Stratégies d'oxygénation dans l'insuffisance respiratoire aiguë

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Conflicts of interest

- Fisher & Paykel

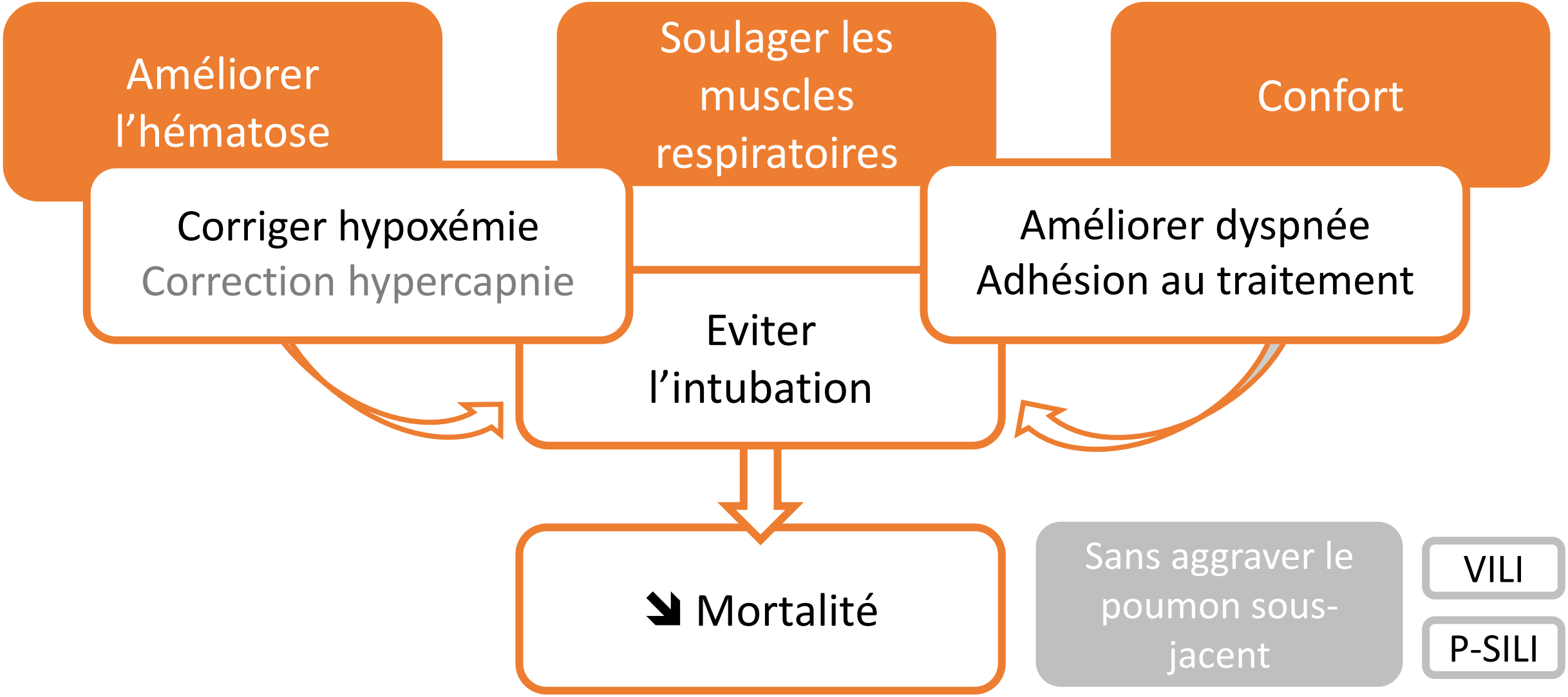
- Bourse du nouveau souffle

LE NOUVEAU SOUFFLE

- La Fondation du Souffle

Fondation du Souffle
Donnez, Cherchons, Respirez !

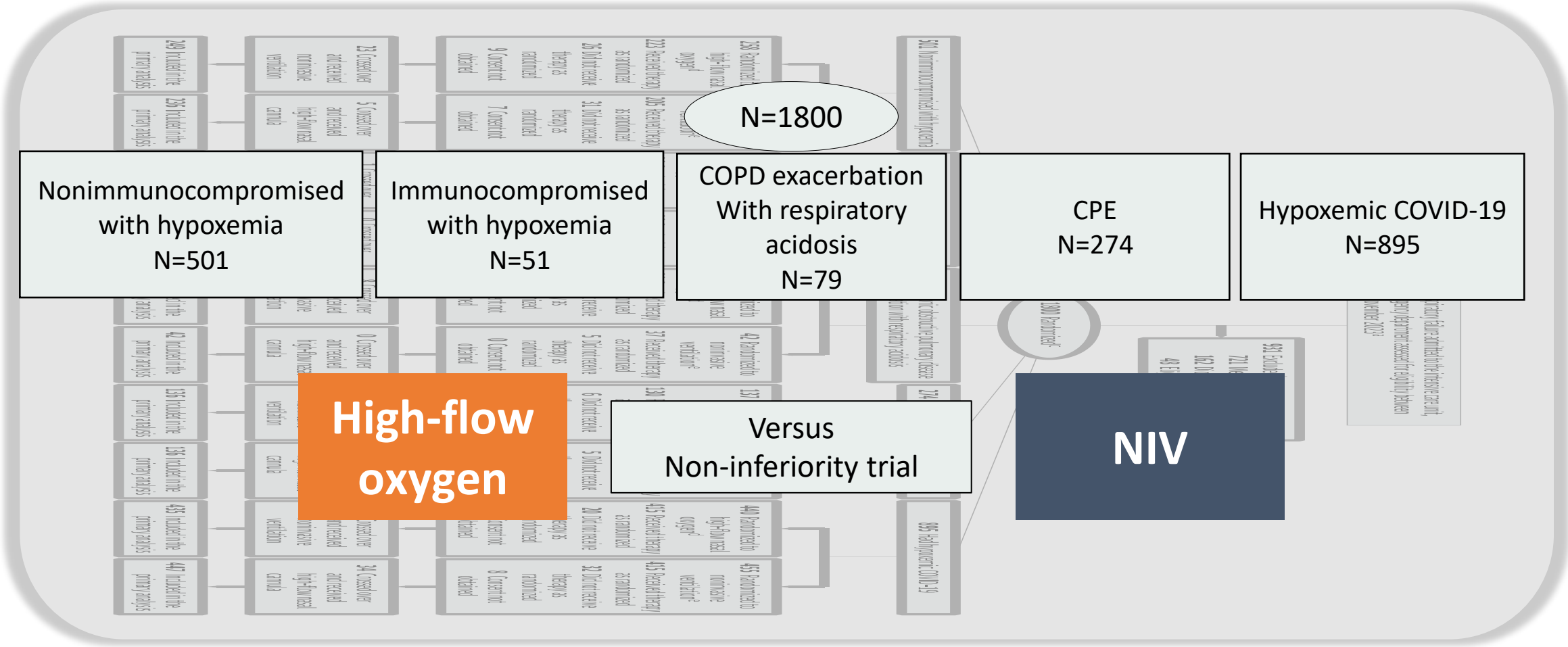
Effets attendus d'un support d'oxygénation



High-Flow Nasal Oxygen vs Noninvasive Ventilation in Patients With Acute Respiratory Failure

The RENOVATE Randomized Clinical Trial

RENOVATE Investigators and the BRICNet Authors

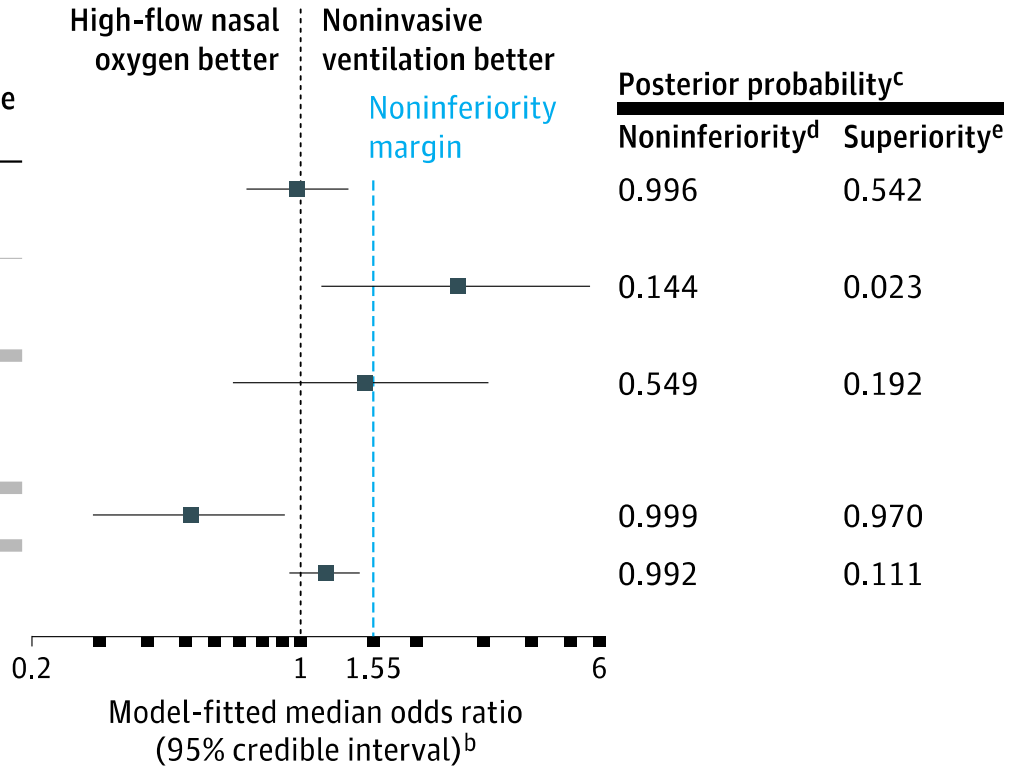


JAMA 2024

Critère de jugement principal
intubation ou décès < 7 jours

B Post hoc analysis of the primary outcome[f]

Patients with acute respiratory failure	No./total (%)		Model-fitted median odds ratio (95% credible interval)[b]	Posterior probability[c]	
	High-flow nasal oxygen	Noninvasive ventilation		Noninferiority[d]	Superiority[e]
Nonimmunocompromised with hypoxemia	81/249 (32.5)	78/236 (33.1)	0.98 (0.73-1.33)	0.996	0.542
Immunocompromised with hypoxemia	16/28 (57.1)	8/22 (36.4)	2.56 (1.14-5.68)	0.144	0.023
COPD with respiratory acidosis	10/35 (28.6)	11/42 (26.2)	1.48 (0.67-3.09)	0.549	0.192
Acute cardiogenic pulmonary edema	14/136 (10.3)	29/136 (21.3)	0.52 (0.29-0.91)	0.999	0.970
Hypoxemic COVID-19	223/435 (51.3)	210/447 (47.0)	1.16 (0.94-1.43)	0.992	0.111



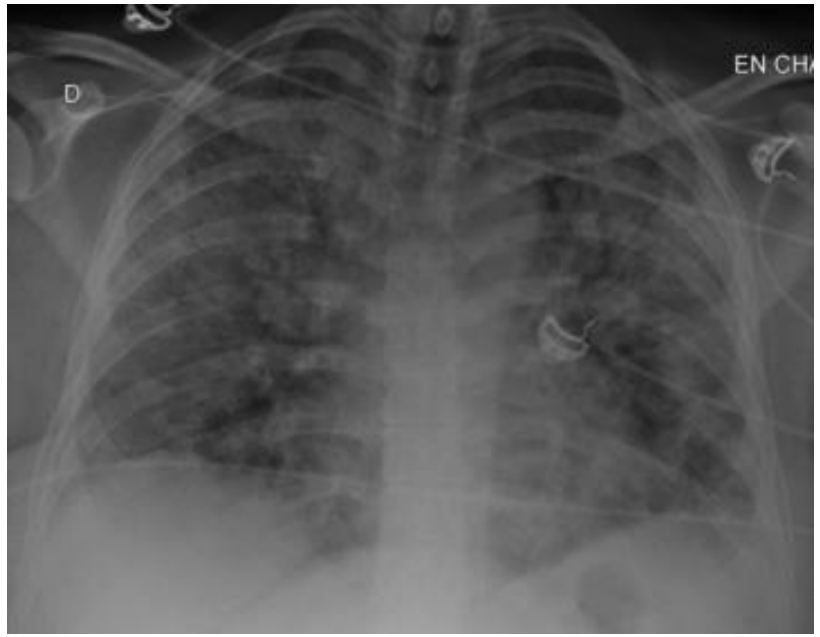
RENOVATE, JAMA 204

Le meilleur support d'oxygénation : pour qui ?

Insuffisance respiratoire aiguë **hypoxémique**

Insuffisance respiratoire **hypercapnique**

Insuffisance respiratoire aiguë **hypoxémique**



La cause la plus fréquente
pneumonie

~~*OAP*~~
~~*exacerbation de BPCO*~~

Hypoxemie
PaO_2/FiO_2 < 200 mm Hg
ou O_2 > 6/min

Effort inspiratoire intense
Contraction muscles respiratoire accessoires
polypnée

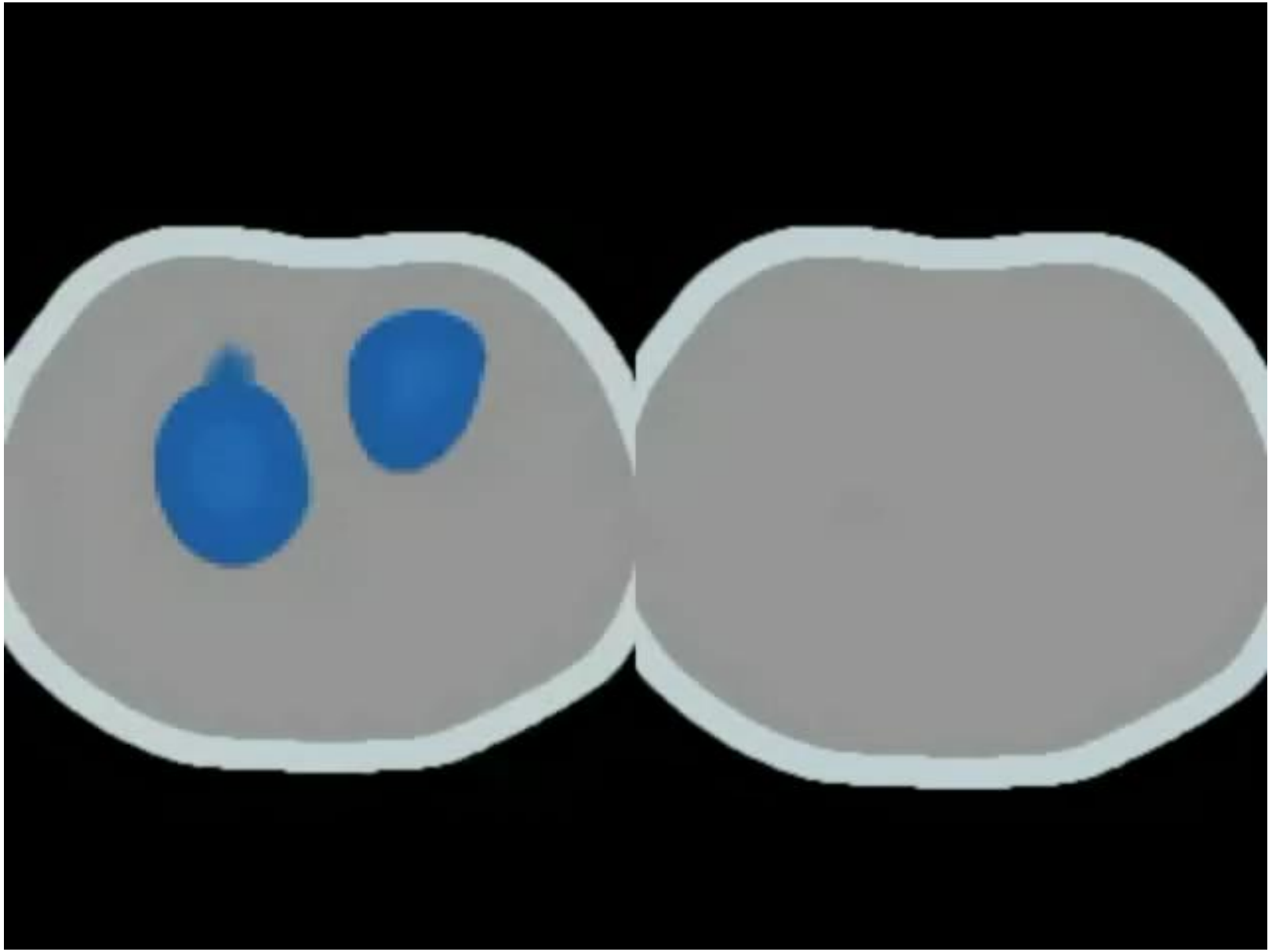
Helms et al. Annals of Intensive Care (2024) 14:140

Quel support d'oxygénation ?

