *et al.* Intensive Care Med 2015



HFNC après extubation

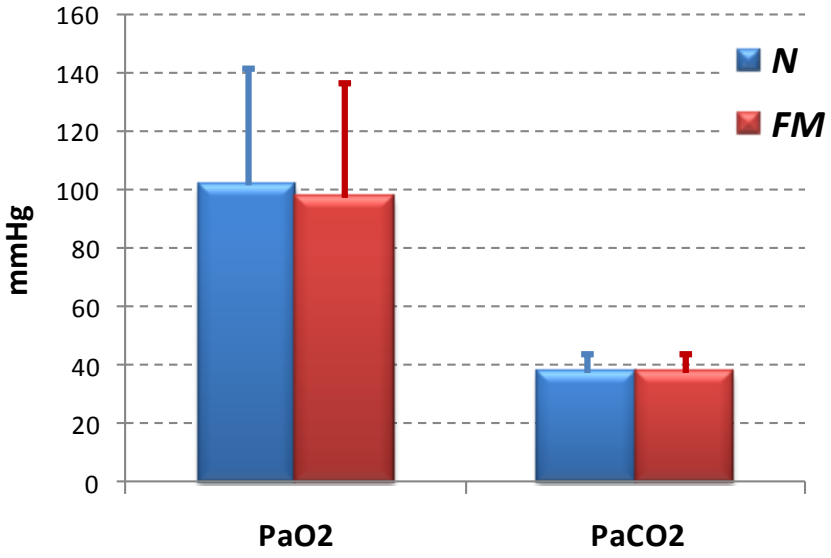
D’un patient de réanimation

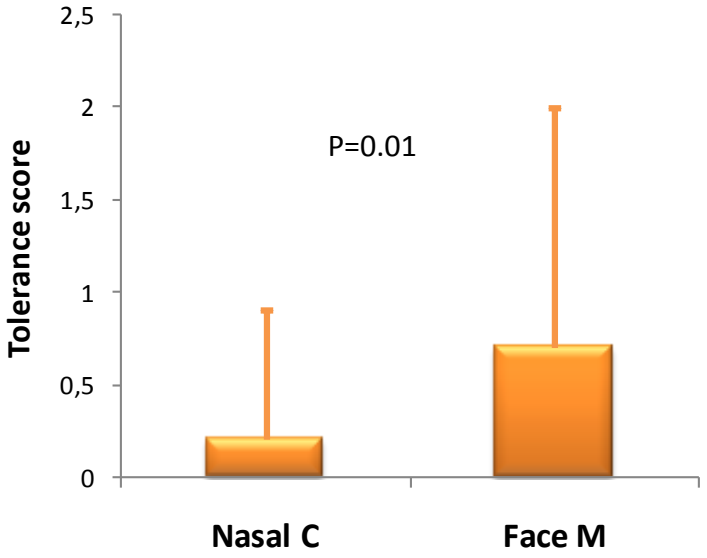
High-flow nasal oxygen vs high-flow face mask: A randomized crossover trial in extubated patients

Ravindranath Tiruvoipati*, David Lewis, Kavi Haji, John Botha

Department of Intensive Care Medicine, Frankston Hospital, Frankston, Victoria 3199, Australia

N=50





Tiruvoipati *et al.* J Crit Care 2010

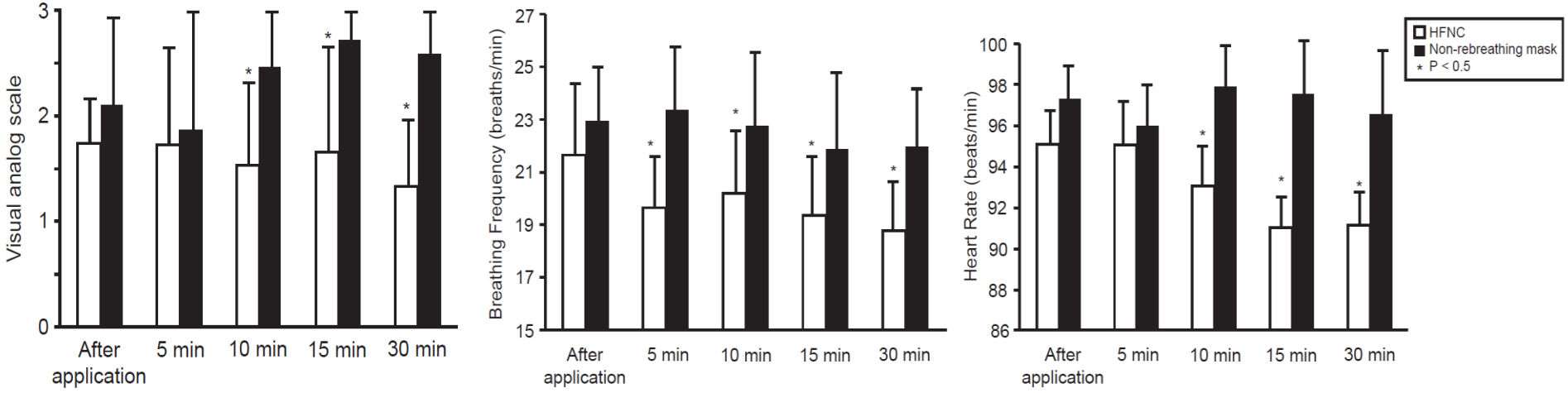
High-Flow Nasal Cannula Versus Conventional Oxygen Therapy After Endotracheal Extubation: A Randomized Crossover Physiologic Study

Nuttapol Rittayamai MD, Jamsak Tscheikuna MD, and Pitchayapa Rujiwit MD

Rittayamai *et al.* Respir Care 2014

17 pts after extubation

HFNC vs non-rebreathing face mask for 30'



Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation

Effects on Oxygenation, Comfort, and Clinical Outcome

Maggiore et al. AJRCCM 2014

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]

- RCT
- Objectif I: P/F à 24h
- 2 centres
- Inclusion :
  - VM > 24h
  - Succès SBT (1 hour: PSV 6-8 cmH2O - PEEP 0, or T-piece)
  - PaO2/FiO2 ≤ 300 (fin SBT)
- Exclusion
  - VNI programmée
    - > 3 échecs SBT et PaCO2 > 45 mm Hg et FR > 25 /min
- Objectif
  - SaO2 92-98% (88-95% qd hypercapnie)

Maggiore et al. AJRCCM 2014

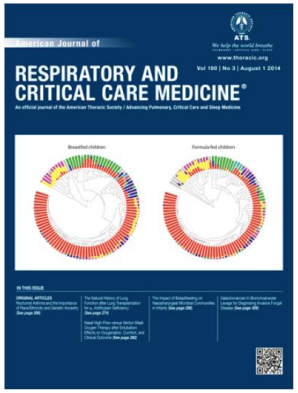
	Control Group (*n* = 52)	NHF (*n* = 53)	*P* Value
Age, yr	64 ± 17	65 ± 18	0.9
Male sex, n (%)	35 (67.3)	33 (62.3)	0.73
SAPS II	44 ± 16	43 ± 14	0.73
Type of admission			0.5
Medical, n (%)	31 (60)	35 (66)	
Surgical-trauma, n (%)	21 (40)	18 (34)	
Cause of acute respiratory failure			0.78
Pneumonia, n (%)	24 (46.2)	24 (45.3)	
Multiple trauma, n (%)	12 (23.1)	11 (20.8)	
Atelectasis, n (%)	5 (9.6)	4 (7.5)	
Shock, n (%)	3 (5.8)	5 (9.4)	
Cardiogenic pulmonary edema, n (%)	3 (5.8)	3 (5.7)	
Cardiac arrest, n (%)	2 (3.8)	3 (5.7)	
Other, n (%)*	3 (5.8)	3 (5.7)	
Length of mechanical ventilation before inclusion, d	5.2 ± 3.7	4.6 ± 4.1	0.43
Length of ICU stay before inclusion	5.6 ± 4.4	5.2 ± 4.4	0.67
Pa_{O_2}, mm Hg	93.4 ± 24.2	89.9 ± 19.5	0.41
Pa_{CO_2}, mm Hg	36 ± 7.1	34.7 ± 7.6	0.36
Sa_{O_2}, %	97.2 ± 2.6	96.9 ± 2.0	0.71
$F_{I_{O_2}}$, %	39 ± 7	38 ± 7	0.47

Nasal High-Flow versus Venturi Mask Oxygen Therapy after Extubation

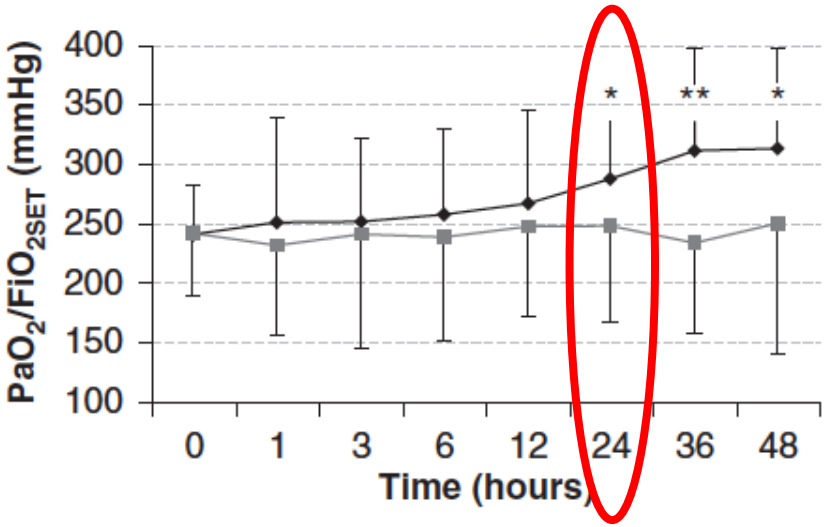
Effects on Oxygenation, Comfort, and Clinical Outcome

