High Flow Nasal Cannula

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Contents

O2 supply

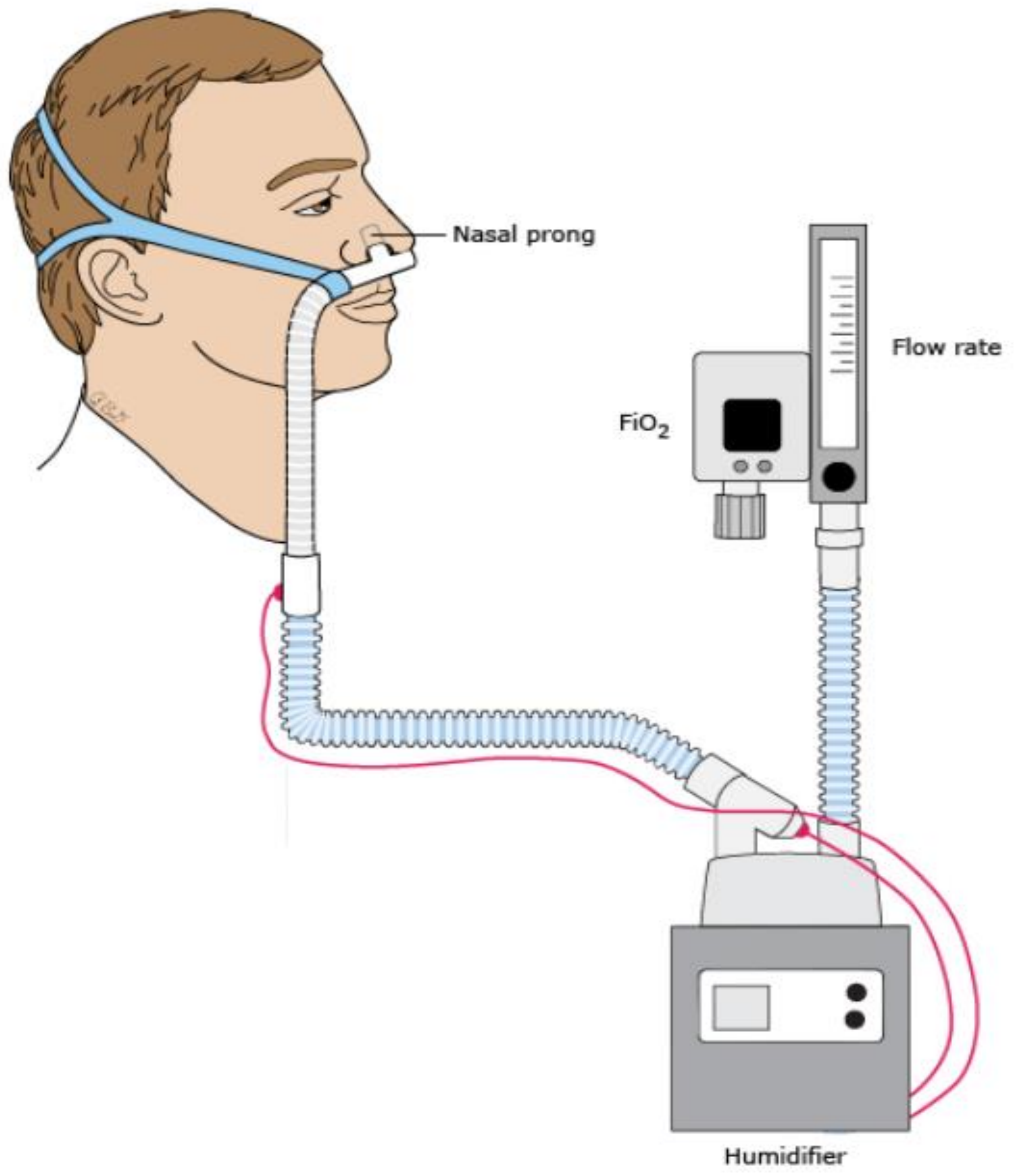
- Low flow system (nasal cannula; simple mask; non-rebreathing mask)
- High flow system (Venturi mask; high flow nasal cannula)