Pour les effets physiologiques et le confort …

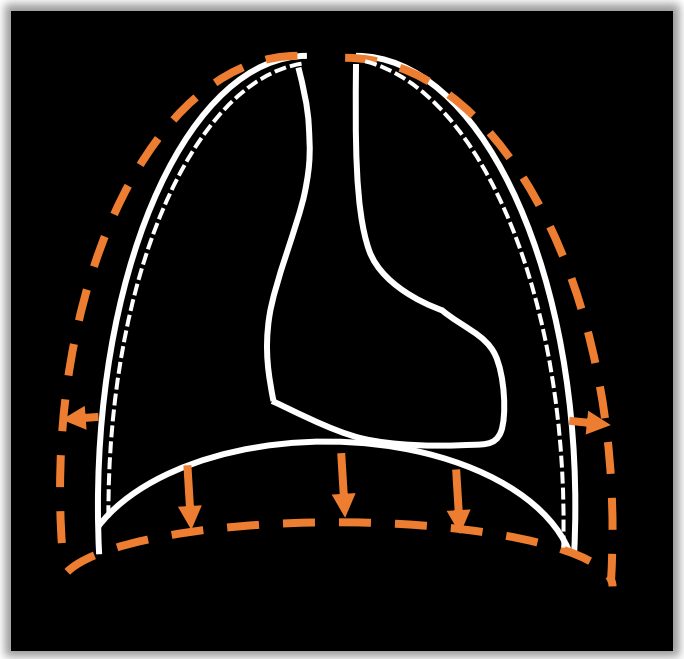
- O_2 standard
- Oxygénothérapie à haut débit
- VNI

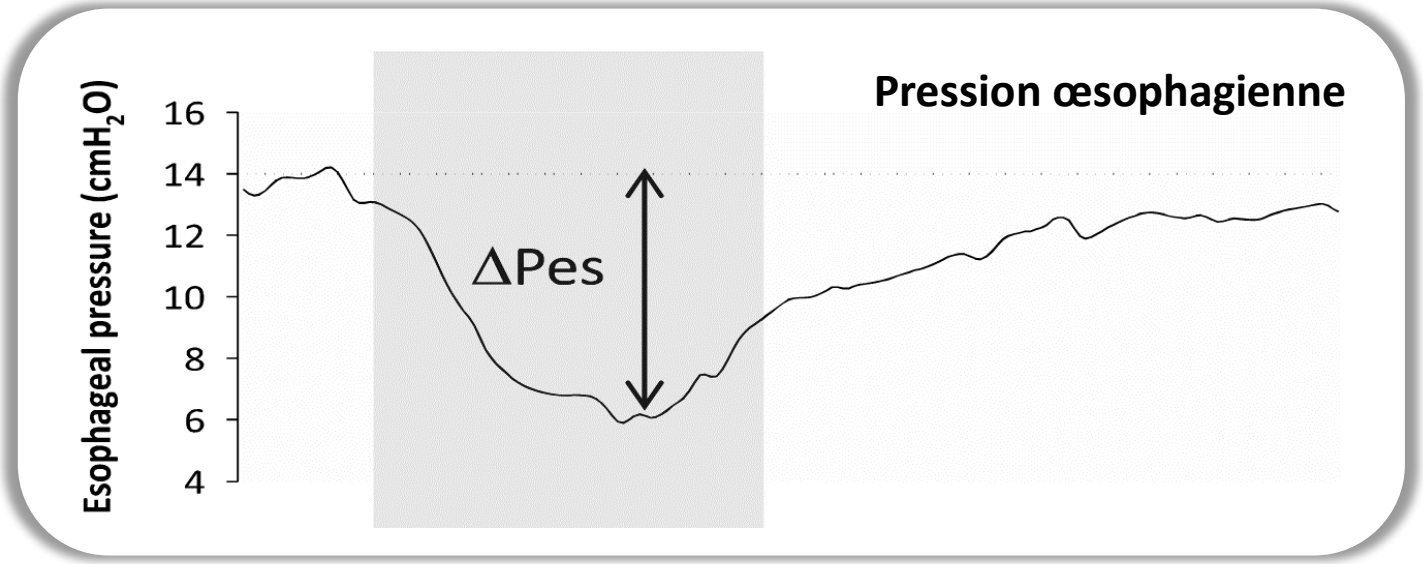
Tomographie par impédance électrique

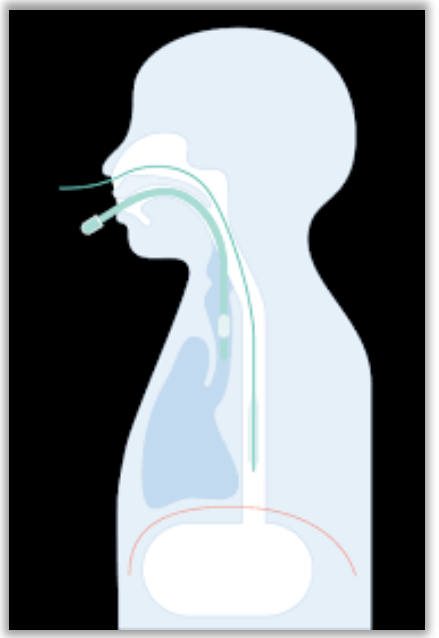


Mesure de la Pression œsophagienne

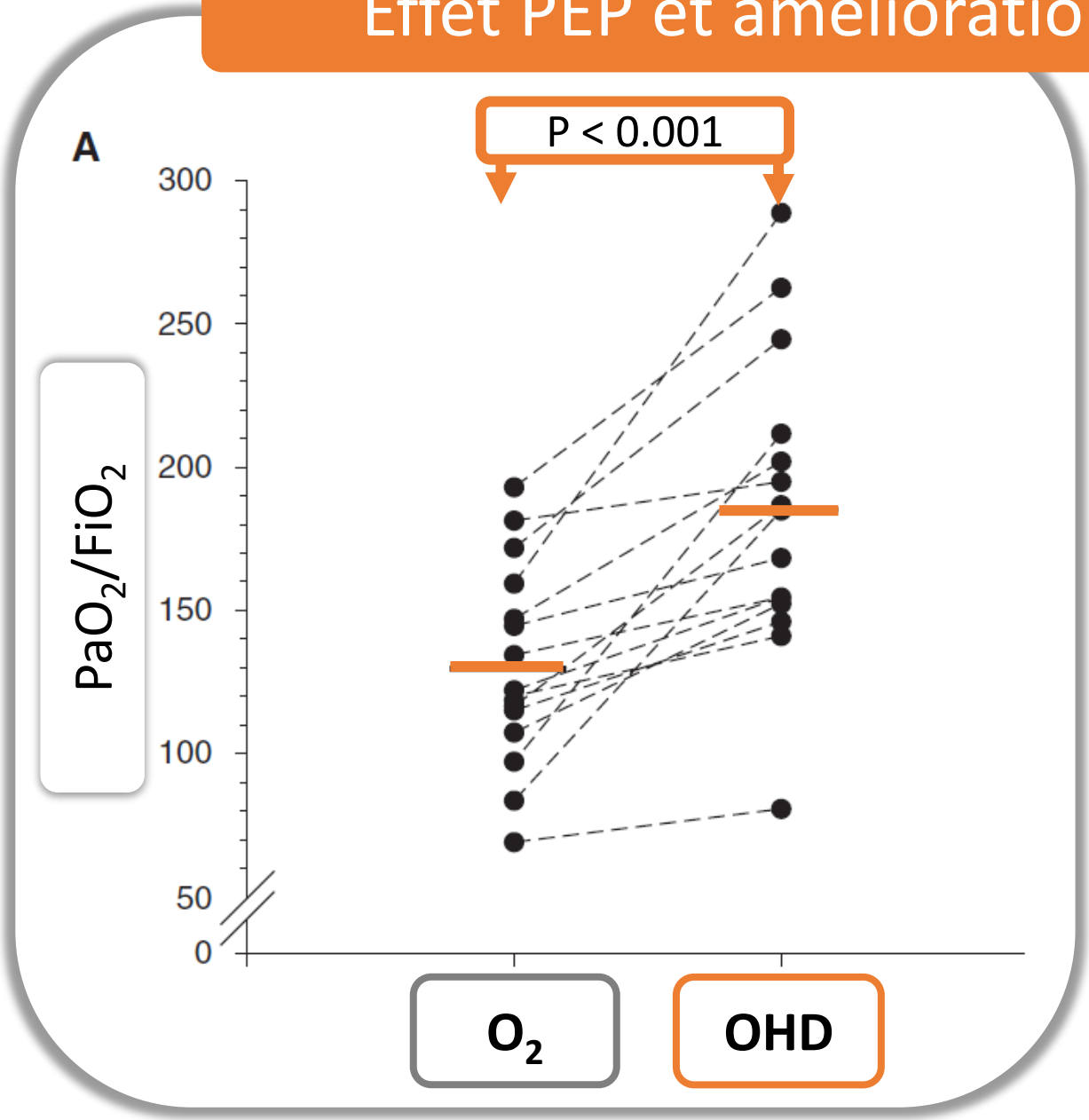
Effort inspiratoire : $\Delta P_{pleurale}$