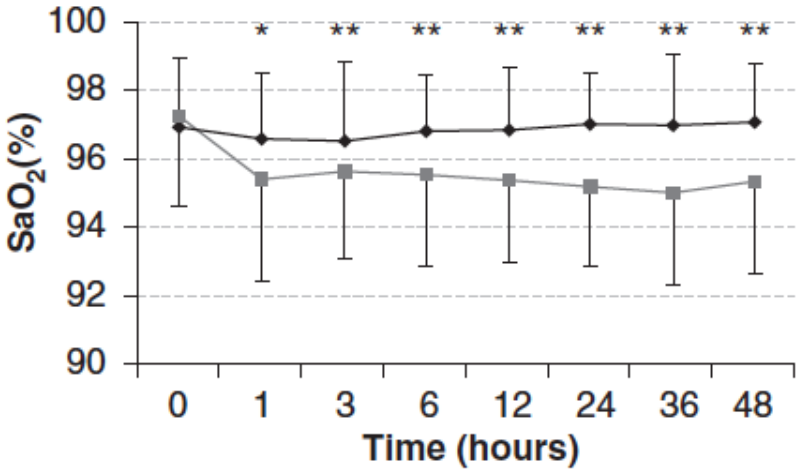
Salvatore Maurizio Maggiore[1], Francesco Antonio Idone[1], Rosanna Vaschetto[2], Rossano Festa[1], Andrea Cataldo[1], Federica Antonicelli[1], Luca Montini[1], Andrea De Gaetano[3], Paolo Navalesi[4,5,6], and Massimo Antonelli[1]

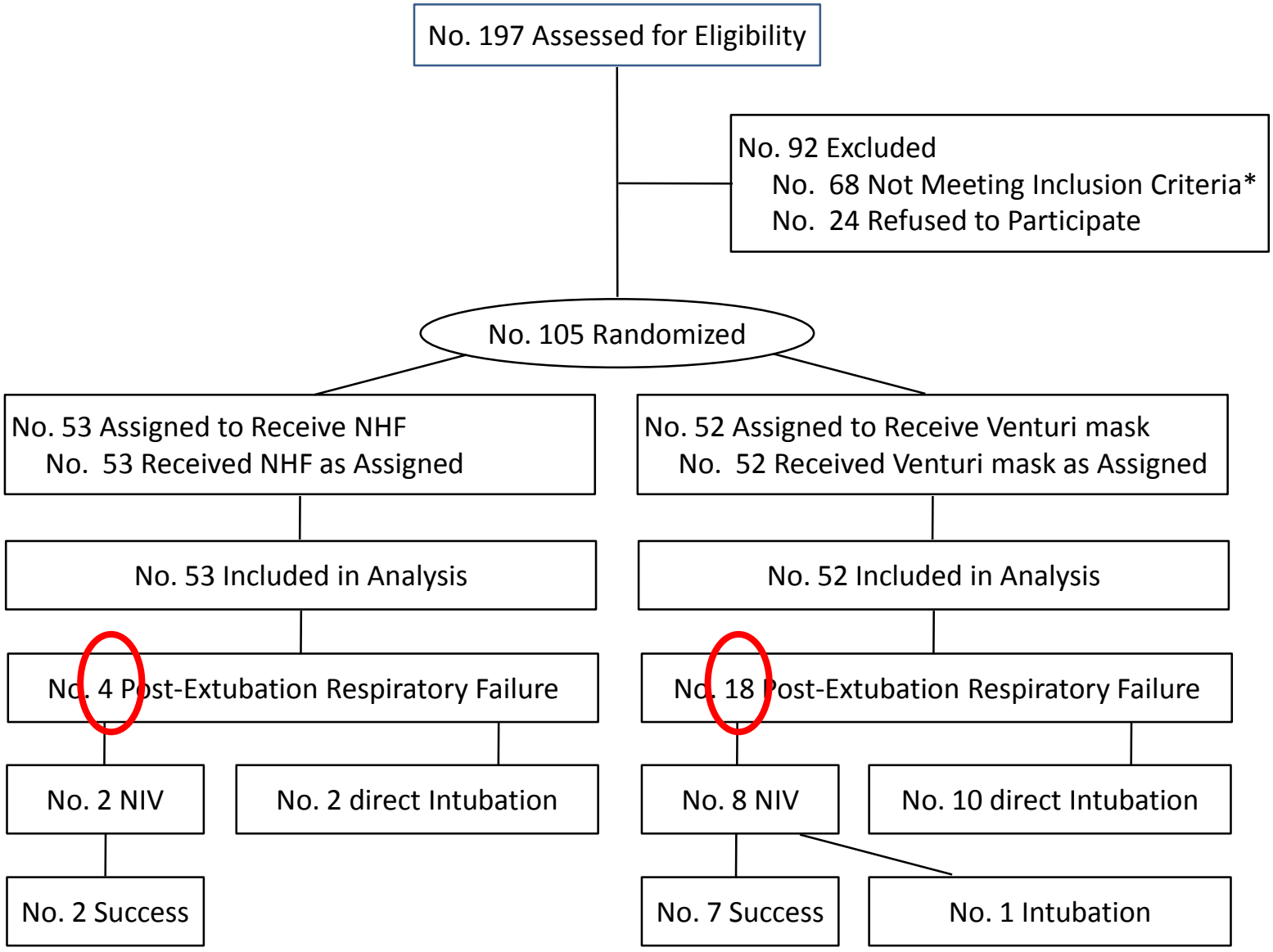
Am J Respir Crit Care Med 2014;190:282–288



Objectif I







Maggiore et al. AJRCCM 2014

	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

LOS ICU: 11.7 ± 10.2 vs. 10.4 ± 8.5 d (HFNC vs. Venturi mask; P =0.44)
ICU mortality: 11.3% vs. 9.6%; P = 0.77

Maggiore et al. AJRCCM 2014

The RINO Trial (ReINtubation rate after Oxygen therapy)

- Multicenter, randomized, controlled, phase III, open trial (NCT02107183)
- 500 patients
- Nasal high-flow vs Venturi mask after extubation
- Study hypothesis: using Optiflow for delivering oxygen therapy after extubation may reduce the extubation failure rate and the need for reintubation as compared with the Venturi mask

HFNC après extubation

D’un opéré

BJA

Open-label, phase II study of routine high-flow nasal oxygen therapy in cardiac surgical patients

Parke *et al.* B J Anaesth 2013

R. Parke[1,2*], S. McGuinness[1], R. Dixon[2,4] and A. Jull[2,3]

A pragmatic, open-label RCT of patients following extubation after cardiac surgery

45 l/min
SpO_2>93%

Assessed for eligibility n=725

Excluded n=309
Did not meet inclusion criteria=138
Declined participation n=144
Exclusion criteria present n=5
Other reason n=22

Enrolled n=416

Excluded n=75
Not extubated by 10 a.m. n=74
Clinician preference for O_2 therapy at extubation n=1

Randomized n=341

Randomized to nasal high flow n=170

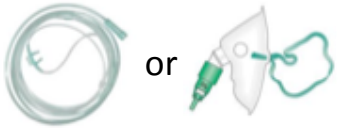
Lost to follow-up n=0
Consent withdrawn n=1

Analysed n=169

Randomized to usual care n=171

Lost to follow-up n=0
Consent withdrawn n=0

Analysed n=171



2-4 l/min
SpO_2>93%

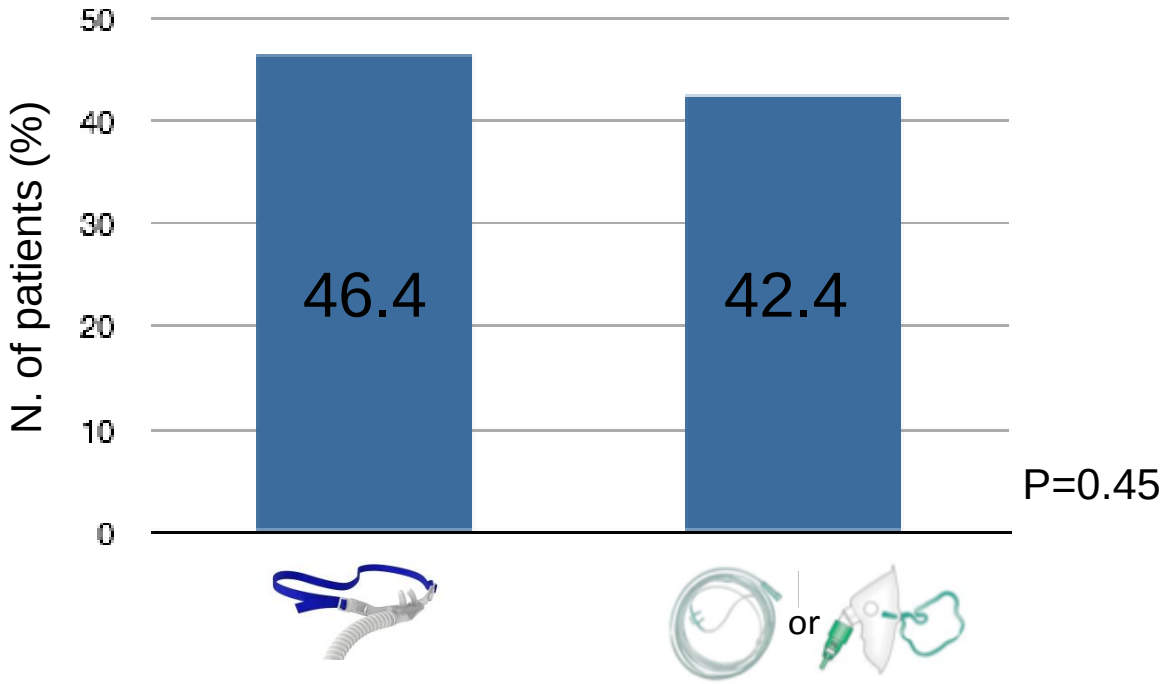
BJA

Open-label, phase II study of routine high-flow nasal oxygen therapy in cardiac surgical patients