Moisture equipment

- Bubble humidifier for low flow O_2 therapy
- Nebulizers for high flow O_2 therapy

氣泡式濕化器對於高流量氧氣治療之加濕效率顯著不足，可能造成鼻乾、喉嚨乾燥、眼睛刺激、與呼吸道黏膜受損等不適症狀，降低了病人對於氧氣治療的耐受性

霧化式加濕器雖然可提供高流量與較足夠的濕度，但霧氣粒子可能因夾帶細菌或病毒等病原體，造成染污與散播的潛在空氣傳染性疾病，也不適用於氣道敏感的病人上

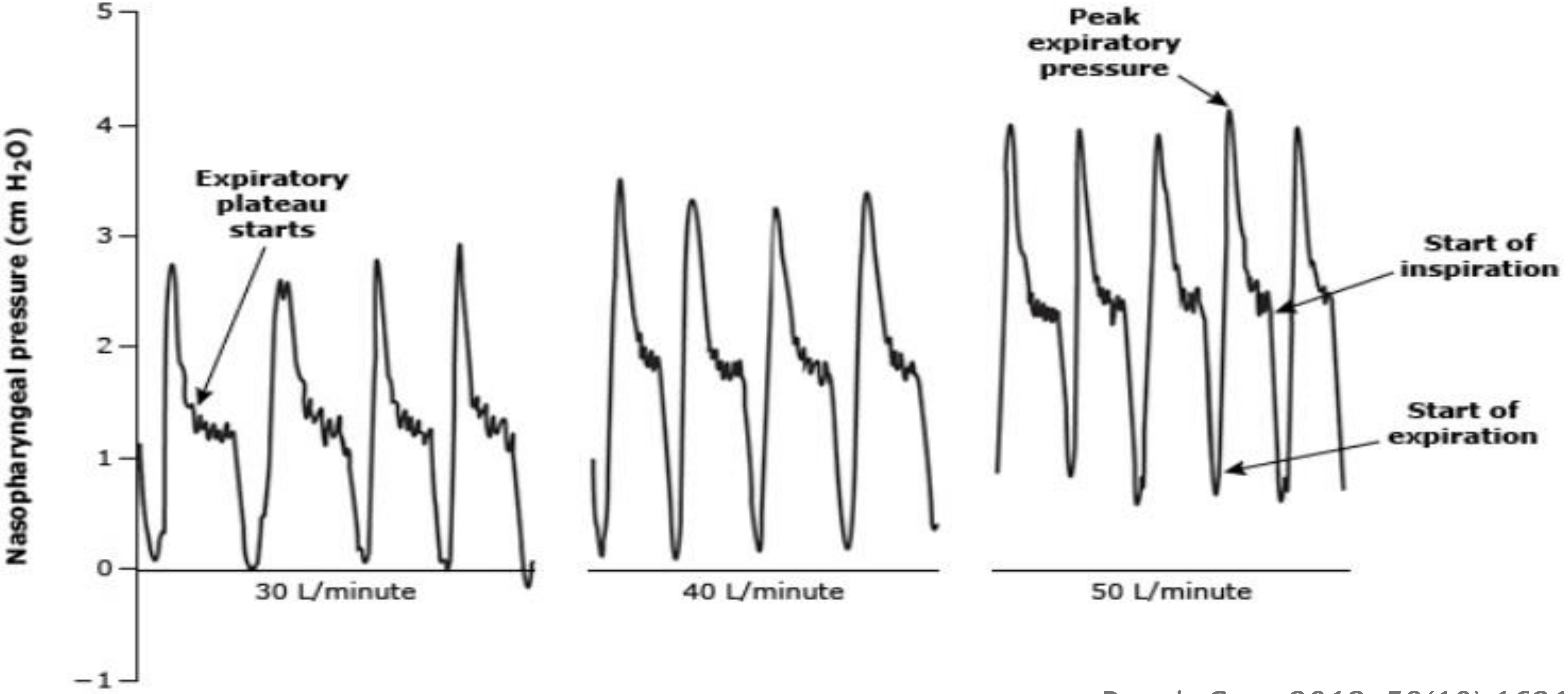


High flow nasal cannula: equipment-patient interface
: 30-60 L/min
: FiO2 =0.21-0.9
: 31-37C
: 相對溼度 100 % 的氣體