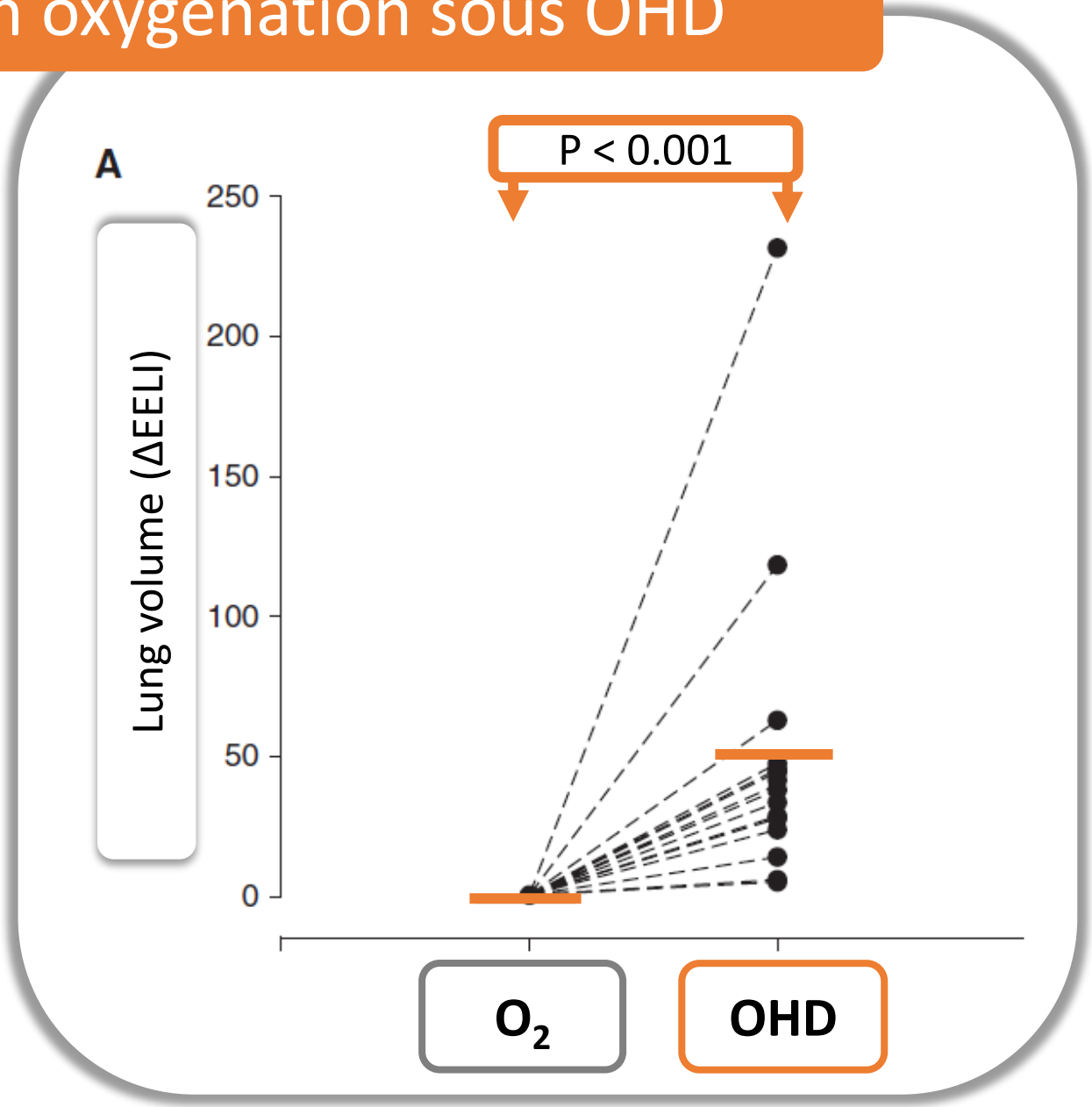






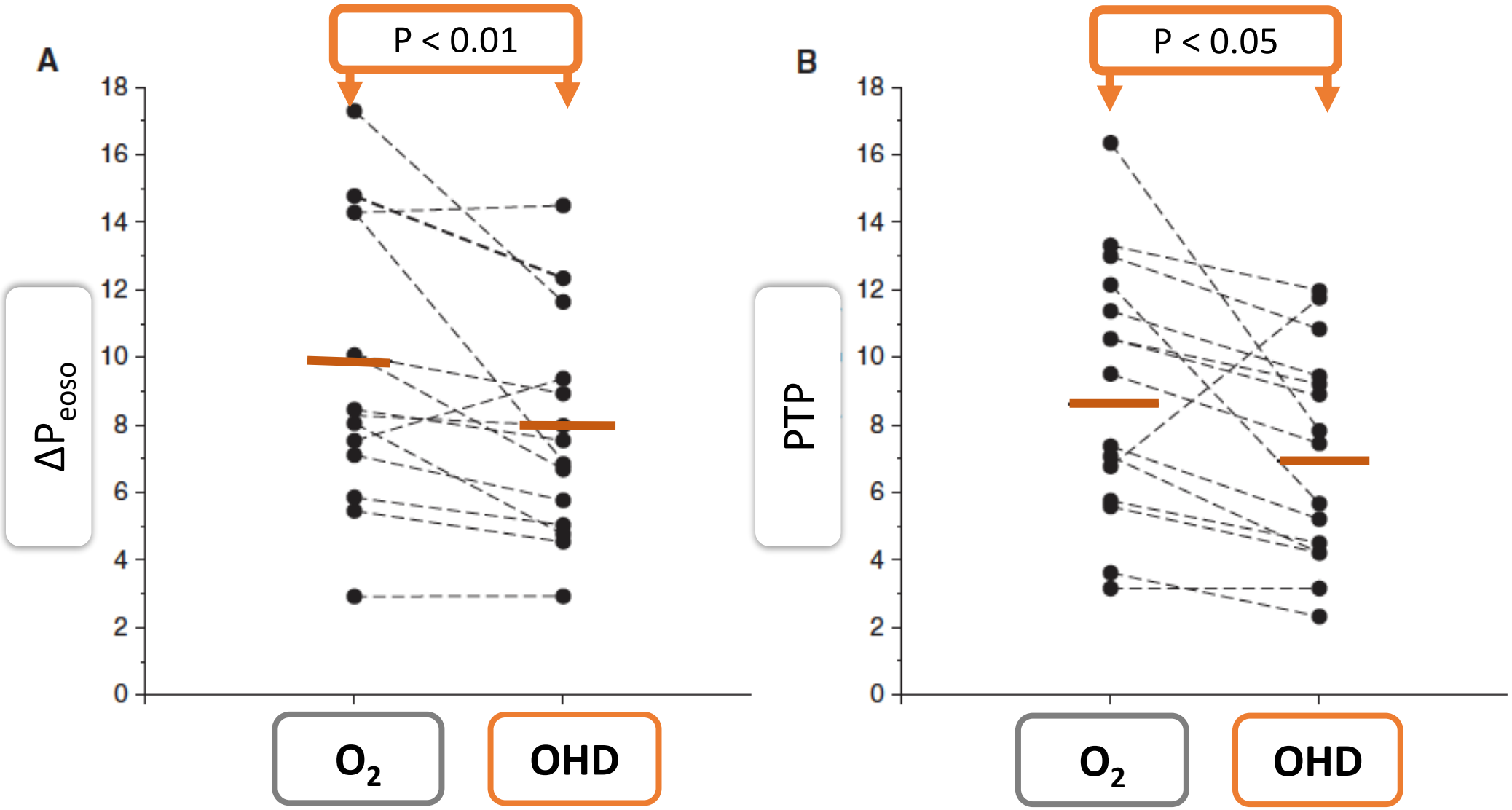
Effet PEP et amélioration oxygenation sous OHD





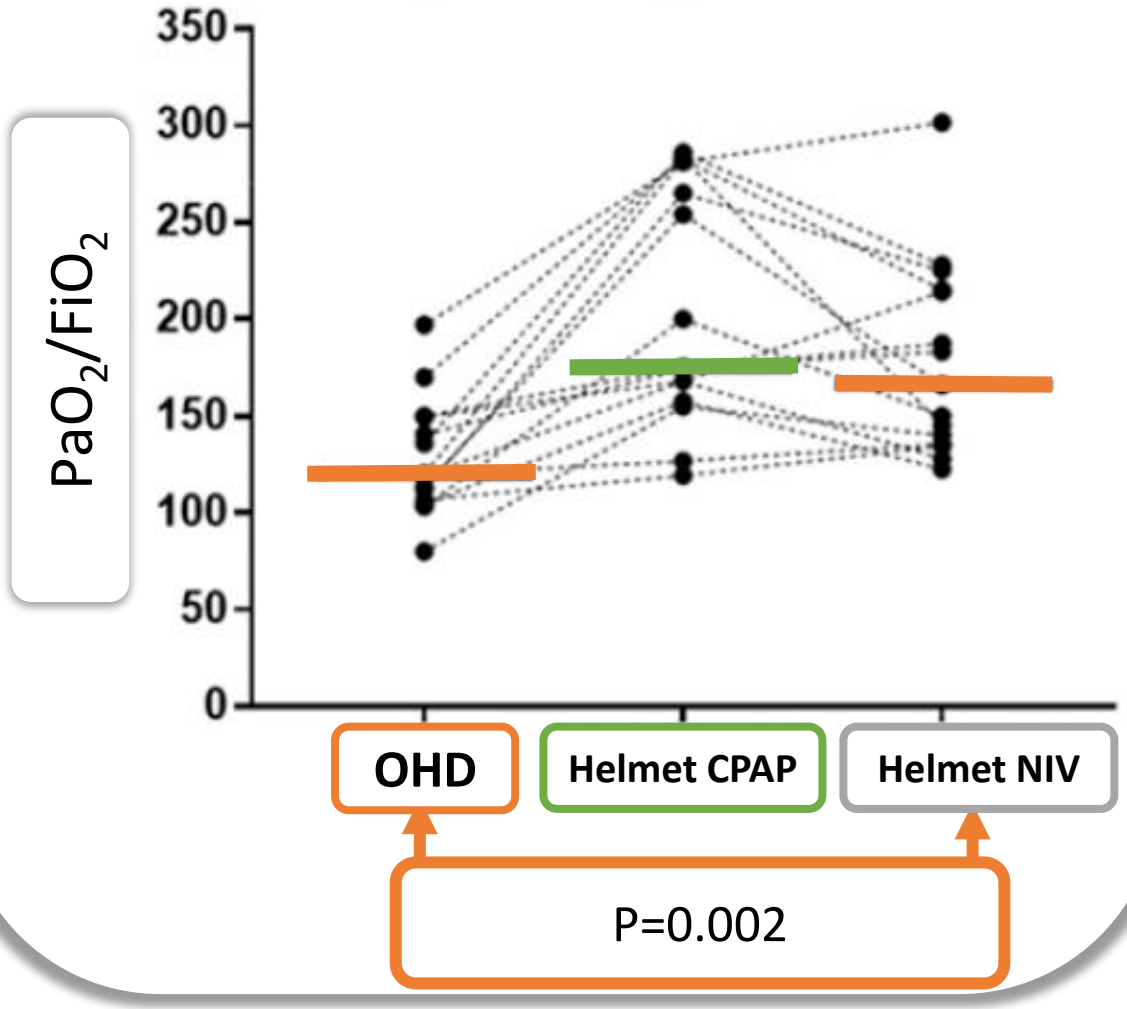
Mauri et al. Am J Resp Crit Care Med 2017; 195; 1207-15

Diminution effort inspiratoire sous OHD

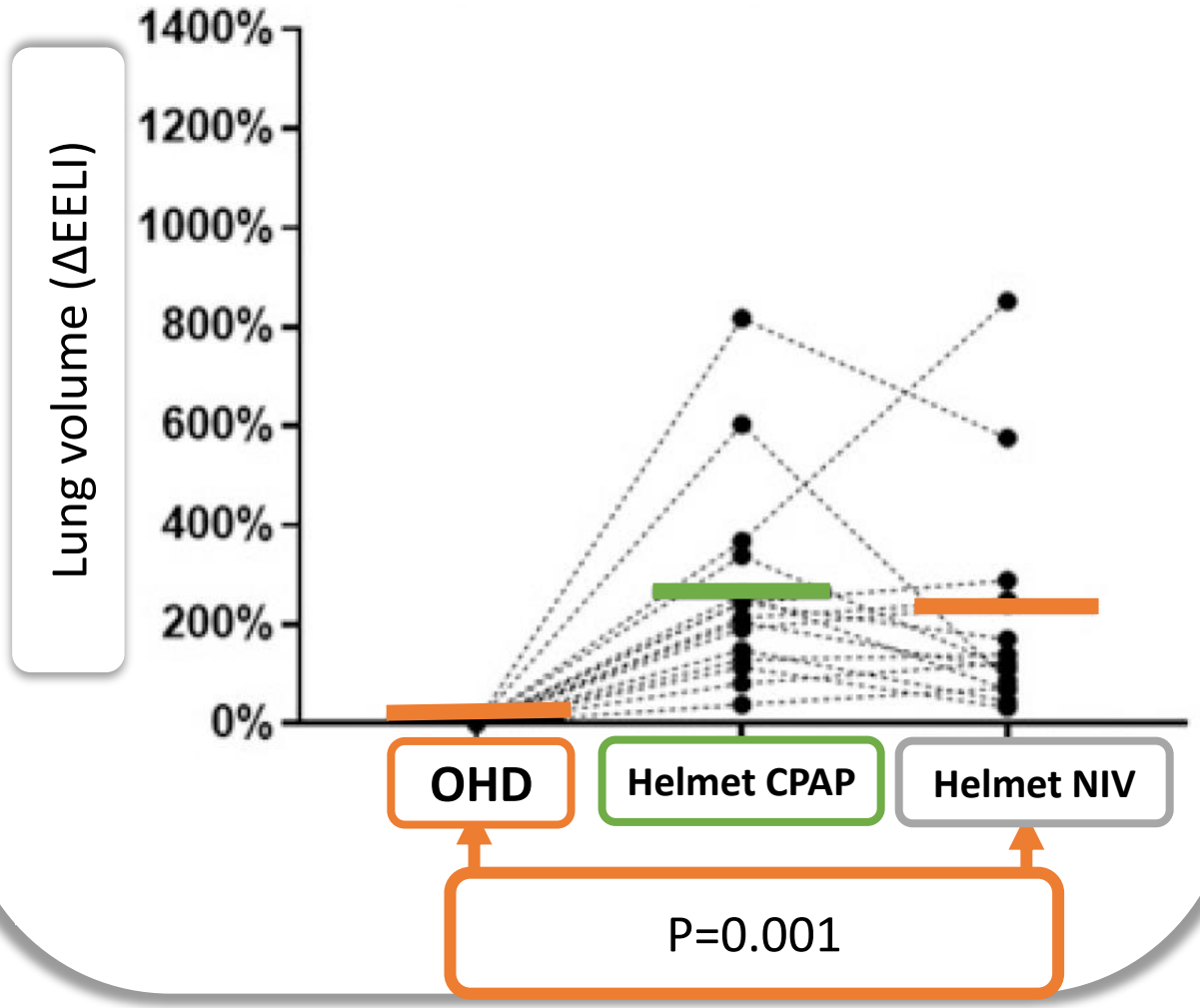


Mauri et al. Am J Resp Crit Care Med 2017; 195; 1207-15

Helmet NIV: PS 10-12, PEEP 14 cmH_2O
Helmet CPAP: PEEP 14 cmH_2O
HFNC: 60 L/min

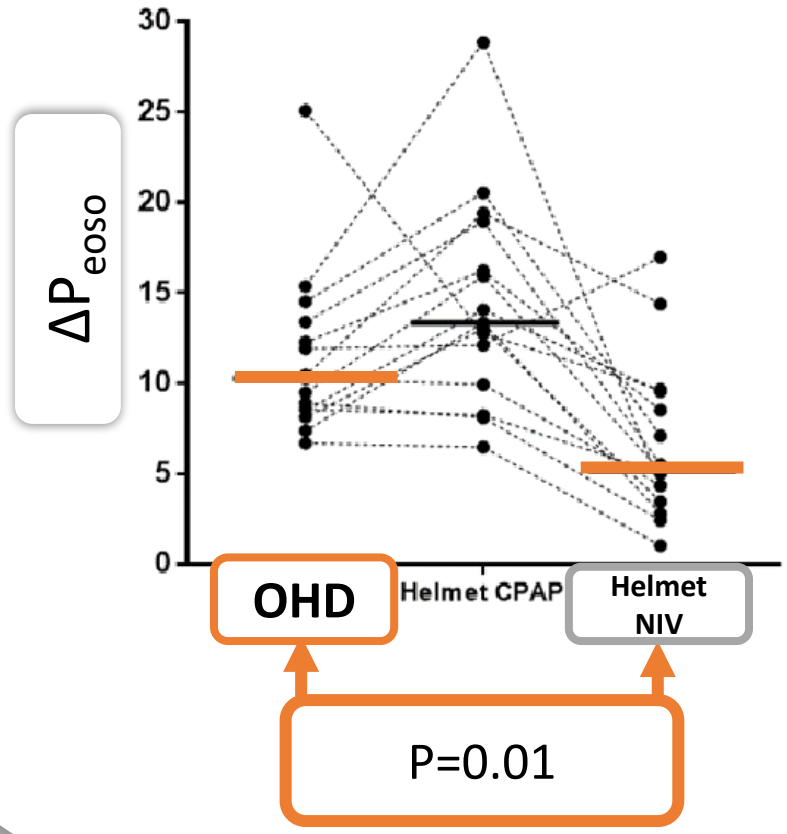


N=15
PaO_2/FIO_2 <200 mmHg



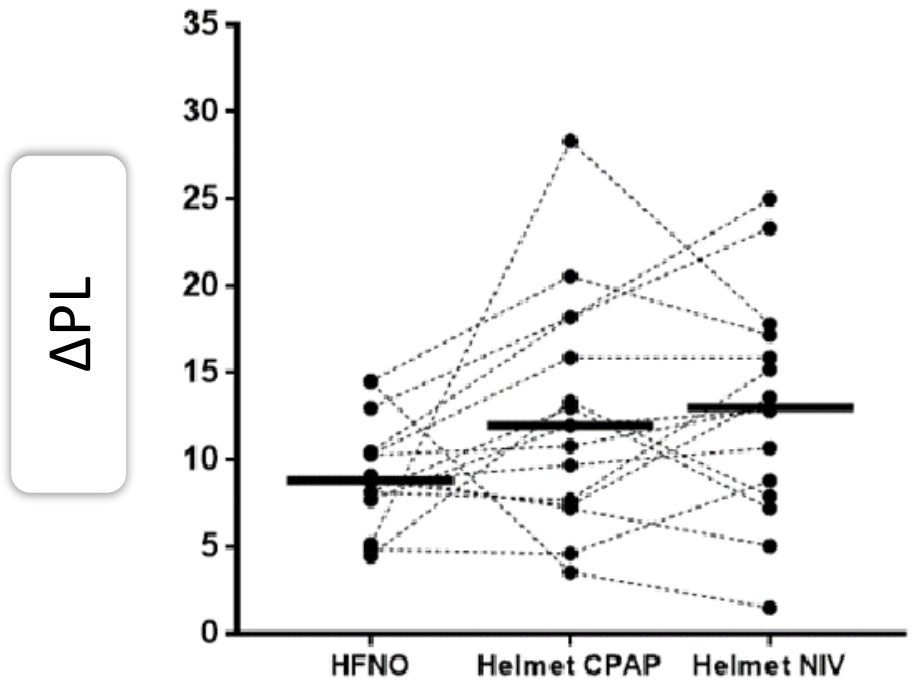
Menga et al. AJRCCM 2022

Effort inspiratoire



Menga et al. AJRCCM 2022

Distension alvéolaire ?