R. Parke[1,2*], S. McGuinness[1], R. Dixon[2,4] and A. Jull[2,3]

Parke *et al.* B J Anaesth 2013

Primary outcome: N. of patients with SpO2/FiO2 >445 on Day 3



SpO_2/FiO_2 >445 on Day 3

BJA

Open-label, phase II study of routine high-flow nasal oxygen therapy in cardiac surgical patients

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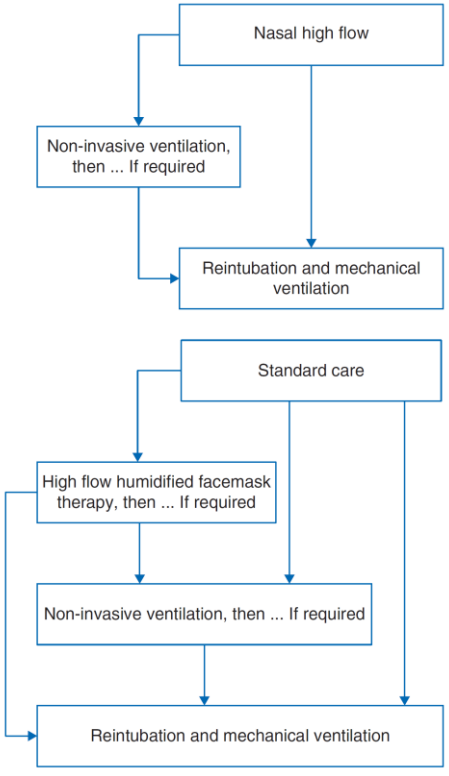
Parke *et al.* B J Anaesth 2013



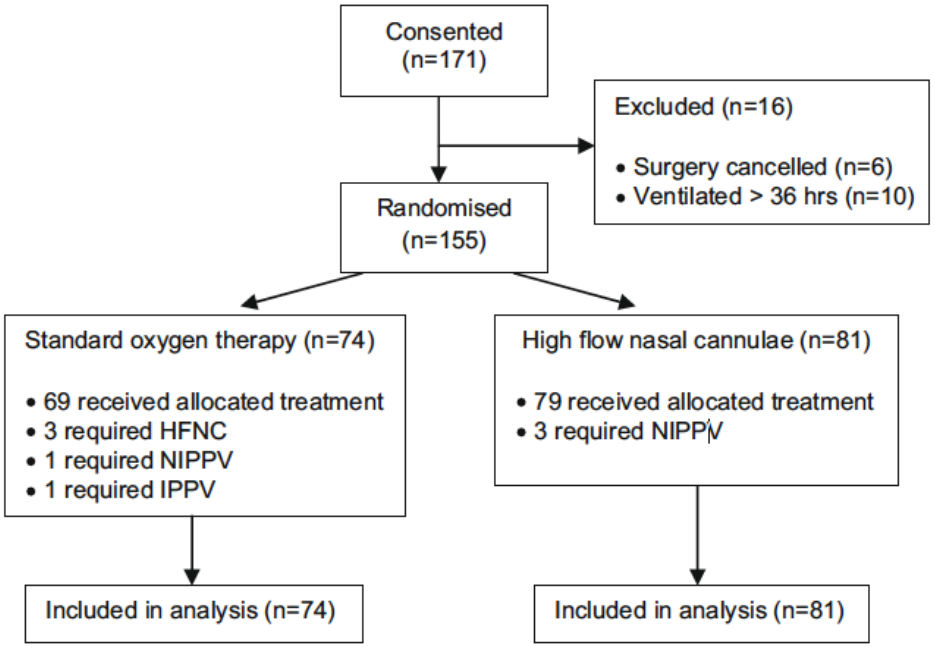
	Usual care (N=171)	**NHF** (N=169)	OR (95%CI)	P value
Escalation therapy	77 (45%)	47 (28%)	0.47 (0.29-0.74)	0.001
N (% of those requiring escalation on that day)				
Up to 4 h after extubation	1 (33.3)	2 (66.7)	NR	NR
On Day 1 postoperative	35 (76.1)	11 (23.9)	0.3 (0.1-0.6)	<0.001
On Day 2 postoperative	35 (66)	18 (34)	0.5 (0.3-0.9)	0.01
On Day 3 postoperative	6 (28.6)	15 (71.4)	2.7 (1.0-7.1)	0.04
Reintroduction of oxygen therapy after Day2	54 (31.6)	29 (17.1)	0.45 (0.27-0.75)	0.002
NIV (CPAP or BiPAP)	5 (2.9%)	9 (5.3%)	1.87 (0.6-5.7)	0.27
Intubation	0	2	NR	NR

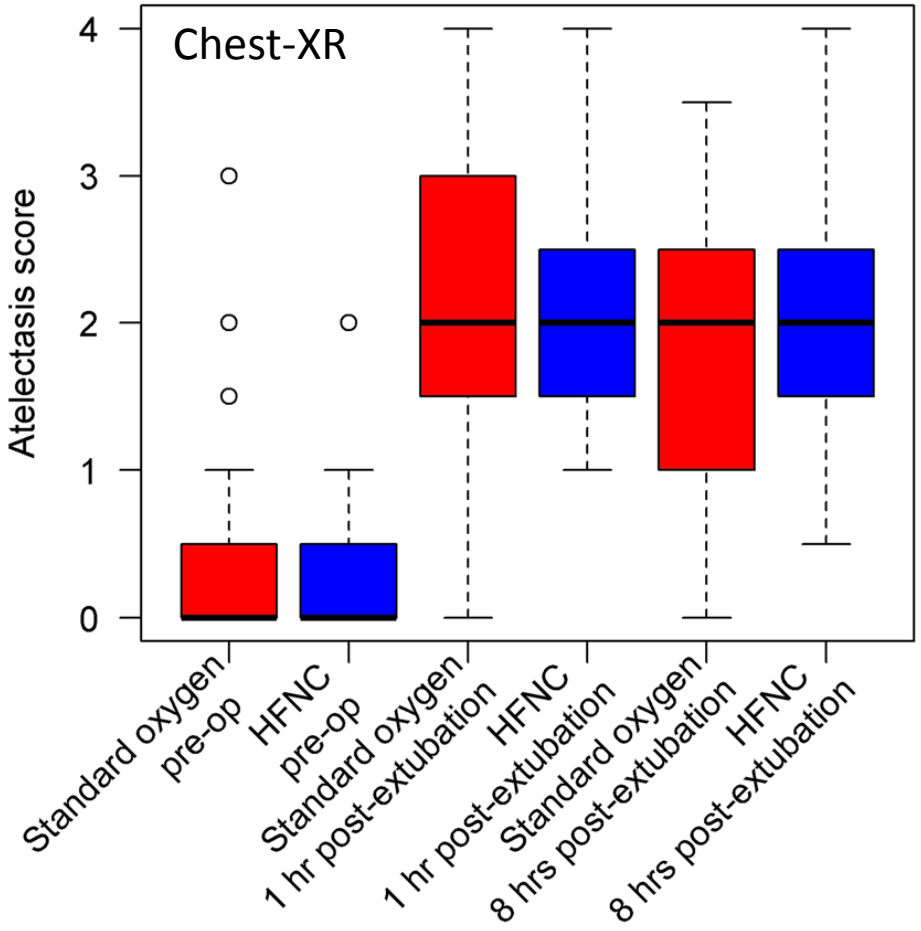
Intensive Care Med (2015) 41:887–894
DOI 10.1007/s00134-015-3765-6

ORIGINAL

Amanda Corley
Taressa Bull
Amy J. Spooner
Adrian G. Barnett
John F. Fraser

Direct extubation onto high-flow nasal cannulae post-cardiac surgery versus standard treatment in patients with a BMI ≥30: a randomised controlled trial