Mechanisms and benefits of oxygen delivered via high flow nasal cannula

Mechanism	Physiologic and clinical benefit
Small, pliable nasal prongs	▪ Enhanced patient comfort
Heat and humidification	▪ Facilitates removal of airway secretions ▪ Avoids airway desiccation and epithelial injury ▪ Decreased work of breathing ▪ Enhances patient comfort
Washout of nasopharyngeal deadspace	▪ Improved ventilation and oxygen delivery
Positive end-expiratory (PEEP) effect	▪ Unload auto-PEEP (if present) ▪ Decrease work of breathing ▪ Enhance oxygenation
High nasal flow rate	▪ Reliable delivery of fraction of inspired oxygen (FiO_2) ▪ Improved breathing pattern (eg, increased tidal volume, decreased respiratory rate)

HFNC increases nasopharyngeal airway pressure that peaks at the end of expiration (ie, "PEEP effect")



Respir Care 2013; 58(10):1621.

Indications

in patients with severe hypoxemic respiratory failure (eg, [PaO_2:FiO_2] ratio <300 mmHg)

Medical patients with severe hypoxemic resp failure

Post-extubation support

Prevention of post-op resp failure

Oxygenating patients during weaning trials or bronchoscopy

HFNC does not have a role to play for those who are sufficiently oxygenated with low-flow nasal cannulae or those with an indication for immediate intubation (which includes failure of NIV)

Contraindications

Abnormalities or surgery of the face, nose, or airway that preclude an appropriate-fitting nasal cannula.

Following upper airway surgery to avoid the theoretical risk that the high pressure may precipitate a venous thromboembolism

Complications of HFNC

Abdominal distension, aspiration, and rarely, barotrauma (eg, pneumothorax)

Systematic Review | Published: 19 March 2019

High flow nasal cannula compared with conventional oxygen therapy for acute hypoxemic respiratory failure: a systematic review and meta-analysis

B. Rochwerg, D. Granton, D. X. Wang, Y. Helviz, S. Einav, J. P. Frat, A. Mekontso-Dessap, A. Schreiber, E. Azoulay, A. Mercat, A. Demoule, V. Lemiale, A. Pesenti, E. D. Riviello, T. Mauri, J. Mancebo, L. Brochard & K. Burns

Intensive Care Medicine **45**, 563–572 (2019) | Cite this article

- Evaluate the safety and efficacy
- no difference in mortality
- decreased risk of requiring intubation (RR 0.85, 95% CI 0.74-0.99) or escalation of oxygen therapy(RR 0.71, 95% CI 0.51-0.98)
- no effect on intensive care unit length of stay; patient reported comfort; or patient reported dyspnea