Menga et al. AJRCCM 2022

Table S5. Assessment of tolerance to the oxygenation strategy at inclusion and 1 hour after inclusion *

	HFNC (n=106)	Standard O_2 (n=94)	NIV (n=110)	P Value
Respiratory patient-discomfort at inclusion – mm †	38±31	44±29	46±30	0.20
Discomfort at H1	29	40	43	<0.01
Grade of dyspnea at H1‡				<0.001
Improvement of dyspnea	76%	42%	58%	
No change– no. (%)	18 (20.9)	33 (44.6)	23 (25.3)	
Slight deterioration – no. (%)	3 (3.5)	9 (12.2)	8 (8.8)	
Marked deterioration – no. (%)	0 (0.0)	1 (1.3)	7 (7.7)	
Respiratory rate– breaths/min				
H1	28±7	31±7	31±8	<0.01
PaO_2 at H1	106	91	118	<0.05 <0.05

Oxygenation non reliée à la dyspnée

Frat et al. N Engl J Med. 2015;372:2185-96

Quel support d'oxygénation ?

Pour les bénfices cliniques…

- O_2 standard
- OHD
- VNI

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.,

313 Underwent randomization

FR > 25/min, signes de DRA
PaO_2/FiO_2 <300 mmHg

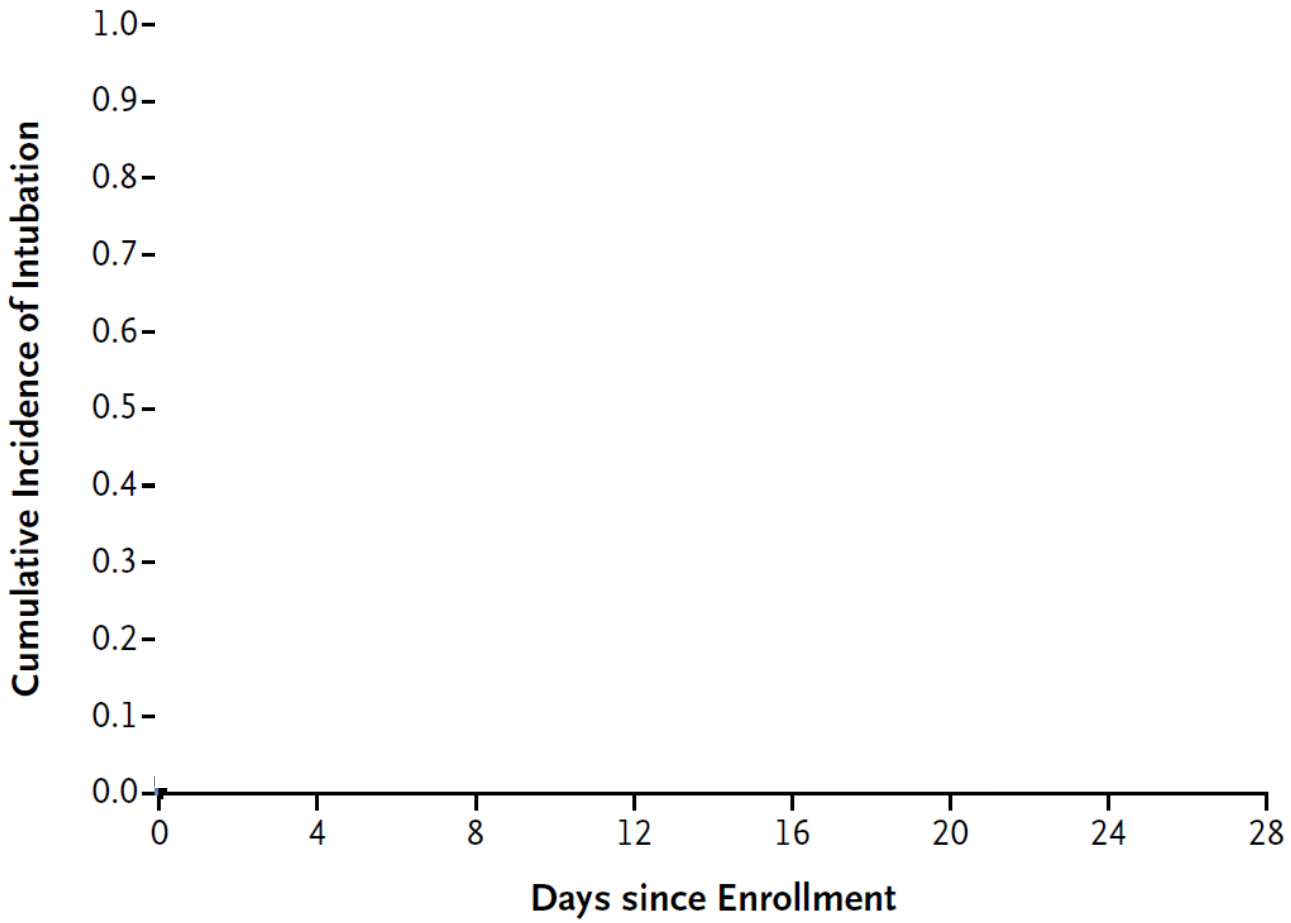
High-flow oxygen N=106

Standard O_2 N=94

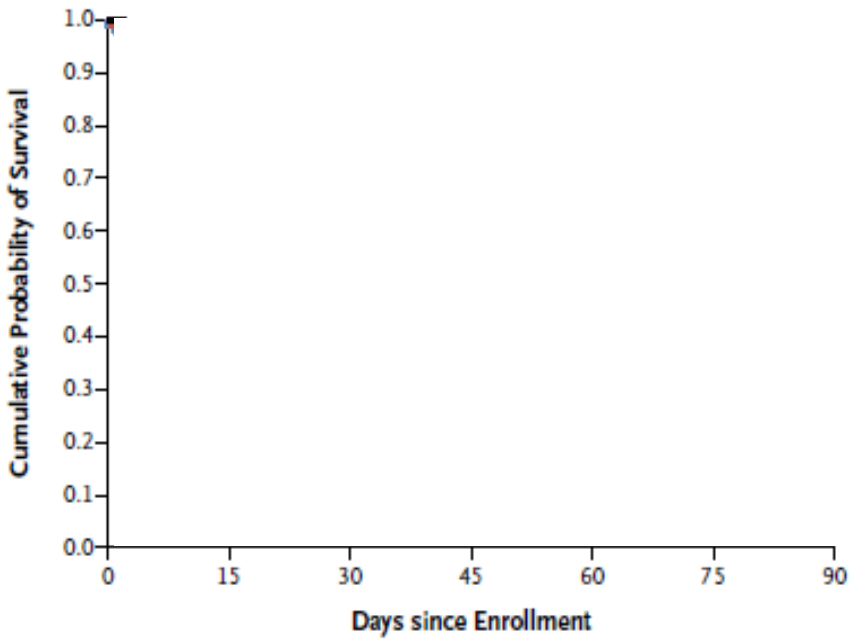
NIV/high-flow oxygen N=111

N Engl J Med. 2015;372:2185-96

Intubation

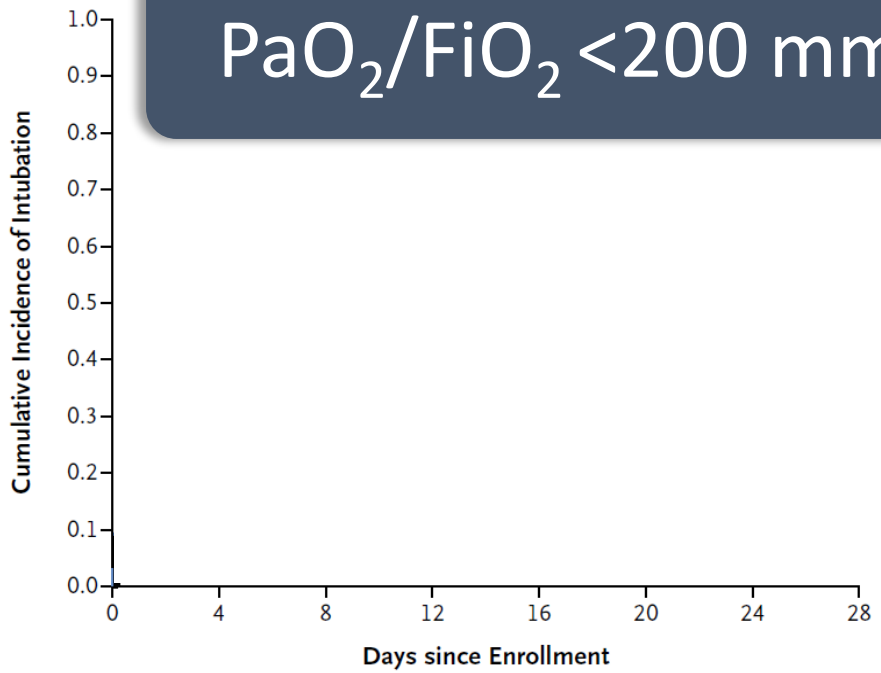

Cumulative Incidence of Intubation
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
4
8
12
16
20
24
28
Days since Enrollment

Survival



Intubation

PaO_2/FiO_2 <200 mmHg

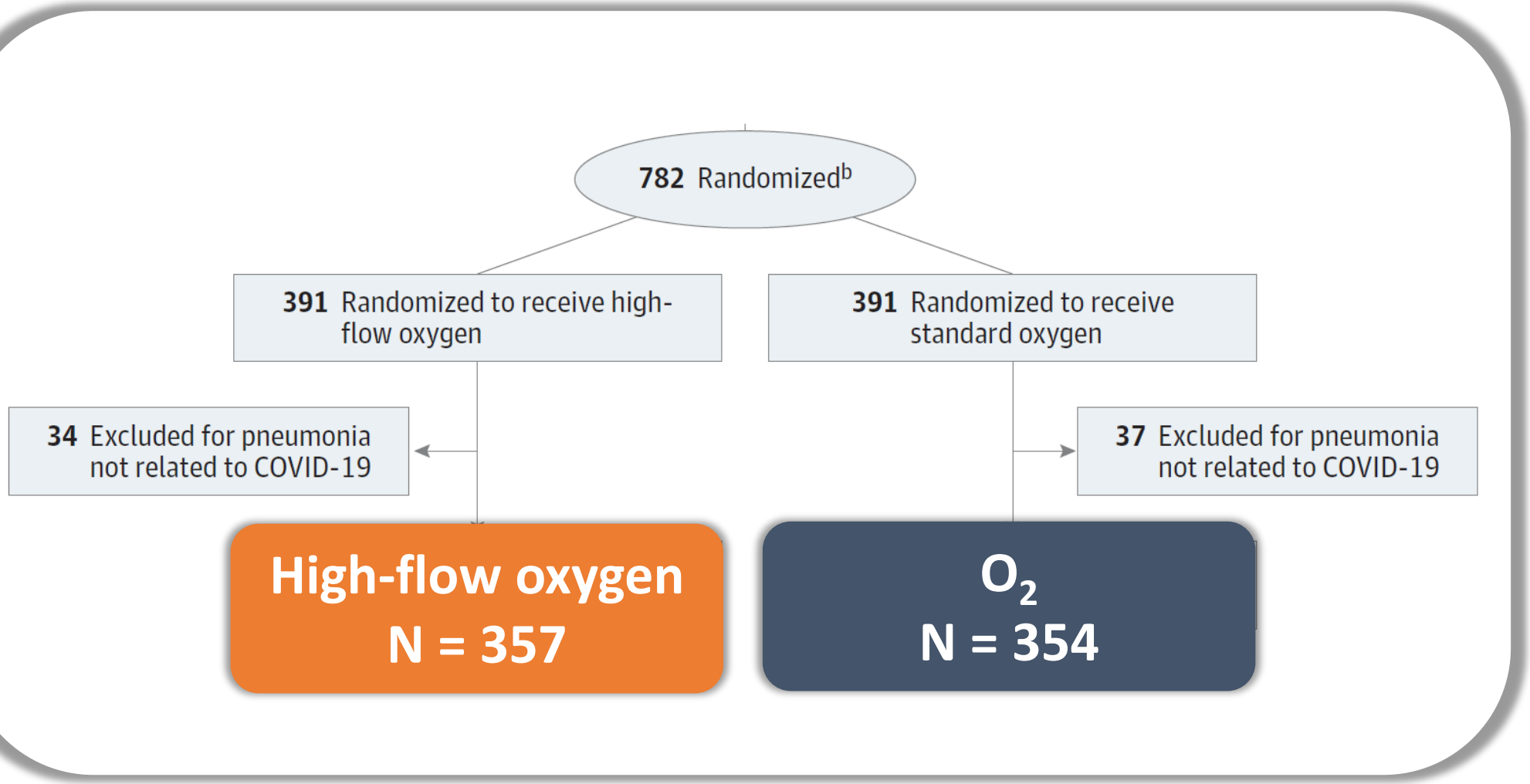


Frat et al. N Engl J Med. 2015

JAMA | Original Investigation

Effect of High-Flow Nasal Cannula Oxygen vs Standard Oxygen Therapy on Mortality in Patients With Respiratory Failure Due to COVID-19