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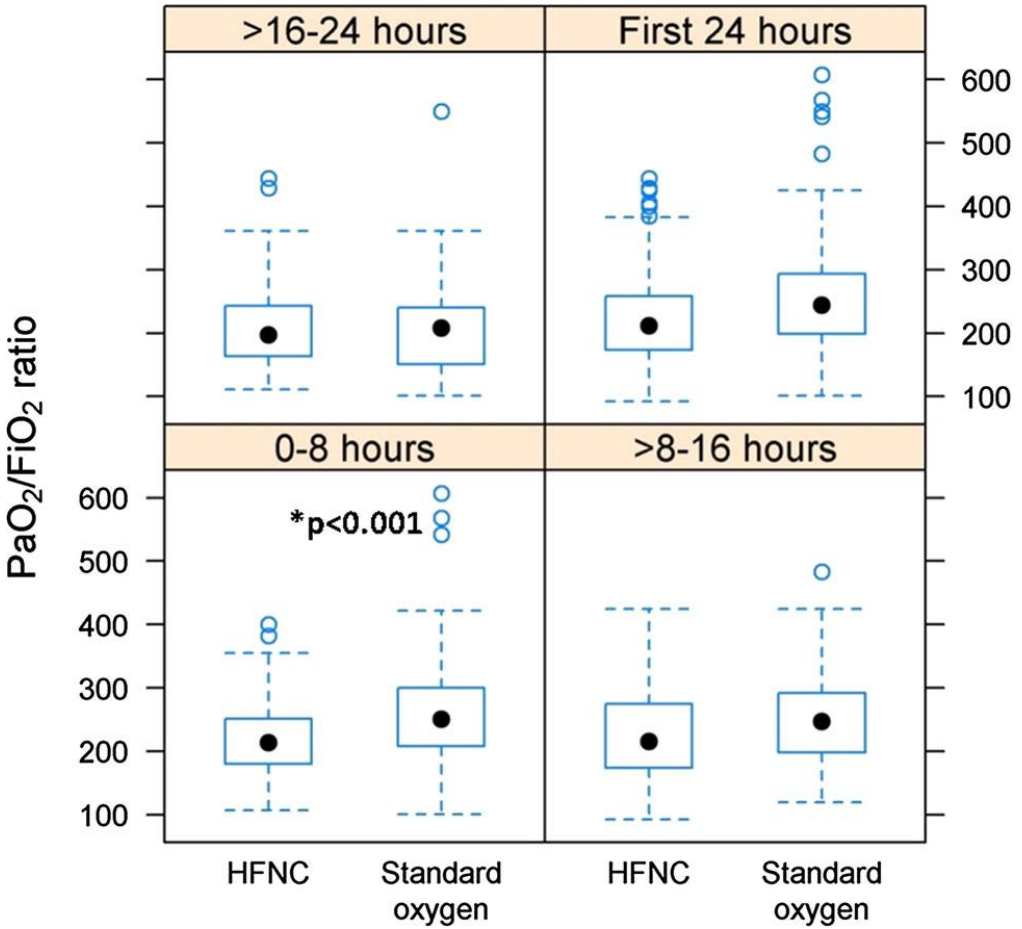
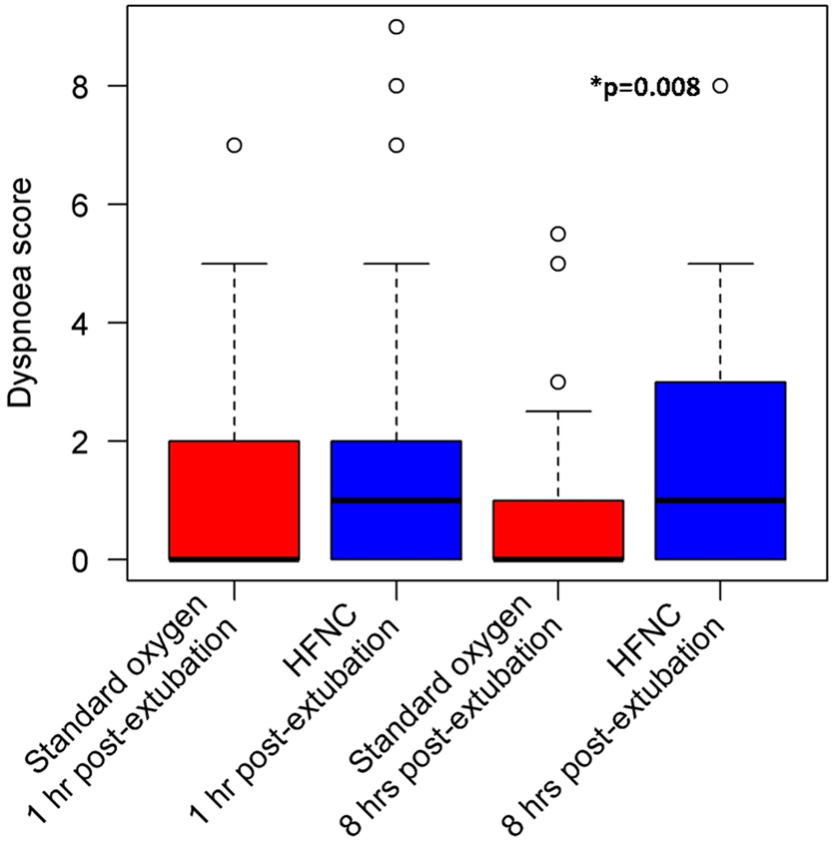


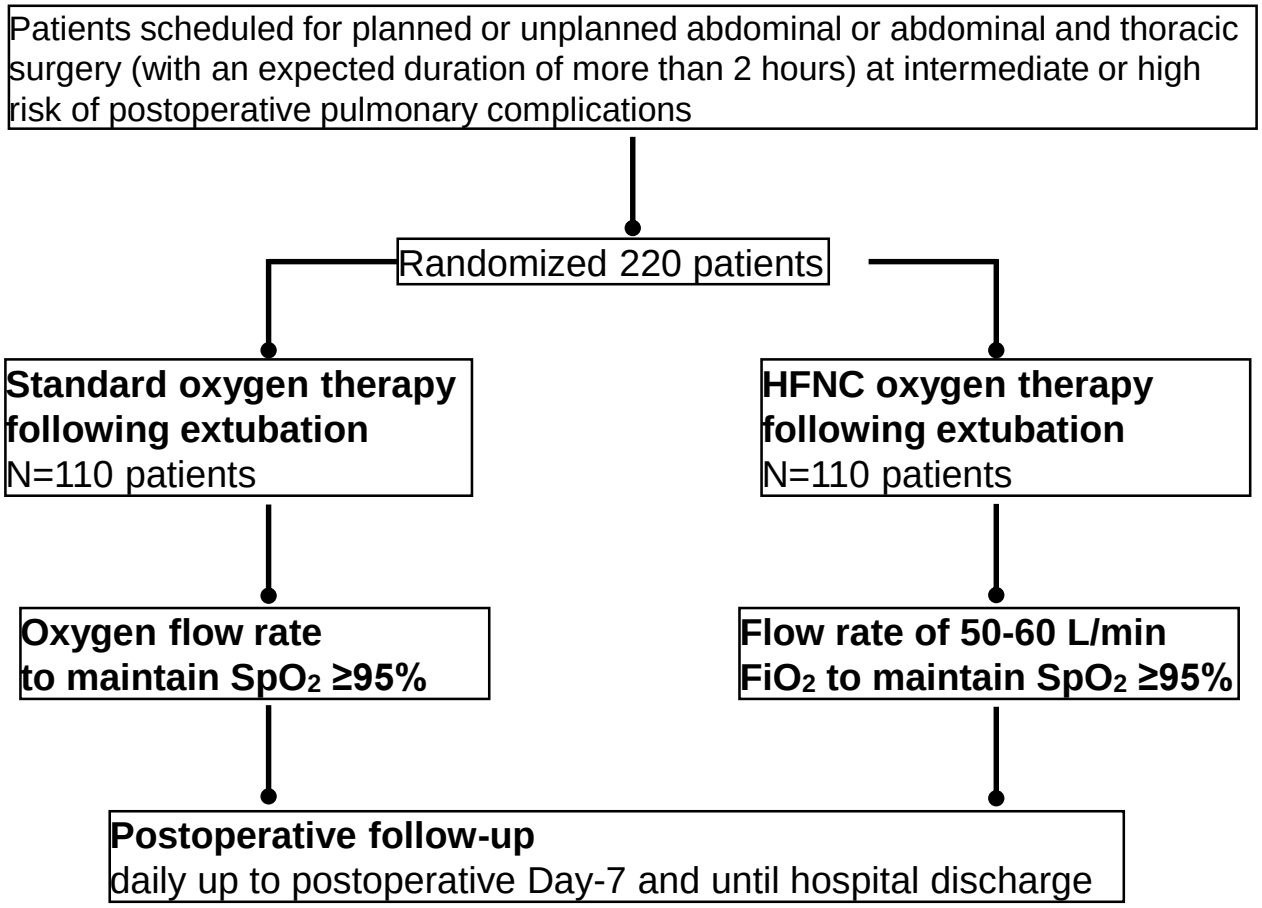


Futier *et al. Trials* 2013, **14**:341
http://www.trialsjournal.com/content/14/1/341

TRIALS

STUDY PROTOCOL Open Access

Optiflow® to Prevent **P**ost-**E**xtubation Hypoxemia afte**R** **A**bdominal Surgery (**OPERA** Trial)