The Clinical Respiratory Journal
Open Access

ORIGINAL ARTICLE

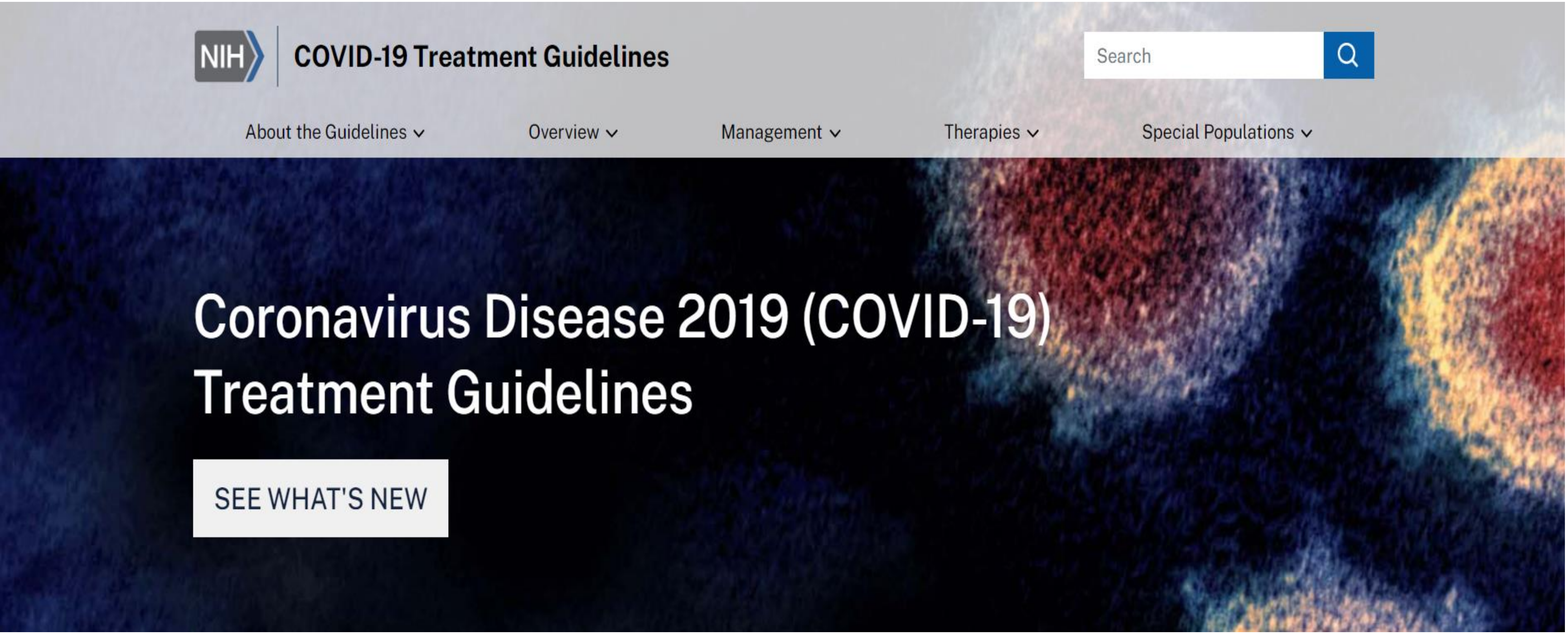
High flow nasal cannulae oxygen therapy in acute-moderate hypercapnic respiratory failure

Myoung Kyu Lee, Jaehwa Choi, Bonil Park, Bumjoon Kim, Seok Jeong Lee, Sang-Ha Kim, Suk Joong Yong, Eun Hee Choi, Won-Yeon Lee

First published: 02 February 2018 | https://doi.org/10.1111/crj.12772 |

1)evaluated the effectiveness in severe AECOPD with moderate hypercapnic acute respiratory failure (ARF) compared to non-invasive ventilation (NIV).
2) prospective observational trial
3) The end point was the intubation rate and 30-day mortality
4) The intubation rate at day 30 was 25.0% in the HFNC group and 27.3% in the NIV group (*P* = .857)
5) the 30-day mortality was 15.9% in the HFNC group and 18.2% in the NIV group (*P* = .845).

no difference of the 30-day mortality and intubation rate



https:// www.covid19treatmentguidelines.nih.gov/

High-Flow Nasal Cannula Oxygen and Noninvasive Ventilation

Recommendations

- For adults with COVID-19 and acute hypoxemic respiratory failure despite conventional oxygen therapy, the Panel recommends starting therapy with HFNC oxygen; if patients fail to respond, NIV or intubation and mechanical ventilation should be initiated **(BIIa)**.
- For adults with COVID-19 and acute hypoxemic respiratory failure who do not have an indication for endotracheal intubation and for whom HFNC oxygen is not available, the Panel recommends performing a closely monitored trial of NIV **(BIIa)**.