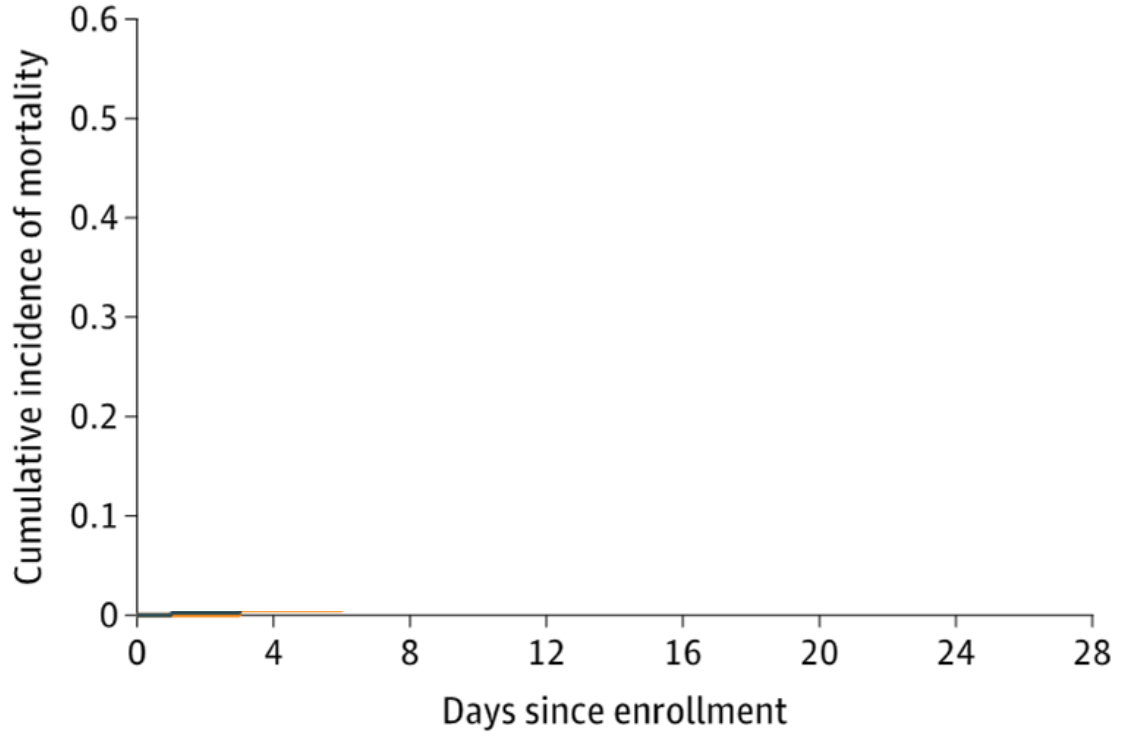
The SOHO-COVID Randomized Clinical Trial



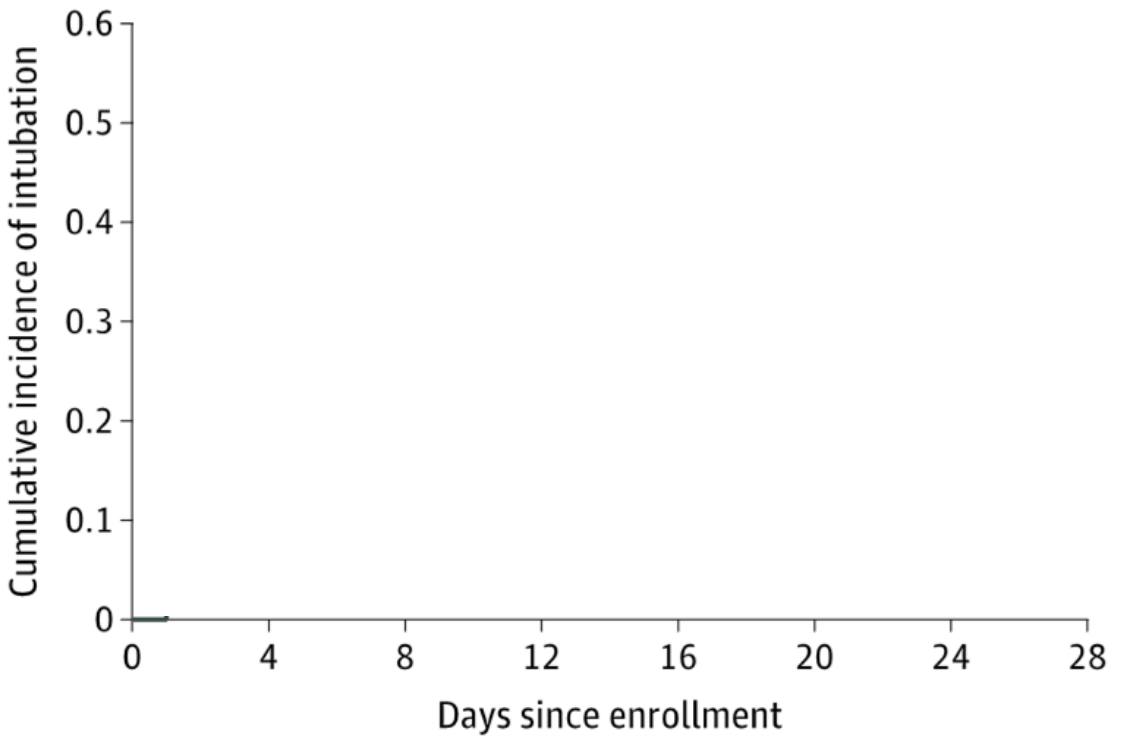
HFNC : 6% intolérance

Frat et al. JAMA. 2022;328:1212-1222

Mortalité



Intubation



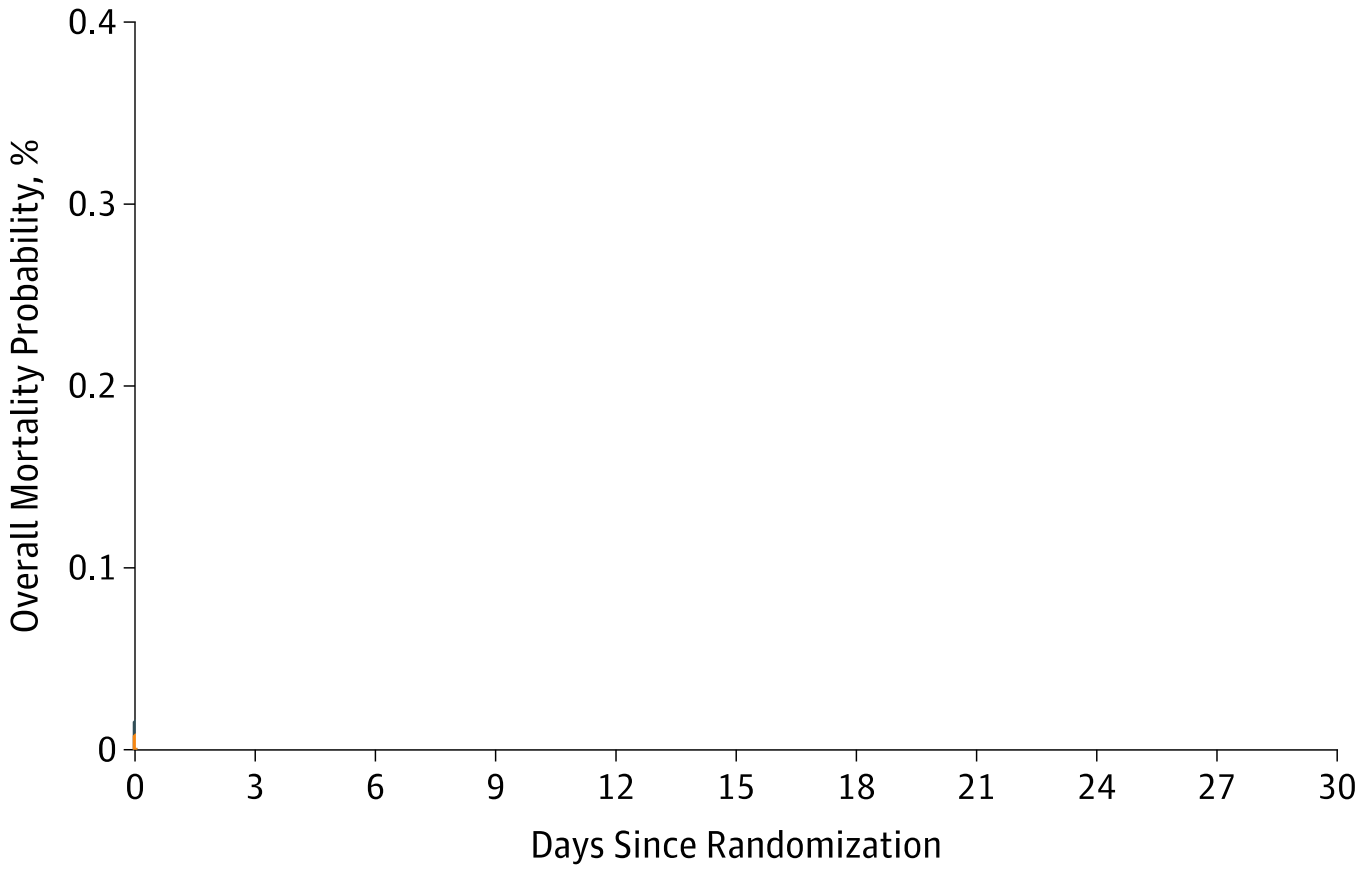
Effect of High-Flow Nasal Oxygen vs Standard Oxygen on 28-Day Mortality in Immunocompromised Patients With Acute Respiratory Failure

The HIGH Randomized Clinical Trial

Characteristic	No. (%) High-Flow Oxygen Therapy (n = 388)	Standard Oxygen Therapy (n = 388)
Respiratory rate, median (IQR), /min	33 **33/min**	32 (27-38)
Pao_2:Fio_2 ratio, median (IQR)	136 (96-187)	128 (92-164)
Received standard oxygen therapy before randomization	311 (80.1)	334 (86.1)
Oxygen flow, median (IQR), L/min	10 (6-15)	10 (6-15)
Pao_2 with standard oxygen, median (IQR)	81 **78 mm Hg**	75 (65-93)

Azoulay et al. JAMA. 2018;320:2099-107

Mortalité



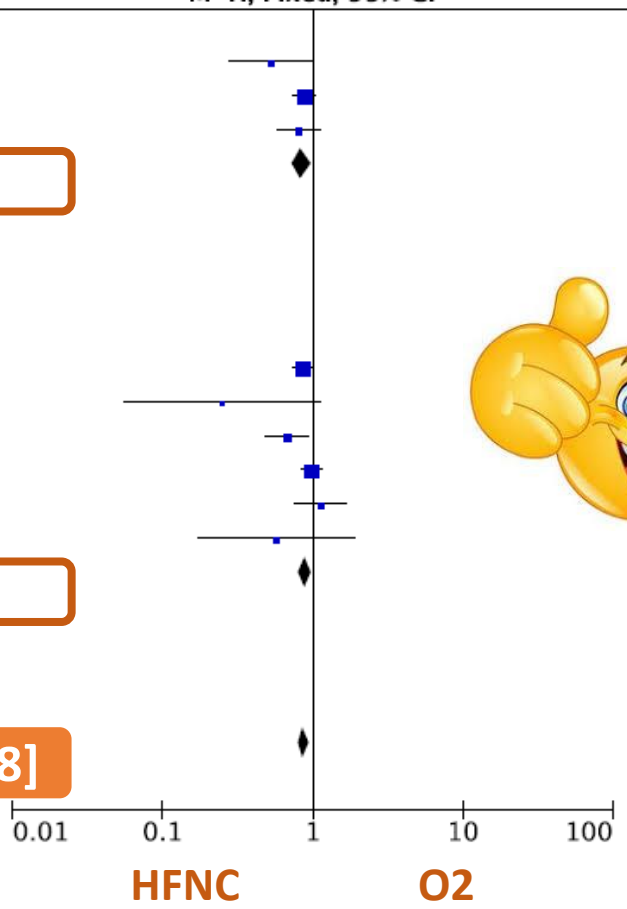
Intubation
- HFNC : 39%
- O_2 : 44%

38% deceased without intubation

Azoulay et al. JAMA. 2018;320:2099-107

Intubation

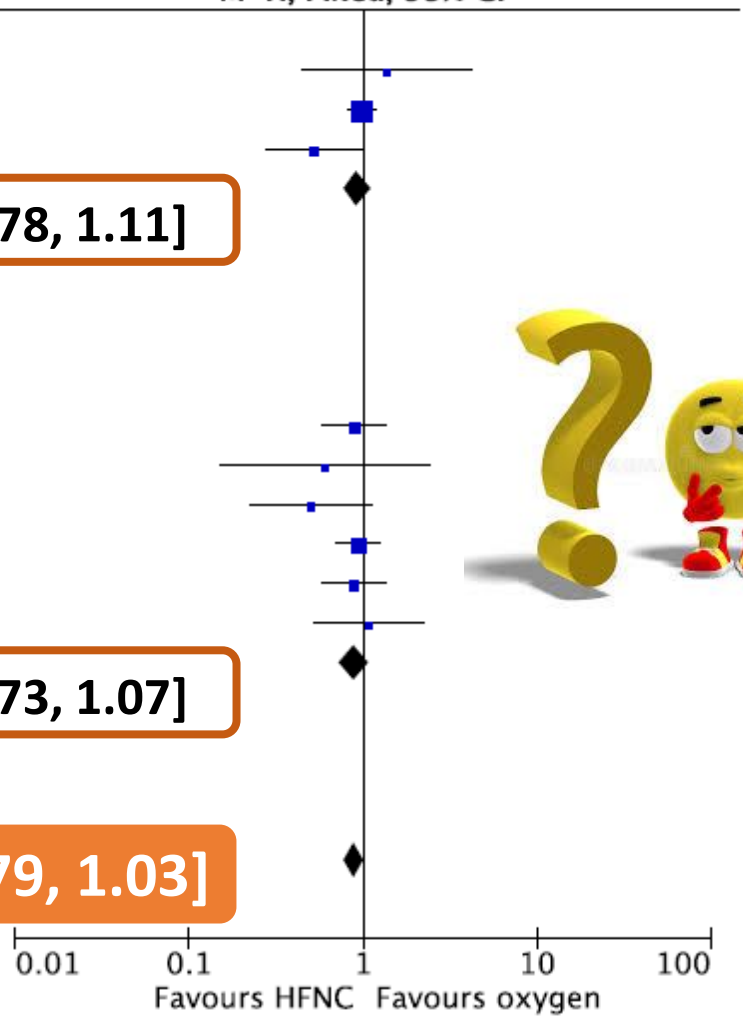
Study or Subgroup	OHD Events	OHD Total	O2 Events	O2 Total	Weight	Risk Ratio M-H, Fixed, 95% CI	Year
3.2.1 Non-COVID-19 respiratory failure							
Andino 2020	8	24	14	22	2.2%	0.52 [0.27, 1.00]	2020
Azoulay 2018	150	388	170	388	25.1%	0.88 [0.75, 1.04]	2018
Frat 2015	40	106	44	94	6.9%	0.81 [0.58, 1.12]	2015
Sub-total	n=518		n=504			**0.84 [0.73, 0.98]**	
Heterogeneity: $Chi^2 = 2.42$, df = 2 (P = 0.30); $I^2 = 18\%$							
Test for overall effect: Z = 2.28 (P = 0.02)							
3.2.2 COVID-19 respiratory failure							
Frat 2022	160	357	186	354	27.6%	0.85 [0.73, 0.99]	2022
Nazir 2022	2	60	8	60	1.2%	0.25 [0.06, 1.13]	2022
Ospina-Tascon 2022	34	99	51	100	7.5%	0.67 [0.48, 0.94]	2022
Perkins_HFNC 2022	170	415	153	368	23.9%	0.99 [0.83, 1.16]	2022
Bouadma_HFNC 2022*	37	115	31	109	4.7%	1.13 [0.76, 1.69]	2022
Crimi 2022	4	181	7	181	1.0%	0.57 [0.17, 1.92]	2022
Sub-total	n=1227		n=1172			**0.89 [0.80, 0.98]**	
Heterogeneity: $Chi^2 = 9.04$, df = 5 (P = 0.11); $I^2 = 45\%$							
Test for overall effect: Z = 2.32 (P = 0.02)							
Total	n=1745		n=1676			**0.89 [0.80, 0.98]**	
Heterogeneity: $Chi^2 = 11.80$, df = 8 (P = 0.16); $I^2 = 32\%$							
Test for overall effect: Z = 3.22 (P = 0.001)							
Test for subgroup differences: $Chi^2 = 0.27$, df = 1 (P = 0.60), $I^2 = 0\%$							