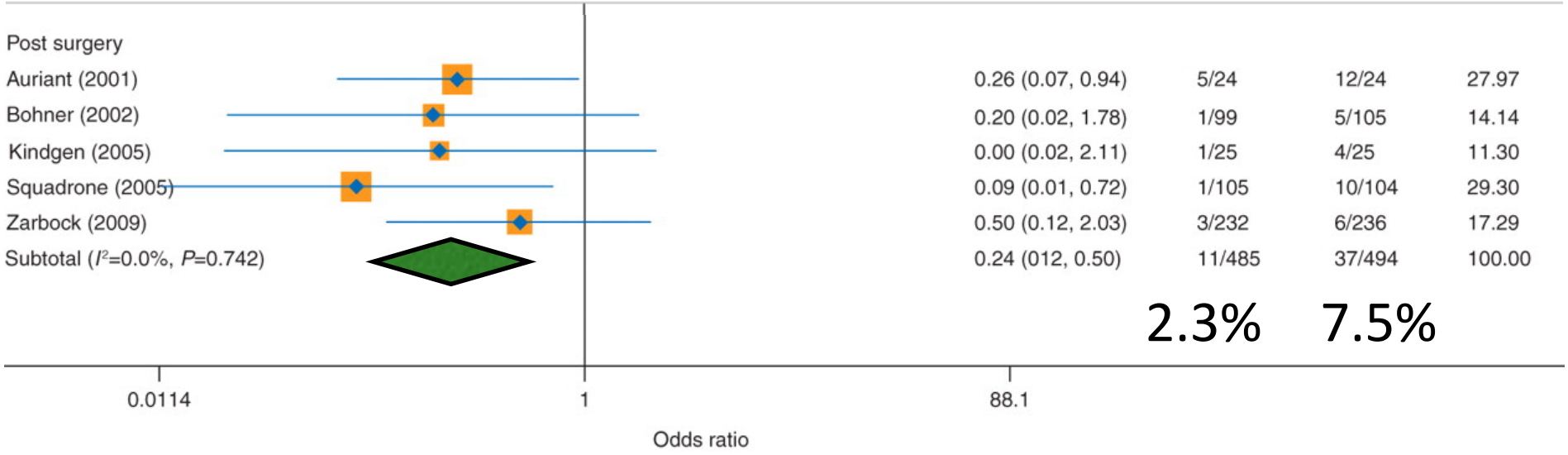
REVIEW ARTICLES British Journal of Anaesthesia 2012;109:305–14

Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis

A. J. Glossop[1*], N. Shepherd[2], D. C. Bryden[3] and G. H. Mills[3]

Reintubation

NIV after surgery



HFNC en post-opératoire

BiPOP

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

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

A Randomized Clinical Trial

JAMA 2015;313(23):2331-9

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

Objectif: Déterminer que HFNC est non inférieur à la VNI pour la prévention des complications respiratoires dans les suites d'une chirurgie cardio-thoracique

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

JAMA 2015;313(23):2331-9

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

A Randomized Clinical Trial

- Echec SBT ("à risque")
  - SaO2< 90% sous O2 12 L pendant T-tube
  - Ou PaO2 < 75mmHg avec FiO2 > 50% avec AI « faible »
- Succès SBT mais FdR IRA ("préventif")
  - body mass index > 30
  - FEVG < 40%
  - Echec extubation antérieure
- Succès SBT mais échec extubation ("curatif")
  - P/F < 300
  - FR > 25/min pendant au moins 2h
  - Mise en jeu muscles respiratoires accessoires ou ventilation paradoxale

Exclusion criteria were obstructive sleep apnea, tracheostomy, do-not-intubate status, delirium, nausea and vomiting, bradypnea, impaired consciousness, and hemodynamic instability.

Méthodes

- Réglages initiaux
  - HFNC 50 lpm, FiO2 0,5 pour SaO2 92-98%
  - Bilevel positive airway pressure (BiPAP)
    - BiPap Vision (Respironics)
    - AI-PEEP (Drager Evita XL ou 4, Monnal T 75)
    - HME
    - AI 8 cmH_2O puis modifiée pour obtenir Vte 8 mL/kg et FR < 25/min
    - PEEP 4 cmH_2O; FiO2 0.5 ajustée pour SaO2 92-98%
    - 2 h puis environ 1 h toutes les 4h, ou davantage
    - Entre les sessions: O2 lunettes, masque facial