Part I:HFNC in acute hypoxemic resp failure

- I: ARDS patients
- II: Pneumonia patients
- III: HF patients

I:HFNC in ARDS patients

Hypoxemic Patients With Bilateral Infiltrates Treated With High-Flow Nasal Cannula Present a Similar Pattern of Biomarkers of Inflammation and Injury to Acute Respiratory Distress Syndrome Patients*

Marina García-de-Acilu, MD[1,2]; Judith Marin-Corral, MD, PhD[3]; Antonia Vázquez, MD[3]; Laura Ruano, BSc[1]; Mònica Magret, MD, PhD[4]; Ricard Ferrer, MD, PhD[1,5]; Joan R. Masclans, MD, PhD[3,5]; Oriol Roca, MD, PhD[1,5]

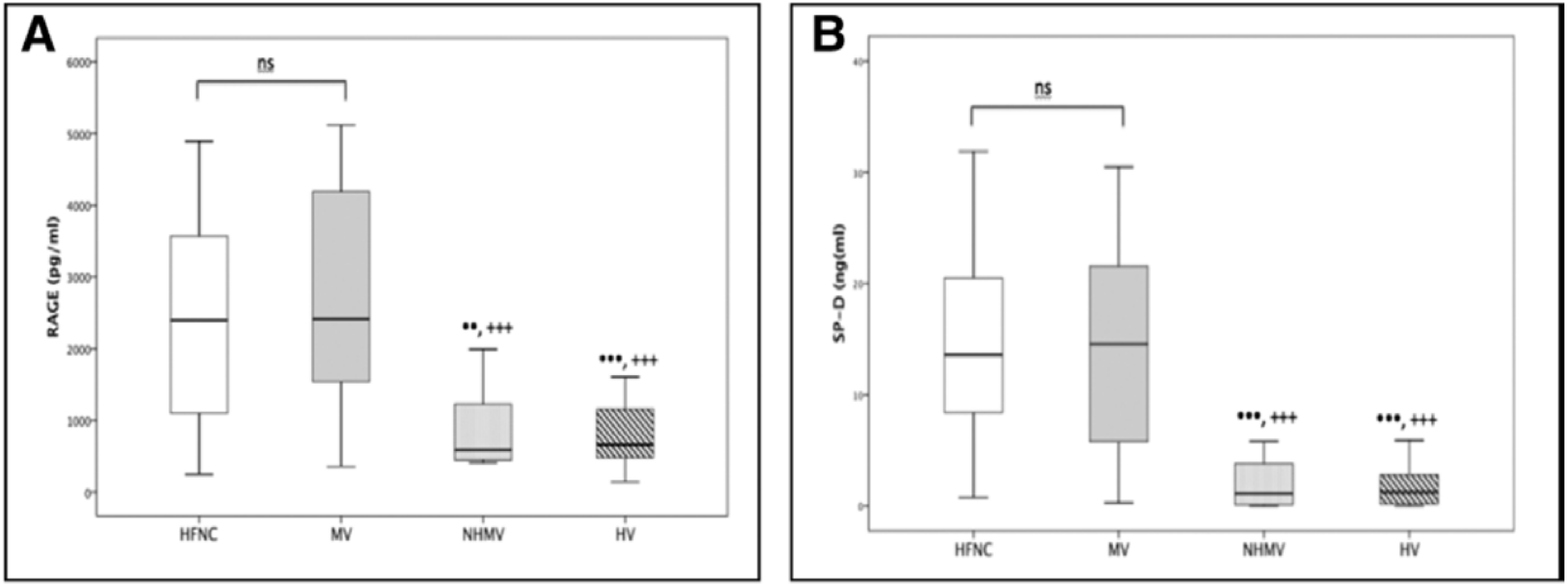
- Crit Care Med. 2017;45(11):1845-1853.