Helms et al. Annals of Intensive Care 2024; 14:140 suppl

Mortalité

Study or Subgroup	HFNC Events	HFNC Total	Oxygen Events	Oxygen Total	Weight	Risk Ratio M-H, Fixed, 95% CI	Year
4.2.1 Non-COVID-19 respiratory failure							
Andino 2020	6	24	4	22	1.2%	1.38 [0.45, 4.24]	2020
Azoulay 2018	138	388	140	388	39.7%	0.99 [0.82, 1.19]	2018
Frat 2015	13	106	22	94	6.6%	0.52 [0.28, 0.98]	2015
Sub-total	518		504			**0.93 [0.78, 1.11]**	
Heterogeneity: Chi² = 4.04, df = 2 (P = 0.13); I² = 51%							
Test for overall effect: Z = 0.79 (P = 0.43)							
4.2.2 COVID-19 respiratory failure							
Frat 2022	36	357	40	354	11.4%	0.89 [0.58, 1.37]	2022
Nazir 2022	3	60	5	60	1.4%	0.60 [0.15, 2.40]	2022
Ospina-Tascon 2022	8	99	16	100	4.5%	0.51 [0.23, 1.13]	2022
Perkins_HFNC 2022	78	416	74	370	22.2%	0.94 [0.70, 1.25]	2022
Bouadma_HFNC 2022*	30	115	32	109	9.3%	0.89 [0.58, 1.36]	2022
Crimi 2022	14	181	13	181	3.7%	1.08 [0.52, 2.23]	2022
Sub-total	1228		1174			**0.88 [0.73, 1.07]**	
Heterogeneity: Chi² = 2.62, df = 5 (P = 0.76); I² = 0%							
Test for overall effect: Z = 1.28 (P = 0.20)							
Total	1746		1678			**0.91 [0.79, 1.03]**	
Heterogeneity: Chi² = 6.90, df = 8 (P = 0.55); I² = 0%							
Test for overall effect: Z = 1.48 (P = 0.14)							
Test for subgroup differences: Chi² = 0.16, df = 1 (P = 0.69), I² = 0%							



Helms et al. Annals of Intensive Care 2024; 14:140 suppl

Quel support d'oxygénation ?

Les bénéfices cliniques…

Standard O_2

OHD

VNI

THE LANCET
Respiratory Medicine

High-flow nasal oxygen alone or alternating with non-invasive ventilation in critically ill immunocompromised patients with acute respiratory failure: a randomised controlled trial

497 immunocompromised patients eligible for inclusion

197 excluded
152 no staff available or logistic issues
45 declined to participate

300 randomly assigned

146 assigned to the NIV group

154 assigned to the HFNO alone group

1 withdrew consent

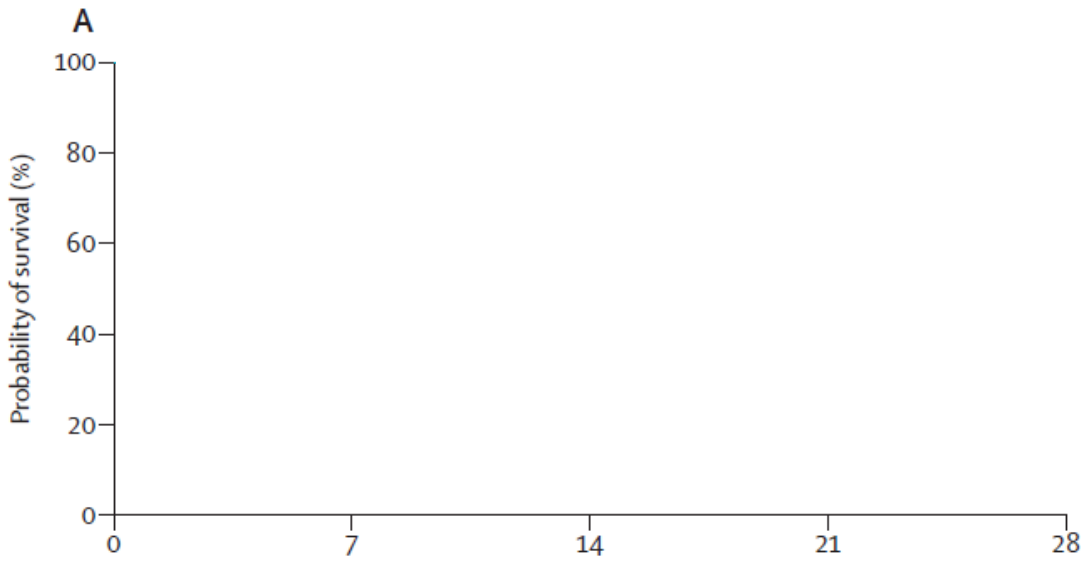
High-flow oxygen
N = 145

NIV
N = 154

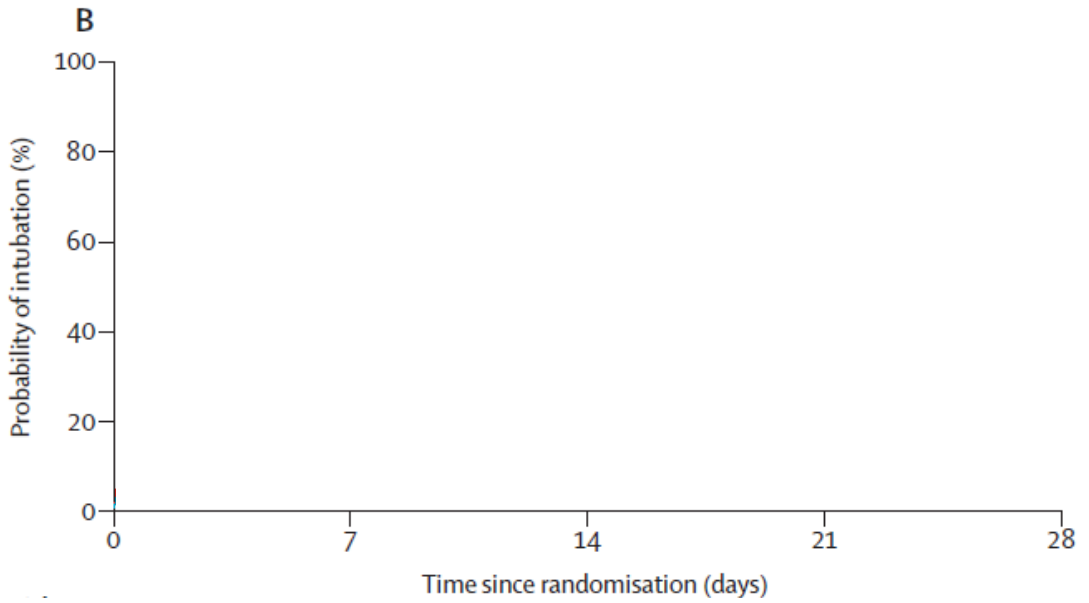
	HFNO alone group (n=154)	NIV group (n=145)
Age, years	62 (13)	65 (12)
Corticosteroids or immunosuppressive therapy	95 (62%)	95 (66%)
Leucopenia or neutropenia	26 (17%)	18 (12%)
Allogeneic stem cell transplant recipient	11 (7%)	12 (8%)
Autologous stem cell transplant recipient	14 (9%)	4 (3%)
Haematological malignancy or leucopenia or neutropenia (strata)	81 (53%)	75 (52%)
At time of randomisation		
Duration from ICU admission to randomisation, h	2·2 (1·1–5·9)	2·6 (1·0–7·6)
Duration from randomisation to start of treatments, h	0·1 (0·0–0·4)	0·4 (0·2–0·9)
Prior treatment with NIV	13 (8%)	23 (16%)
F Resp 32/min		
Arterial blood gases		
pH	7·44 (0·07)	7·44 (0·08)
PaO_2, mm Hg	85 (28)	84 (31)
FiO_2	0·61 (0·16)	0·61 (0·18)
PaO_2/FiO_2 147 mm Hg		
$PaCO_2$, mm Hg	34 (6)	35 (6)
Bilateral infiltrates on chest x-ray	117 (76%)	106 (73%)

Coudroy et al. Lancet Respir Med 2022; 10:641-649

Survie



Intubation



Coudroy et al. Lancet Respir Med 2022

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Helmet Noninvasive Ventilation vs High-Flow Nasal Oxygen on Days Free of Respiratory Support in Patients With COVID-19 and Moderate to Severe Hypoxemic Respiratory Failure

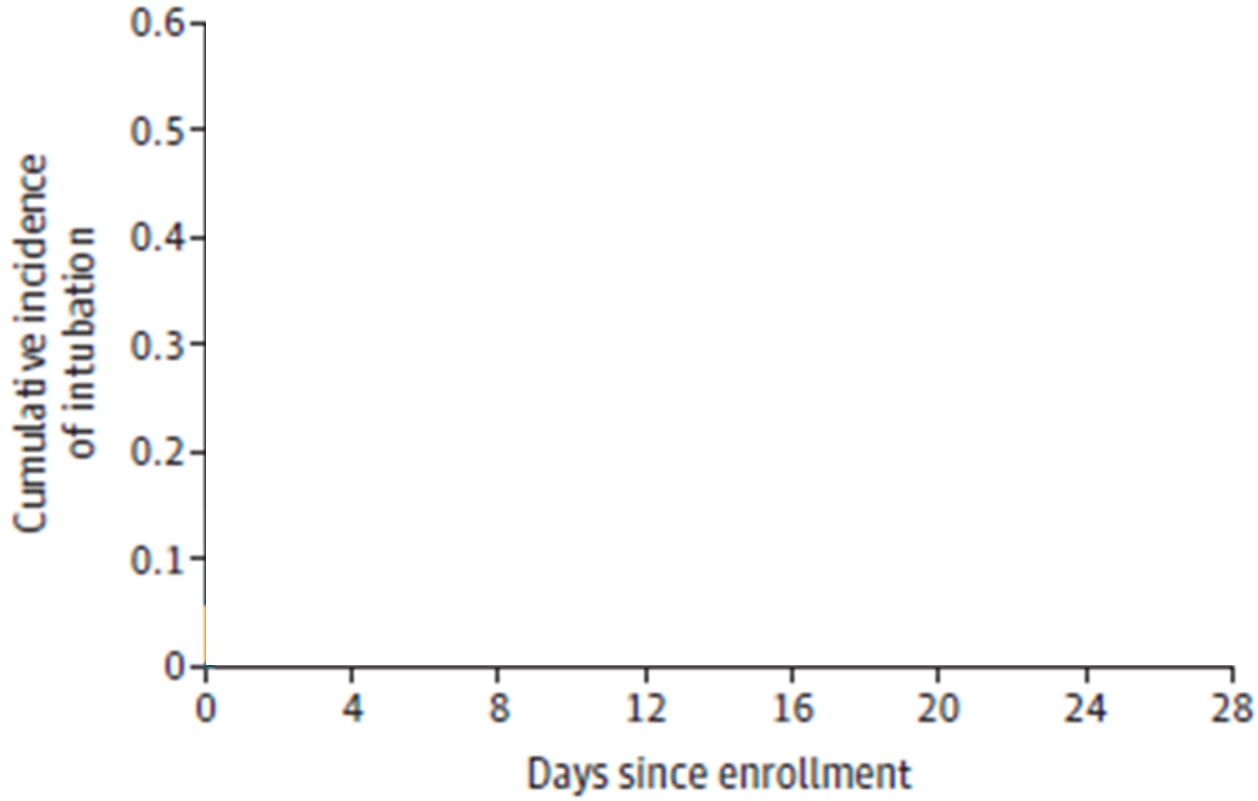
The HENIVOT Randomized Clinical Trial

Helmet NIV

- PS: 10 cm H2O (10-12)
- PEEP 12 cm H2O (10-12)

Grieco et al. JAMA. 2021; 325:1731-43

Intubation



Pas de différence sur la mortalité

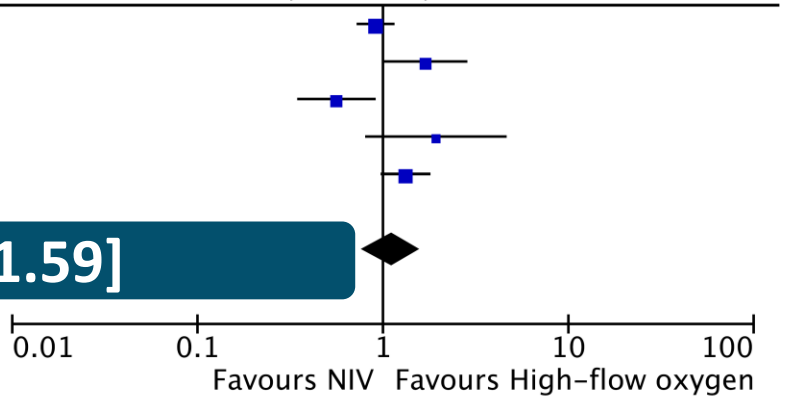
20% d'intolérance dans groupe Helmet

Grieco et al. JAMA. 2021; 325:1731-43

Intubation
VNI vs. OHD

Study or Subgroup	NIV Events	NIV Total	High-flow oxygen Events	High-flow oxygen Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Coudroy 2022	67	145	78	154	26.6%	0.91 [0.72, 1.15]	2022
Nair 2021	25	54	15	55	18.5%	1.70 [1.01, 2.85]	2021
Grieco 2021	16	55	28	54	19.4%	0.56 [0.35, 0.91]	2021
Doshi 2018	13	100	7	104	10.9%	1.93 [0.80, 4.64]	2018
Frat 2015	55	110	40	106	24.6%	1.32 [0.97, 1.80]	2015
Total	**464**		473			**1.11 [0.77-1.59]**	