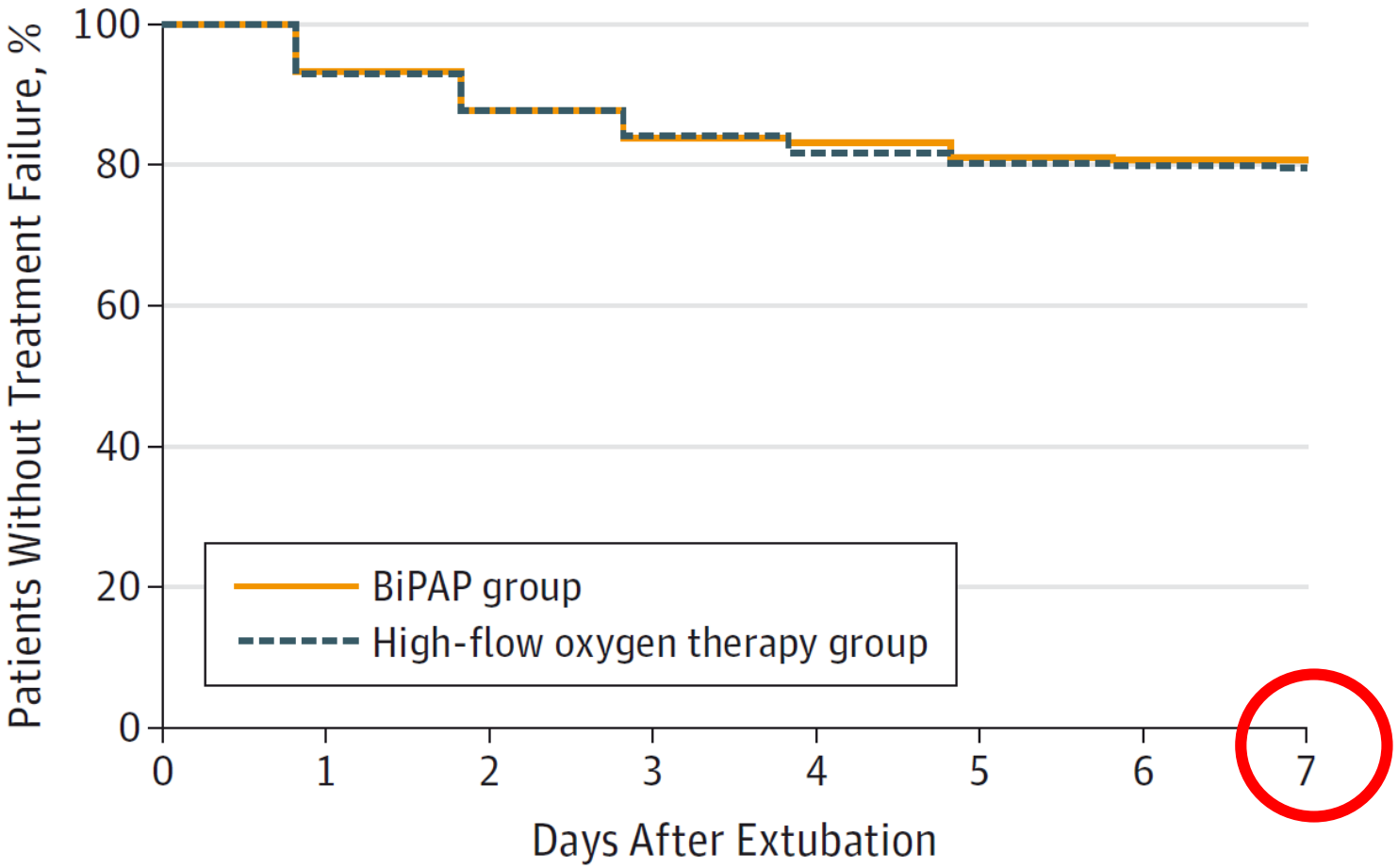
Stephan *et al.* JAMA 2015

Définitions

Stephan *et al.* JAMA 2015

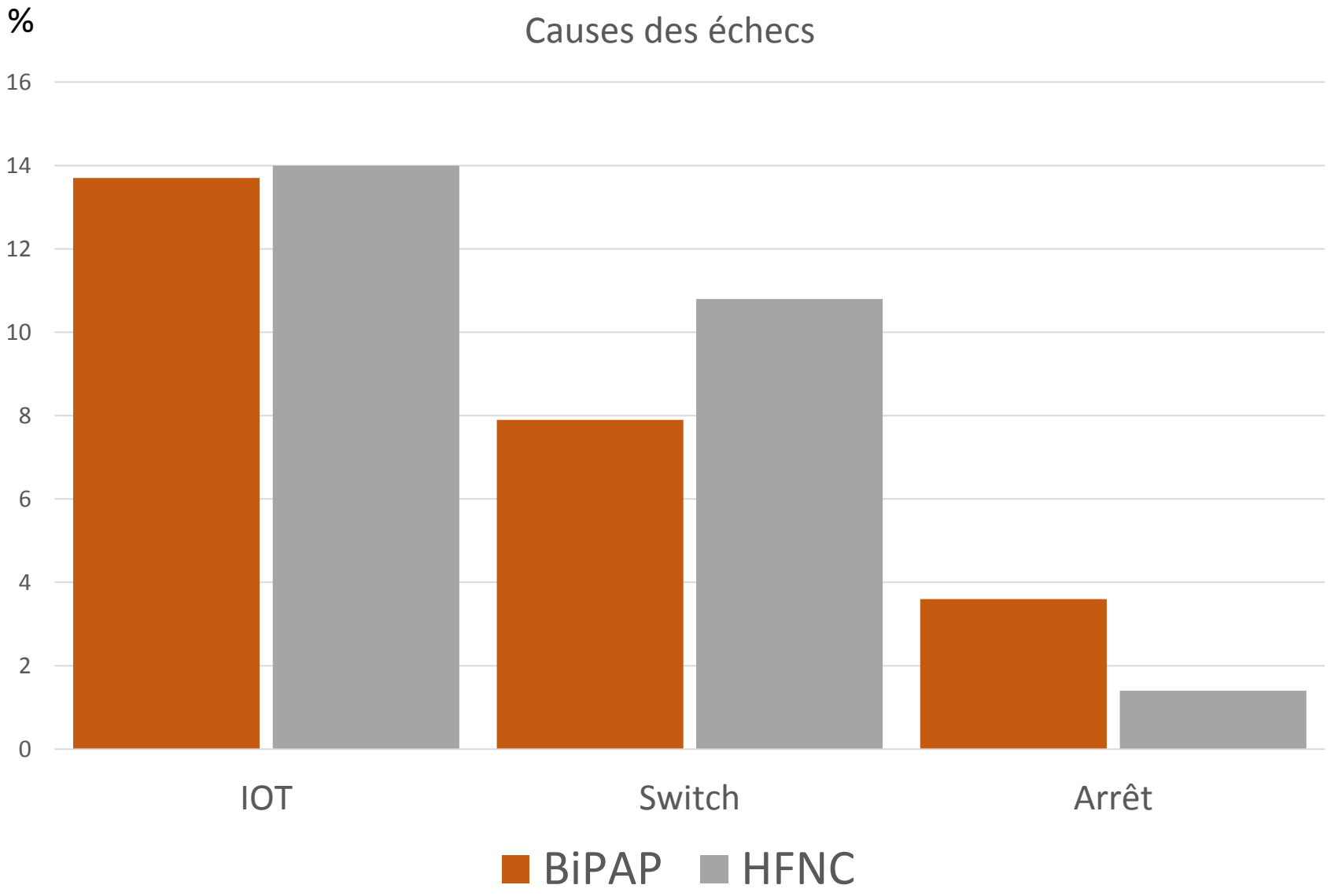
- Echec du traitement
  - Réintubation et VM
  - Switch pour un autre traitement
  - Arrêt prématuré
    - À la demande du patient
    - Pour motif médical
- Réintubation
  - Arrêt respiratoire
  - Pauses respiratoires avec alteration du niveau de vigilance
  - Instabilité hémodynamique
  - Sécrétions très abondantes (encombrement majeur)
  - Epuisement
  - $SaO_2 < 88\%$ sous $FiO_2=1$
  - Acidose respiratoire: pH < 7,30 et $PaCO_2 > 50$ mmHg

Characteristics	BiPAP (n = 416)	High-Flow Nasal Oxygen Therapy (n = 414)
Age, mean (95% CI), y	63.9 (62.6-65.2)	63.8 (62.5-65.2)
Men, No. (%)	278 (66.8)	273 (65.9)
Body mass index[a]		
Mean (95% CI)	28.2 (27.6-28.7)	28.3 (27.8-28.8)
>30, No. (%)	136 (32.7)	135 (32.6)
Smoking, No. (%)[b]		
Former	217 (52.2)	226 (54.6)
Current	69 (16.6)	83 (20.0)
SAPS II score at admission, mean (95% CI)	28.8 (27.7-30.0)	29.0 (27.8-30.1)
Surgical procedures, No. (%)		
Coronary artery bypass grafting	111 (26.7)	122 (29.5)
Valvular surgery	83 (20.0)	88 (21.3)
Combined cardiac surgery with coronary artery bypass grafting	27 (6.5)	26 (6.3)
Thoracic aorta	28 (6.7)	23 (5.6)
Pulmonary thromboendarterectomy	90 (21.6)	68 (16.4)
Lung resection	30 (7.2)	34 (8.2)
Heart, lung, and heart-lung transplantations	9 (2.2)	18 (4.3)
Others	38 (9.1)	35 (8.5)
Cardiopulmonary bypass, No. (%)	340 (81.7)	320 (77.2)
Duration of cardiopulmonary bypass, mean (95% CI), min	137 (129-146)	137 (128-146)
Time from surgery to randomization, median (IQR), d	1.0 (1.0-3.0)	1.0 (1.0-3.0)
Duration of mechanical ventilation at randomization, median (IQR), h	13.0 (6.0-27.5)	11.5 (5.0-25.4)



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

Stephan *et al.* JAMA 2015



Stephan *et al.* JAMA 2015

Pas d'amélioration du confort

Parameters	Mean (95% CI)							
	Baseline		1 Hour			6-12 Hours		
	BiPAP Group	HFNO Group	BiPAP Group	HFNO Group	*P* Value	BiPAP Group	HFNO Group	*P* Value
Dyspnea score, No./total (%) [95% CI]								
Improvement			266/404 (65.8) [61.0-70.7]	236/403 (58.6) [53.6-63.4]		229/379 (60.4) [55.3-65.4]	217/373 (58.2) [52.9-63.2]	
No improvement			120/404 (29.7) [25.3-34.4]	151/403 (37.5) [32.7-42.4]	.39	133/379 (35.1) [30.3-40.1]	139/373 (37.3) [32.4-43.4]	.99
Deterioration			18/404 (4.5) [2.7-7.0]	16/403 (4.0) [2.3-6.4]		17/379 (4.5) [2.6-6.1]	17/373 (4.6) [2.7-7.2]	
Comfort score, No. (%) [95% CI]								
Poor			51/397 (13.0) [9.7-16.5]	67/402 (16.7) [13.2-20.7]		67/376 (17.8) [14.1-22.1]	66/372 (17.7) [14.0-22.0]	
Acceptable			128/397 (32.2) [27.7-37.1]	101/402 (25.1) [21.0-29.7]	.32	110/376 (29.3) [24.7-34.1]	115/372 (31.0) [26.3-36.9]	.99
Good			218/397 (55.0) [49.9]	234/402 (58.2) [53.2-63.1]		199/376 (53.0) [47.7-58.1]	101/372 (51.0) [46.1-56.5]	

Events	Group		*P* Value
	BiPAP (n = 416)	HFNO (n = 414)	
Nosocomial pneumonia, No. (%) [95% CI]	90 (21.6) [17.8-25.9]	83 (20.0) [16.4-24.3]	.57
Pneumothorax, No. (%) [95% CI]	7 (1.7) [0.7-3.6]	8 (1.9) [0.9-3.9]	.86
Acute colonic pseudo-obstruction, No. (%) [95% CI]	8 (1.9) [0.9-3.9]	9 (2.2) [1.0-4.2]	.86
No. of days with respiratory support, median (IQR)	2 (1-3)	2 (1-3)	.59
Stay length, median (IQR), d			
ICU	6 (4-10)	6 (4-10)	.77
Hospital	14 (9-20)	13 (9-22)	.59

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- Echec SBT (“à risque”)
  - SaO2< 90% sous O2 12 L pendant T-tube
  - Ou PaO2 < 75mmHg avec FiO2 > 50% avec AI « faible »

Stephan *et al.* JAMA 2015

- Succès SBT mais FdR IRA (“préventif”)
  - body mass index > 30
  - FEVG < 40%
  - Echec extubation antérieure
- Succès SBT mais échec extubation (“curatif”)
  - P/F < 300
  - FR > 25/min pendant au moins 2h
  - Mise en jeu muscles respiratoires accessoires ou ventilation paradoxale

Table. Treatment Failure Rate According to the Eligibility Criteria

Eligibility Criteria	Treatment Failure, No./Total (%)		*P* Value[a]
	Bilevel Positive Airway Pressure	High-Flow Nasal Oxygen Therapy	
Failure of spontaneous breathing trial	7/25 (28.0)	11/27 (40.7)	.33
Successful spontaneous breathing trial in high-risk patients	19/151 (12.6)	8/139 (5.7)	.04
Failed extubation	65/240 (27.8)	68/248 (27.4)	.93

EDITORIAL

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High-Flow Nasal Cannulae or Noninvasive Ventilation for Management of Postoperative Respiratory Failure

Lorenzo Del Sorbo, MD; Niall D. Ferguson, MD, MSc

How should clinicians apply the results of the trial by Stephan et al. in clinical practice? The answer is, as usual, it depends. In centers with considerable expertise with NIV and for patients who are hypercapnic, a reasonable approach would be to favor NIV in this setting. Alternatively, based on these data and others, for many postoperative patients HFNC appear to be a viable alternative that is better tolerated and may lead to non inferior clinical outcomes.