Study designs

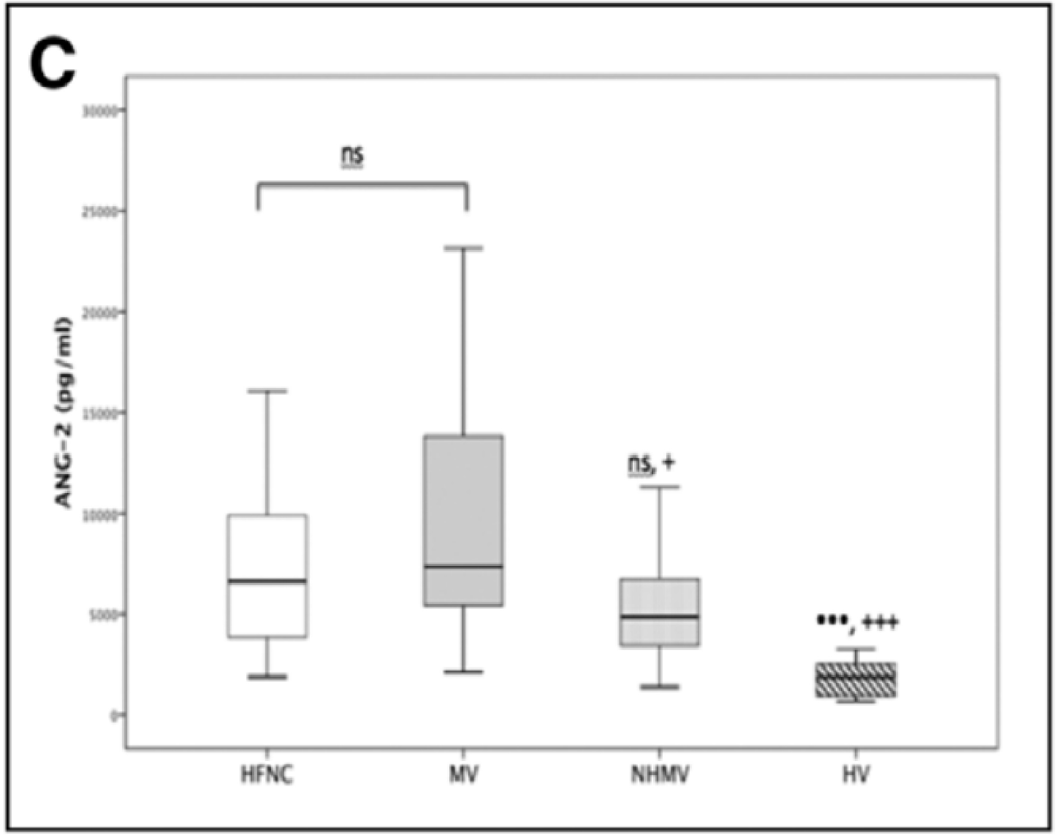
Intubated and non-intubated patients admitted to the ICU with acute hypoxemia ($PaO_2/FiO_2 \leq 300$) and bilateral opacities