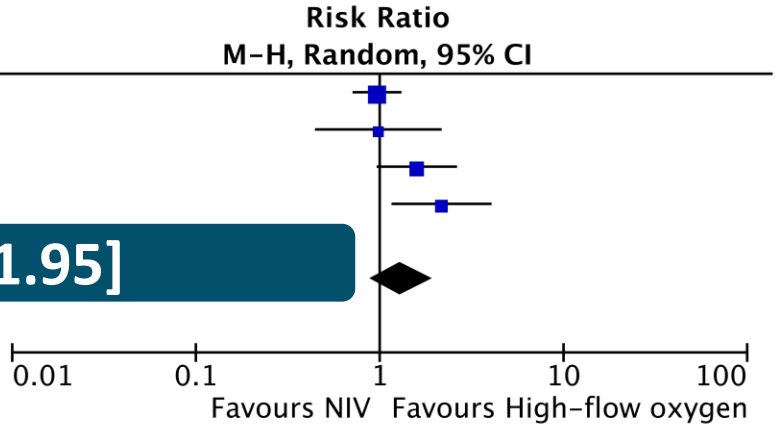
Heterogeneity: $Tau^2 = 0.11$; $Chi^2 = 15.16$, df = 4 (P = 0.004); $I^2 = 74\%$
Test for overall effect: Z = 0.55 (P = 0.58)



Mortalité
VNI vs. OHD

Study or Subgroup	NIV Events	NIV Total	High-flow oxygen Events	High-flow oxygen Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
Coudroy 2022	51	145	56	154	36.1%	0.97 [0.71, 1.31]	2022
Grieco 2021	10	55	10	54	16.2%	0.98 [0.44, 2.17]	2021
Nair 2021	25	54	16	55	26.4%	1.59 [0.96, 2.63]	2021
Frat 2015	27	110	12	106	21.4%	2.17 [1.16, 4.05]	2015
Total	**113**		94			**1.31 [0.88-1.95]**	
Total events	113		94				

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 6.89$, df = 3 (P = 0.08); $I^2 = 56\%$
Test for overall effect: Z = 1.35 (P = 0.18)



Helms et al. Annals of Intensive Care 2024; 14:140 suppl

Bénéfice de l'OHD sur l'O2 standard car diminution risqué d'**intubation**

- Pas de benefice de l'OHD sur la survie
- Pas de prevue de la supériorité de l'OHD sur la VNI et inversement

RESEARCH Open Access

Oxygen therapy in acute hypoxemic respiratory failure: guidelines from the SRLF-SFMU consensus conference

Recommendation 5B

High-flow nasal cannula oxygen therapy should probably be used rather than standard oxygen therapy in patients with hypoxemic ARF, with an oxygen flow rate > 6L/min to achieve SpO2 > 92% or a $PaO_2/Fi\ O_2$ ratio < 200
(GRADE 2 + , moderate quality of evidence, strong agreement).

Recommendation 6 A

In the absence of intubation criteria, high-flow nasal cannula oxygen therapy should probably be used rather than NIV in patients with de novo acute hypoxemic respiratory failure
(GRADE 2 + , moderate quality of evidence, strong agreement).

Helms et al. Annals of Intensive Care (2024) 14:140

Le meilleur support d'oxygénation : **pour qui ?**

Insuffisance respiratoire aiguë **hypoxémique**

Insuffisance respiratoire aiguë **hypercapnique**

Insuffisance respiratoire aiguë **hypercapnique**

- Augmentation des **resistance bronchiques**
- **Hyperinflation** dytnamique (bronchospasme, secretions bronchiques)

Exacerbation BPCO

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Bram Rochwerg[1], Laurent Brochard[2,3], Mark W. Elliott[4], Dean Hess[5], Nicholas S. Hill[6], Stefano Nava[7] and Paolo Navalesi[8] (members of the steering committee); Massimo Antonelli[9], Jan Brozek[1], Giorgio Conti[9], Miquel Ferrer[10], Kalpalatha Guntupalli[11], Samir Jaber[12], Sean Keenan[13,14], Jordi Mancebo[15], Sangeeta Mehta[16] and Suhail Raoof[17,18] (members of the task force)

Clinical indication#	Certainty of evidence¶	Recommendation
Prevention of hypercapnia in COPD exacerbation	⊕⊕	Conditional recommendation against
Hypercapnia with COPD exacerbation	⊕⊕⊕⊕	Strong recommendation for
Cardiogenic pulmonary oedema	⊕⊕⊕	Strong recommendation for
Acute asthma		…n made
Immunocomp		…ndation for
***De novo* respi**		…n made
Post-operativ		…ndation for
Palliative care		…endation for
Trauma		Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients		Conditional recommendation for
Post-extubation respiratory failure		Conditional recommendation against
Weaning in hypercapnic patients		Conditional recommendation for

La VNI est le traitement de reference de l'exacerbation de BPCO avec acidose hypercapnique

- ↘ intubation
- ↘ pneumonie nosocomiale
- ↘ mortalité

Eur Respir J 2017; 50: 1602426

Pour qui ?

Haut debit dans exacerbation **légère** ?

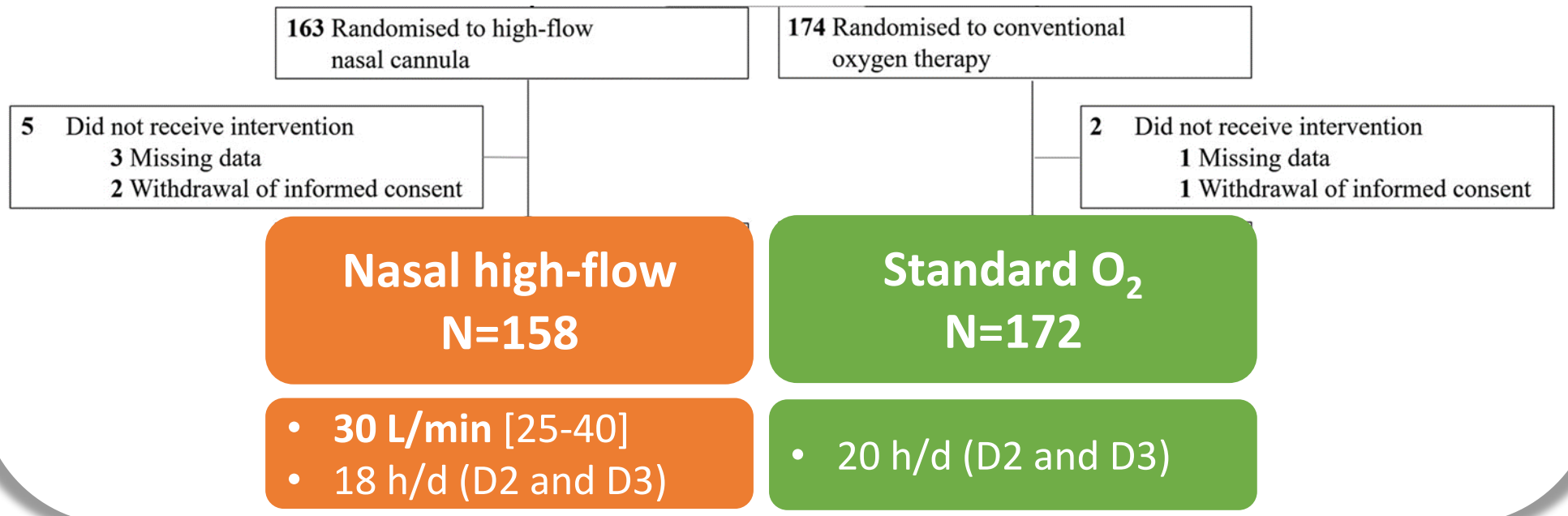
Haut debit dans exacerbation **modérée à sévère** ?

RESEARCH Open Access

High-flow nasal cannula versus conventional oxygen therapy in acute COPD exacerbation with mild hypercapnia: a multicenter randomized controlled trial

Nasal high-flow vs. O_2

Mild *COPD exacerbation*
pH >7.35, $PaCO_2 \geq 45$ mmHg
(n=330)



Xia et al. Crit care 2022, 26:109

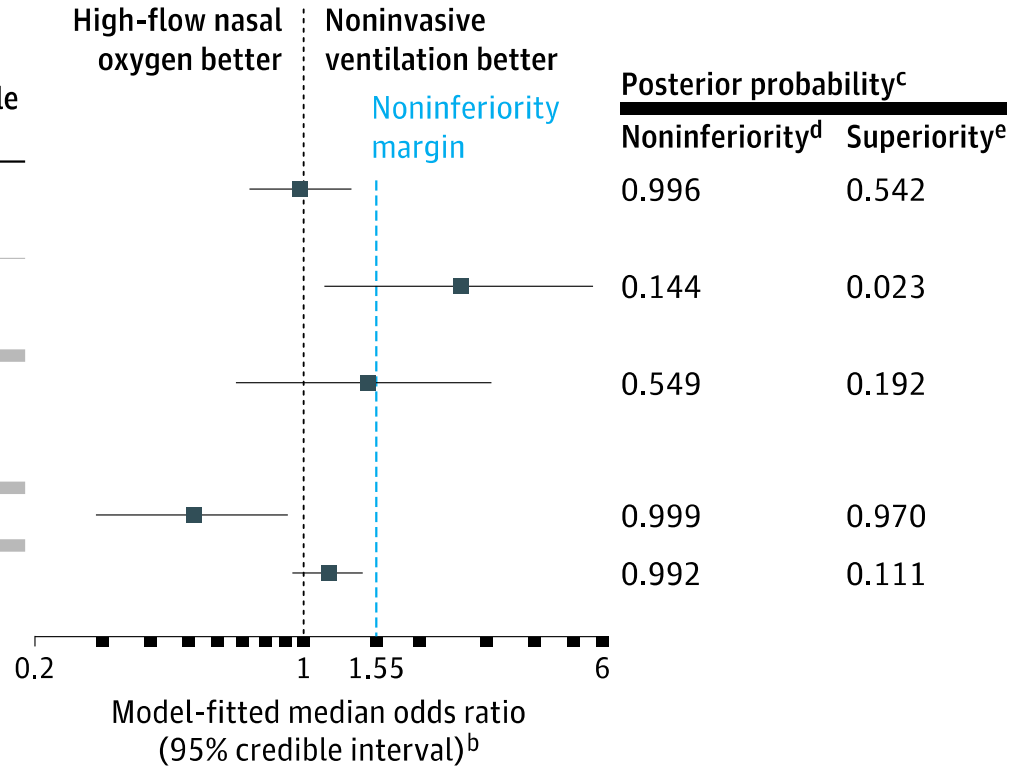
Characteristic	Nasal high-flow (n=158)	O_2 (n=172)	Absolute difference, % (95%CI)	*P*
Criteria for intubation	**2.5%**	**0.6%**	1.95 (— 0.8–4.7)	**P=0.2**
Secondary outcome				
Treatment failure, No. (%)	25 (15.8%)	25 (14.5%)	1.29 (— 6.5–9.0)	0.745*
intubation	**2%**	**0.6%**	1.95 (— 0.8–4.7)	**P=0.35**
NPPV, No. (%)	15 (9.5%)	22 (12.8%)	— 3.3 (— 10.1–3.5)	0.343*
Duration of NPPV, median (IQR), days	6.0 (2.0–10.0)	5.5 (4.0–8.0)	1.0 (— 2.7–4.7)	0.780†
Mortality in hospital, No. (%)	0 (0%)	1 (0.6%)		> 0.999*
Mortality at day 90, No. (%)	5/153 (3.3%)	5/171 (2.9%)	0.34 (— 3.4–4.1)	> 0.999*
Length of hospital stay, median (IQR), days	9.0 (7.0–13.0)	8.0 (7.0–11.0)	1.0 (0.0–2.0)	0.021†
Hospital cost, median (IQR), $	2298 (1613–3782)	2005 (1439–2968)	265 (— 104–632)	0.006†
Readmission rate at day 90, No. (%)	25/153 (16.3%)	23/170 (13.5%)	2.8 (— 5.0–10.6)	0.478*

Xia et al. Crit care 2022, 26:109

Critère de jugement principal
intubation ou décès < 7 jours

B Post hoc analysis of the primary outcome[f]

Patients with acute respiratory failure	No./total (%)		Model-fitted median odds ratio (95% credible interval)[b]	Posterior probability[c]	
	High-flow nasal oxygen	Noninvasive ventilation		Noninferiority[d]	Superiority[e]
Nonimmunocompromised with hypoxemia	81/249 (32.5)	78/236 (33.1)	0.98 (0.73-1.33)	0.996	0.542
Immunocompromised with hypoxemia	16/28 (57.1)	8/22 (36.4)	2.56 (1.14-5.68)	0.144	0.023
COPD with respiratory acidosis	10/35 (28.6)	11/42 (26.2)	1.48 (0.67-3.09)	0.549	0.192
Acute cardiogenic pulmonary edema	14/136 (10.3)	29/136 (21.3)	0.52 (0.29-0.91)	0.999	0.970
Hypoxemic COVID-19	223/435 (51.3)	210/447 (47.0)	1.16 (0.94-1.43)	0.992	0.111