HFNC en pré-intubation

Vourc'h *et al.* Intensive Care Med 2015

Pré- et per-intubation

PREOXYFLOW

- Multicentrique
- IOT par juniors/seniors
- ARF
  - FR > 30 et FiO2 ≥ 50 % pour SpO2 ≥ 90 %
  - et PaO2/FiO2 ratio < 300 mmHg dans les 4h précédant inclusion
- HFNC 60 lpm FiO2=1 pendant 4 minutes avant induction et pendant l'intubation vs. masque 15 lpm O2 pendant 4 minutes avant induction
- Objectif I: SpO2 la plus basse entre l'induction et la connexion au ventilateur

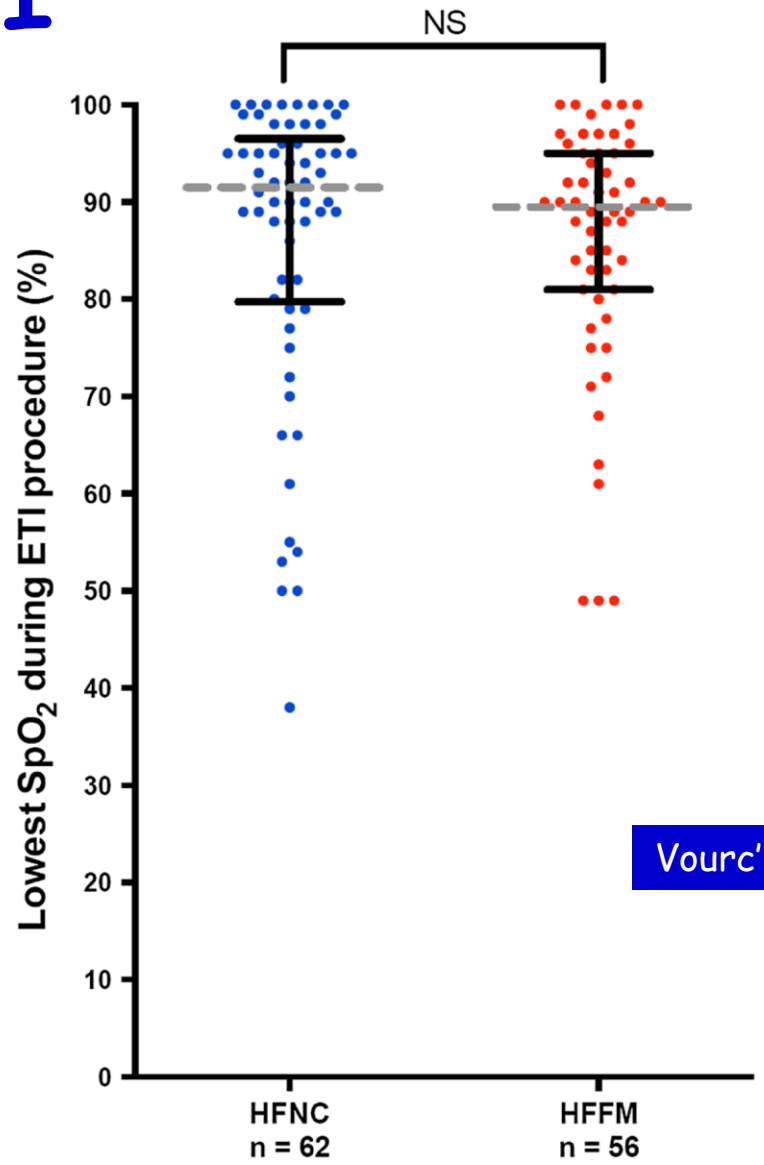
Vourc'h *et al.* Intensive Care Med 2015

	High-flow nasal cannulae ($n = 62$)	High-flow face mask ($n = 57$)
Sex ratio M/F	39/23	39/18
Age, mean (SD), years	64.9 (14)	59.3 (14.5)
BMI, mean (SD)[a]	27.6 (5.8)	27.6 (7.3)
Medical patients, *n* (%)	54 (87.1)	50 (87.7)
SAPS II score, mean (SD)[b]	54.5 (20.2)	51.3 (16.5)
Comorbidities		
Chronic heart failure (NYHA III or IV), *n* (%)	4 (6.5)	3 (5.3)
Chronic respiratory failure, *n* (%)	5 (8)	5 (8.8)
Obstructive sleep apnoea syndrome, *n* (%)	1 (1.6)	6 (10.7)
COPD patients, *n* (%)[c]	7 (11.3)	6 (10.7)
Past upper airway tract cancer, *n* (%)	1 (1.6)	1 (1.8)
Diabetes requiring insulin therapy, *n* (%)	2 (3.2)	4 (7)
Vasopressor support at inclusion, *n* (%)	18 (29)	11 (19.3)
Glasgow Coma Score, mean (SD)	13.5 (2.8)	13.4 (2)
McCabe scale 2 or 3, *n* (%)[d]	30 (48.4)	23 (40.4)
Functional status KNAUS (class C or D), *n* (%)[e]	19 (30.6)	13 (22.8)
Respiratory failure aetiology, *n* (%)		
Pneumonia	25 (40.3)	29 (50.9)
Extra-respiratory ARDS	19 (30.6)	11 (19.3)
Cardiogenic pulmonary oedema	3 (4.8)	5 (8.7)
COPD exacerbation	4 (6.4)	0
Thoracic trauma	1 (1.6)	5 (8.7)
Other	10 (16.1)	7 (12.2)
Advanced oxygenation support in the last hour before inclusion, *n* (%)		
NIV	11 (17.8)	8 (14)
HFNC	10 (16.1)	3 (5.3)
Arterial blood gas oxygenation		
PaO_2/FiO_2, mean (SD), mm Hg	120.2 (55.7)	115.7 (63)
$PaCO_2$, mean (SD), mm Hg	39.8 (14.7)	37.4 (11)
SpO_2, mean (SD), %	94.6 (4.7)	93.4 (6)

Vourc'h *et al.* Intensive Care Med 2015

	High-flow nasal cannulae ($n = 62$)	High-flow face mask ($n = 57$)
Airway description		
At least 2 difficult mask ventilation criteria[a], *n* (%)	43 (69.4)	33 (57.9)
Medical history of difficult intubation, *n* (%)	0	2 (3.5)
Mouth opening less than 3 cm, *n*/*n* tot[b] (%)	4/52 (7.7)	8/48 (16.7)
Limitation of cervical mobility ≤35°, *n*/*n* total[b] (%)	2/44 (4.6)	8/42 (19)
Thyromental distance < 65 mm, *n*/*n* tot[b] (%)	4/51 (7.8)	10/40 (25)
Mallampati III or IV, *n*/*n* tot[b] (%)	10/39 (25.6)	12/32 (37.5)
Macocha score, *n* (%)[c]		
<3	25 (78.1)	11 (55)
≥3	7 (21.88)	9 (45)
First operator[d]		
Senior *n* (%)	11 (17.7)	16 (28)
Junior *n* (%)	51 (82.2)	41 (71.9)
Emergency intubation[e]		
Real emergency, *n* (%)	12 (19.3)	29 (50.8)
Relative emergency, *n* (%)	48 (77.4)	25 (43.8)
Deferred emergency, *n* (%)	2 (3.2)	3 (5.2)

Objectif I



Median (IQR)	91.5 (80-96)	89.5 (81-95)
Mean (SD)	86.2 (15.2)	85.9 (12.9)