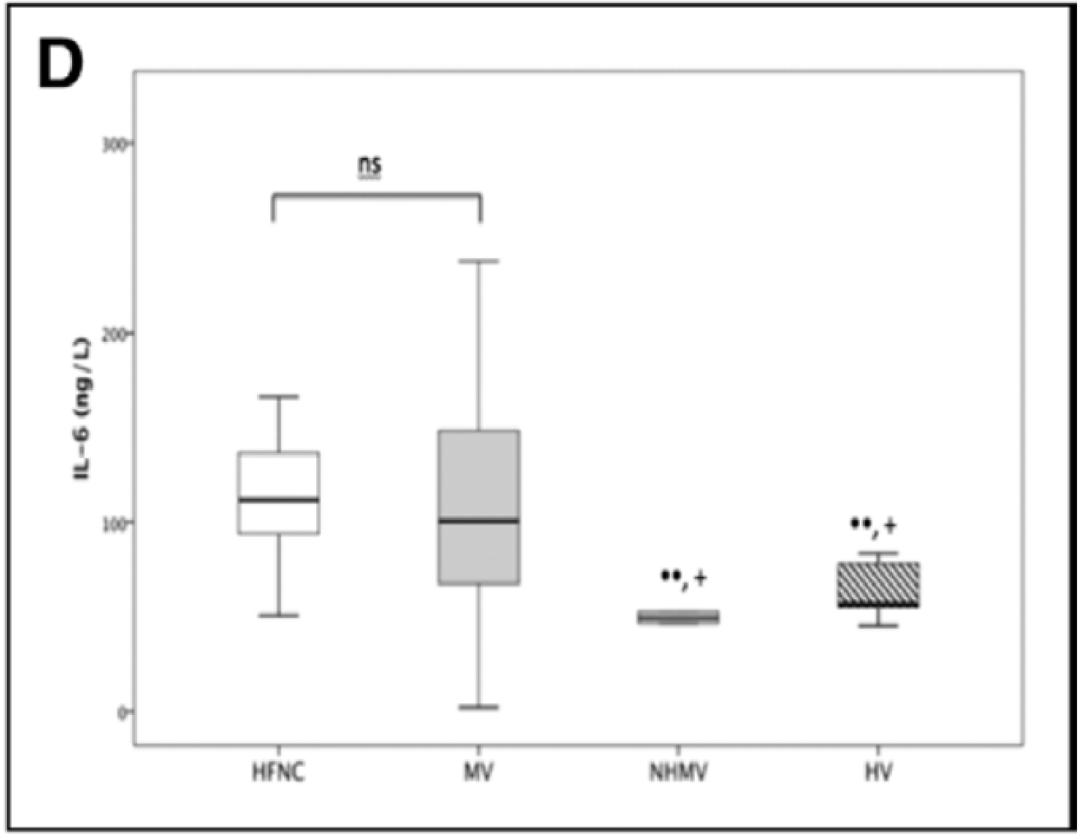
If similar in terms of Lung epithelial, endothelial, and inflammatory biomarkers