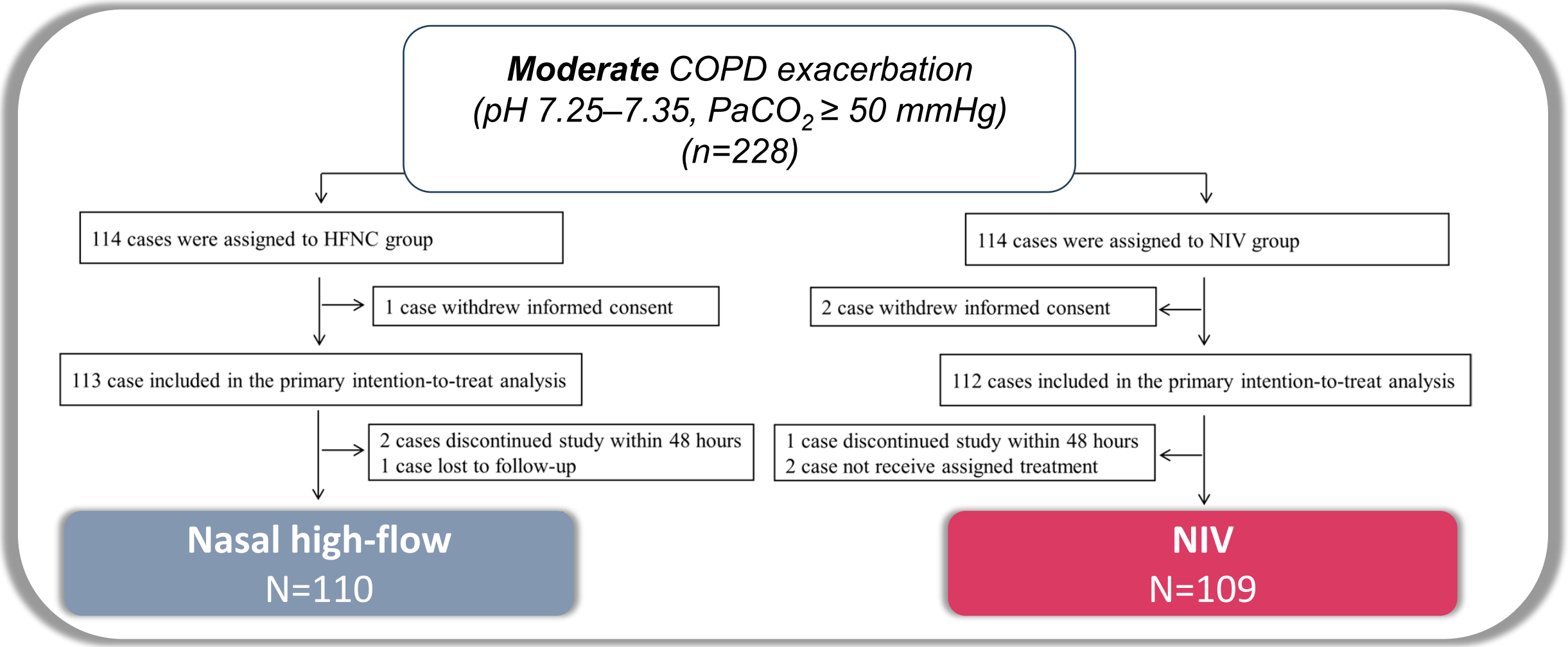


RENOVATE, JAMA 204

RESEARCH Open Access

High flow nasal cannula oxygen therapy versus non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease with acute-moderate hypercapnic respiratory failure: a randomized controlled non-inferiority trial

Nasal high-flow vs. NIV



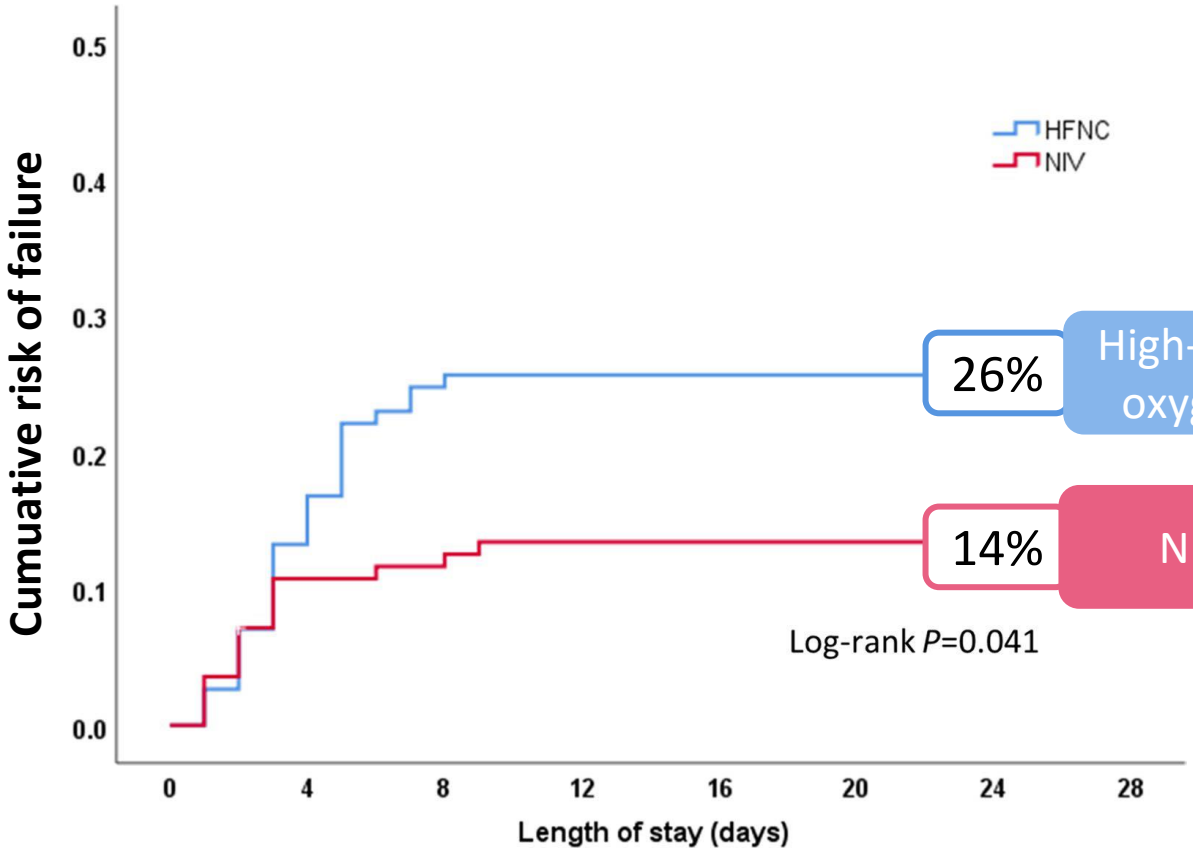
Tan et al. Crit Care 2024; 28:250

RESEARCH Open Access

High flow nasal cannula oxygen therapy versus non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease with acute-moderate hypercapnic respiratory failure: a randomized controlled non-inferiority trial

Nasal high-flow vs. NIV

***Moderate** COPD exacerbation*
(pH 7.25–7.35, $PaCO_2$ ≥ 50 mmHg)
(n=228)

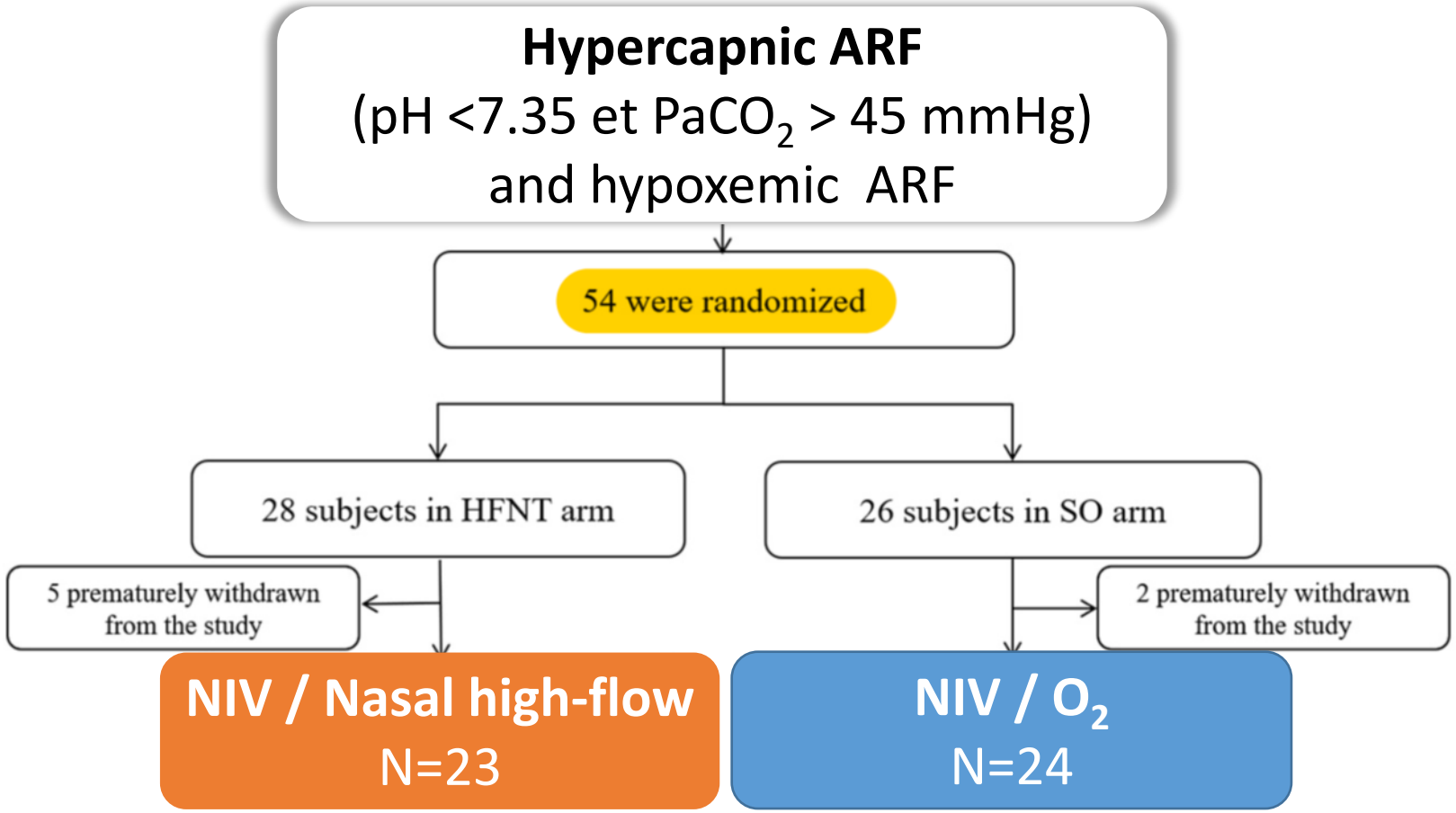


	HFNC (n = 113)	NIV (n = 112)	*p* value
Invasive ventilation	14.2)	6 (5.4)	0.026
Treatment switch	13 (11.5)	10 (8.9)	0.524
Length of stay in ICU, days	7 (6–9)	9 (6–11)	0.059
Length of stay in hospital, days	10 (8–13)	11 (9–13)	0.228
28-day mortality, n (%)	11 (9.7)	8 (7.1)	0.485

Tan et al. Crit Care 2024; 28:250

High-flow nasal therapy vs standard oxygen during breaks off noninvasive ventilation for acute respiratory failure: A pilot randomized controlled trial

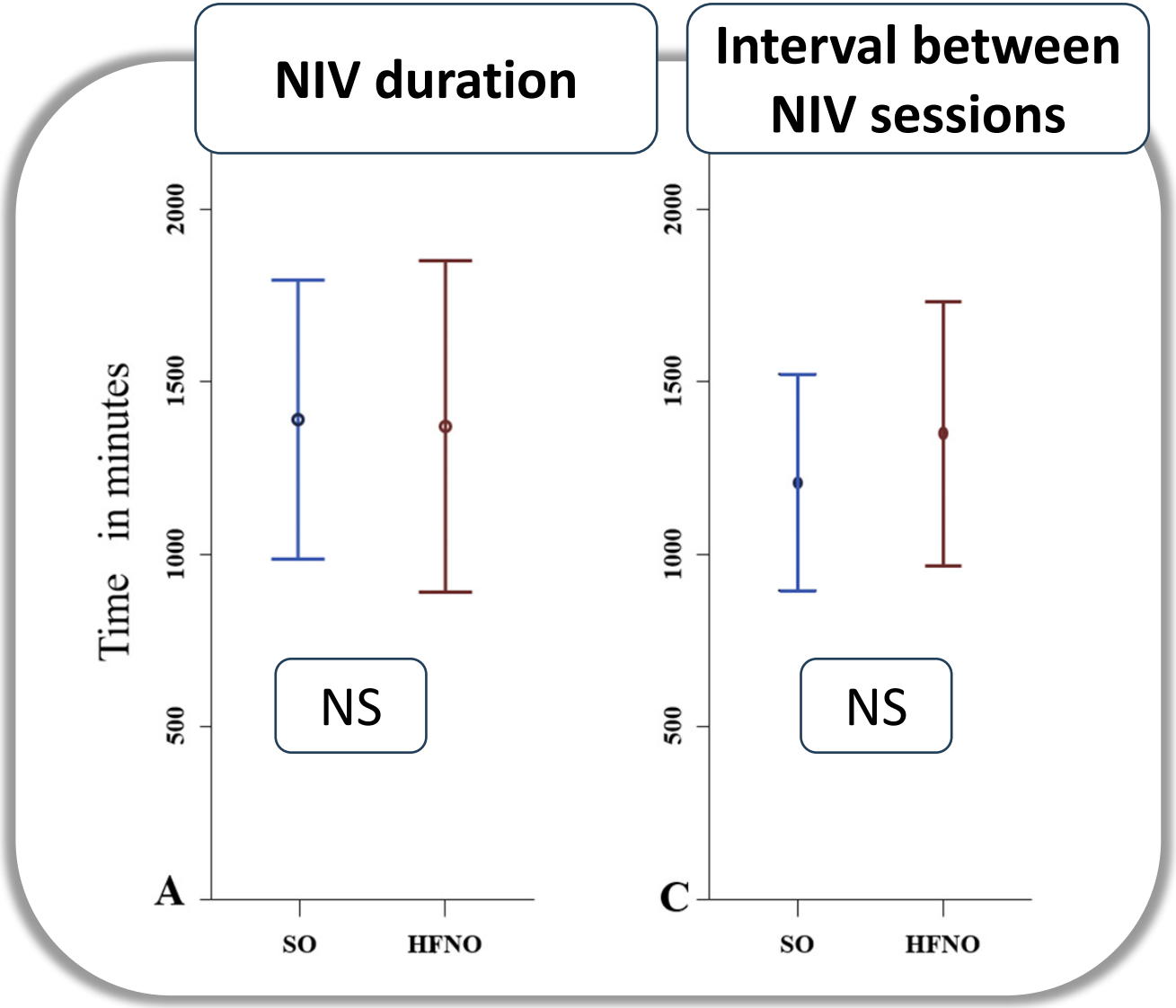
Nasal high-flow (vs. O_2) ***to optimize NIV***



Nasal high-flow
38 ± 7 L/min

Spoletini et al. J Crit Care 2018; 48:418-25

Nasal high-flow (vs. O_2)
to optimize NIV



No difference between

HFNC and O_2

- NIV duration
- interval between NIV session

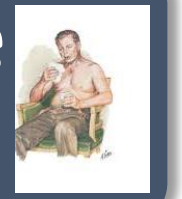
Spoletini et al. J Crit Care 2018; 48:418-25

Insuffisance respiraoire aiguë **hypoxémique**

Oxygène à haut debit nasal

- La VNI n’est pas recommandée
- Place de la VNI avec haut niveaux de PEP ?

Insuffisance respiraoire aiguë **hypercapnique**



VNI

- Pas de bénéfice de l’OHD
- Association VNI/OHD ?

Merci pour votre attention