Vourc'h *et al.* Intensive Care Med 2015

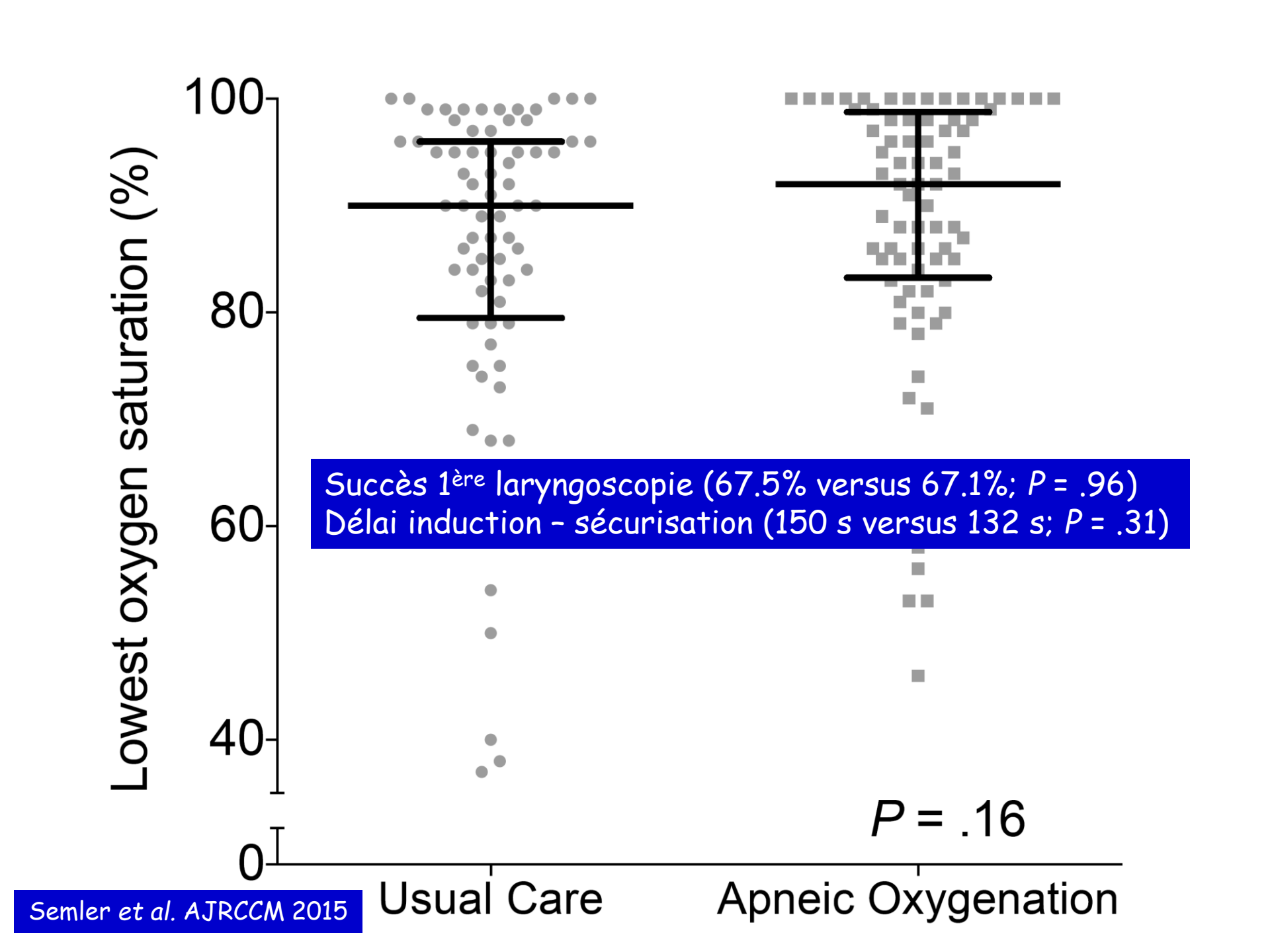
	High-flow nasal cannulae ($n = 62$)	High-flow face mask ($n = 57$)	p^a
Primary outcome			
Lowest SpO_2 during ETI procedure, median (IQR)	91.5 (80–96)	89.5 (81–95)	0.44
Secondary outcomes			
Preoxygenation			
Duration of preoxygenation, *n* (%)			
<4 min	4 (6.5)	3 (5.3)	
4 min or more	58 (93.5)	54 (94.7)	0.83
SpO_2 at the beginning of preoxygenation, mean (SD)	95.4 (3.9)	94.1 (6.0)	0.15
SpO_2 at the end of preoxygenation, mean (SD)	97.1 (3.8)	96.3 (4.4)	0.98
Failure to increase saturation to 90 % during preoxygenation, *n* (%)	4 (6.5)	2 (3.5)	0.49
Respiratory outcome			
PaO_2 1 h after ETI, median (IQR), mm Hg	98.2 (72–139.5)	89.5 (69.8–144)	0.94
Duration of mechanical ventilation, median (IQR), days	6 (4–14)	10 (5–17)	0.02
Ventilator-free days (day 28), median (IQR), days[d]	14 (0–22)	5 (0–16)	0.09
Ventilator-associated pneumonia, *n* (%)	6 (9.7)	8 (14)	0.62
Morbidity in ICU			
ICU length of stay, median (IQR), days	10 (6–16)	13 (7–24)	0.12
SOFA score, mean (SD)			
Day 1	8.8 (4.1)	9.2 (3.6)	0.57
Day 2 ($n = 112$)	8.5 (4)	9.3 (4.1)	0.65
Day 3 ($n = 103$)	7.1 (3.5)	8 (4.7)	0.63
Day 4 ($n = 99$)	6.1 (3.6)	7.3 (4.5)	0.23
Day 5 ($n = 95$)	5.6 (3.8)	6.8 (4.6)	0.21
Death in ICU, *n* (%)	21 (33.9)	23 (40.4)	0.46
Mortality at 28 days, *n* (%)	22 (35.4)	24 (42.1)	0.48

Per-intubation (apnée)

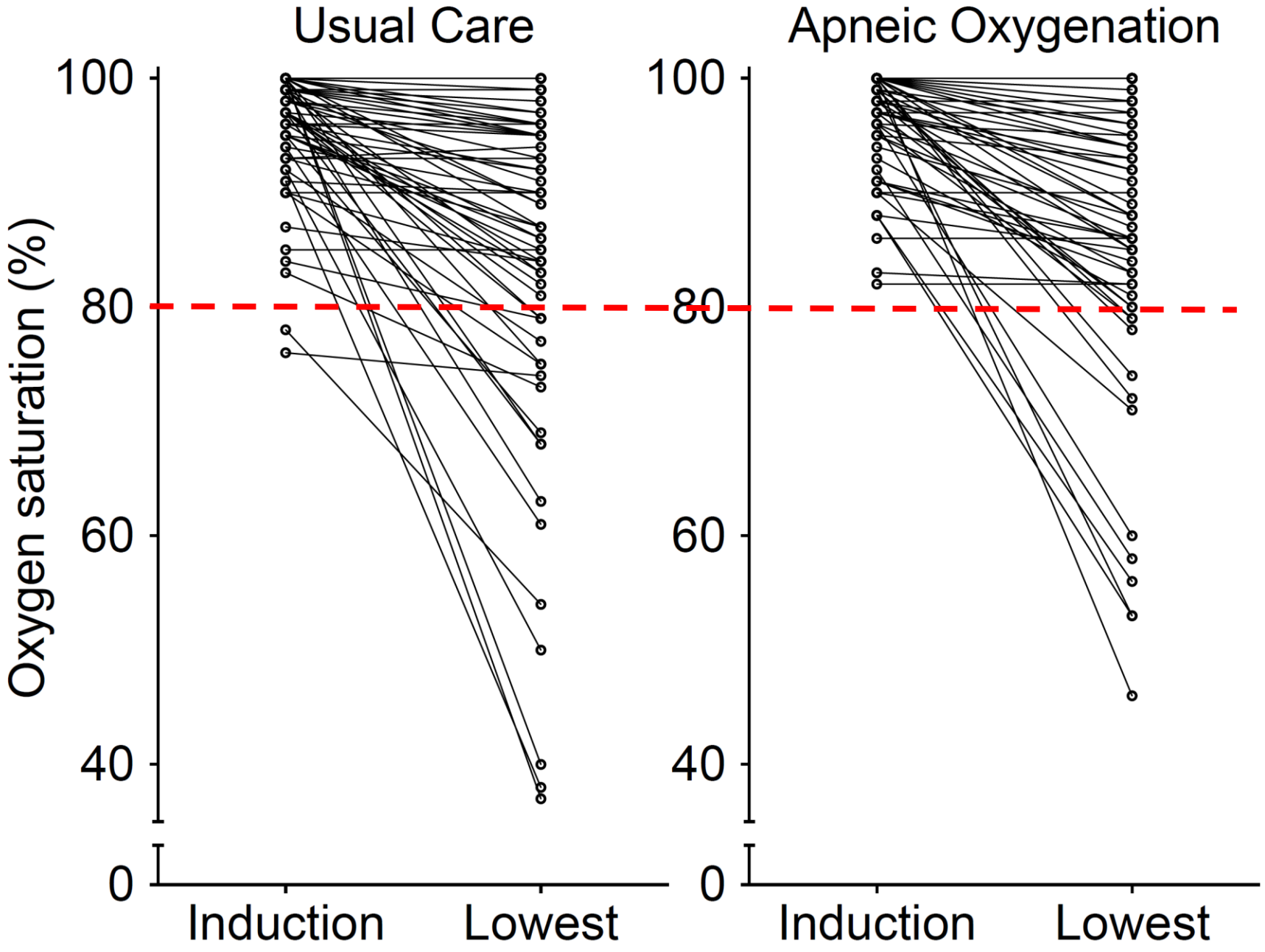
FELLOW

- Monocentrique
- IOT par fellows
- Compare efficacité HFNC 15 lpm FiO2=1 vs. pas d'O2 pendant premier essai de laryngoscopie
- Objectif I: SpO2 la plus basse entre l'induction et la 2ème minute après l'intubation

Semler *et al.* AJRCCM 2015


Lowest oxygen saturation (%)
100
80
60
40
0
Usual Care
Apneic Oxygenation
P = .16
Succès 1ère laryngoscopie (67.5% versus 67.1%; P = .96)
Délai induction – sécurisation (150 s versus 132 s; P = .31)
Semler et al. AJRCCM 2015

Semler *et al.* AJRCCM 2015



	Usual Care	Apneic Oxygenation	
Oxygenation Outcomes	**(n = 73)**	**(n = 77)**	***P* Value**
Lowest oxygen saturation, median [IQR], %	90 [80-96]	92 [84-99]	.16
Lowest oxygen saturation < 90%, No. (%)	34 (47.2%)	34 (44.7%)	.87
Lowest oxygen saturation < 80%*, No. (%)	18 (25.0%)	12 (15.8%)	.22
Decrease in oxygen saturation, median [IQR], %	4.5 [1-14]	4.0 [0-12]	.60
Decrease in oxygen saturation > 3%, No. (%)	40 (55.6%)	41 (53.9%)	.87
Clinical Outcomes			
Duration of mechanical ventilation, median [IQR], days	3 [2-7]	3 [1-10]	.73
Intensive care unit length of stay, median [IQR], days	7 [3-10]	4 [2-9]	.24
Died within one hour of intubation, No. (%)	1 (2.8%)	0 (0.0%)	>.99
Died before hospital discharge, No. (%)	36 (49.3%)	27 (35.1%)	.10

Semler *et al.* AJRCCM 2015

Recommendations of the task force regarding the use of HFNC

Indication	Acute respiratory failure	In obese patients	Prior intubation	Following extubation	During bronchoscopy	For the delivery of aerosol therapy
Level of evidence	High To be confirmed	Low Additional trials are needed	Low to Moderate Additional trials are needed	Moderate Additional trials are needed	Moderate Additional trials are needed	Low to Moderate Additional trials are needed

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