*RAGE: receptor for advanced glycation end products
*surfactant protein-D



*ANG-2:angiopoietin-2
*IL-6





*IL-8 and IL-33

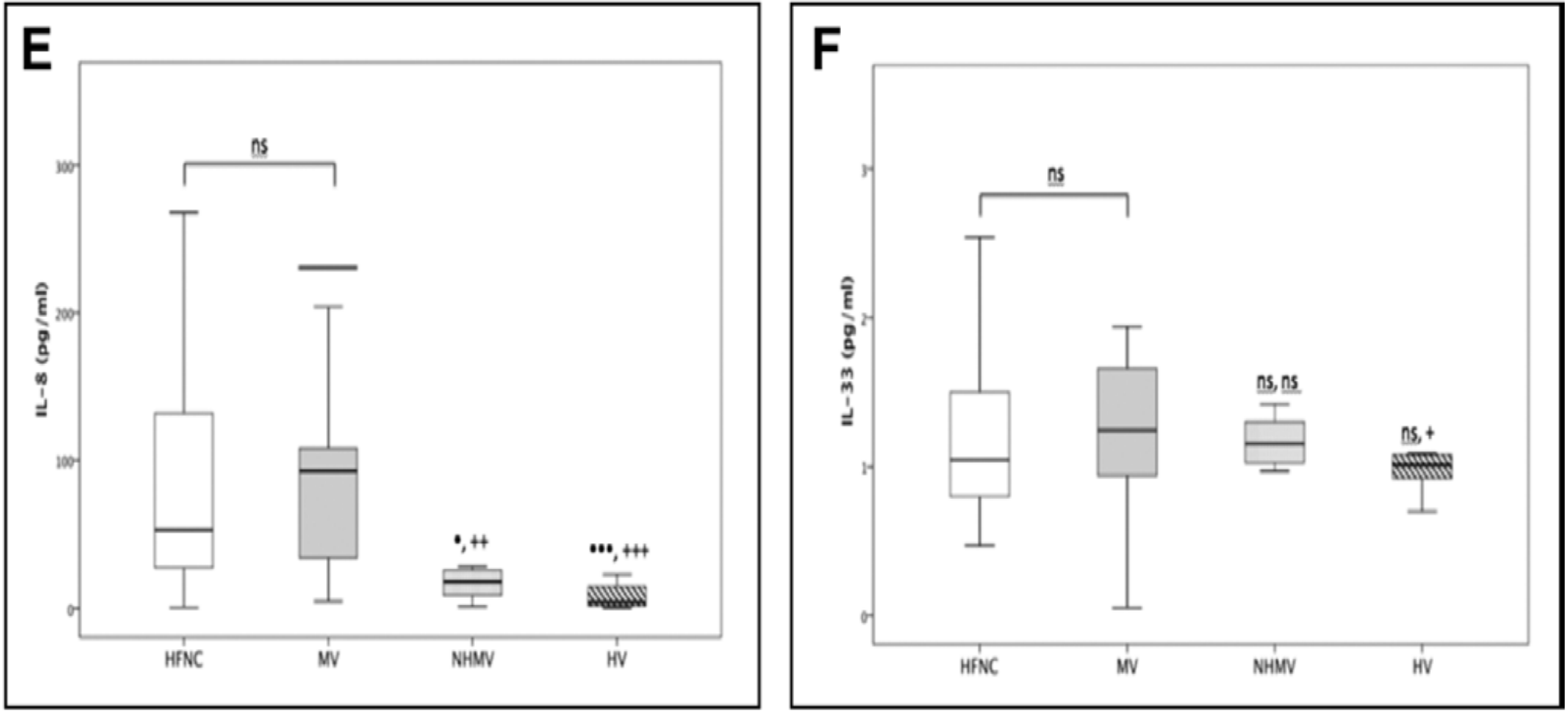

E
IL-8 (pg/ml)
300
200
100
0
ns
*, ++
***, +++
HFNC
MV
NHMV
HV
F
IL-33 (pg/ml)
3
2
1
0
ns
ns, ns
ns, +
HFNC
MV
NHMV
HV

TABLE 3. Biomarkers Concentration in the Matched Groups

Biomarker	Mechanical Ventilation ($n = 39$)	High-Flow Nasal Cannula ($n = 39$)	Mean Difference Between Groups (95% CI)	p
Receptor for advanced glycation end products (ρg/mL)	2,653.80 (2,169.80–3,137.81)	2,387.19 (1,972.10–2,802.28)	−280.56 (−969.41 to 408.30)	0.41
Surfactant protein D (ng/mL)	15.07 (12.15–17.99)	14.43 (11.78–17.07)	−1.05 (−4.84 to 2.74)	0.58
Angiopoietin-2 (ρg/mL)	9,885.55 (7,628.81–12,142.29)	7,660.29 (6,213.89–9,106.68)	−2,009.41 (−4,948.72 to 929.89	0.17
IL-6 (ng/L)	122.95 (96.81–149.08)	120.01 (101.67–138.35)	−2.17 (−37.54 to 33.20)	0.90
IL-8 (ρg/mL)	130.89 (91.40–170.38)	90.20 (55.85–124.55)	−40.34 (−95.72 to 15.03)	0.15
IL-33 (ng/mL)	1.48 (1.14–1.82)	1.21 (1.00–1.41)	−0.27 (−0.65 to 0.13)	0.18
Soluble suppression of tumorigenicity-2 (ρg/mL)	3,389.92 (1,789.78–4,990.06)	3,066.77 (1,425.94–4,707.59)	−569.93 (−2,620.75 to 1,480.90)	0.58

IL = interleukin.

Data of mechanical ventilation and high-flow nasal cannula groups are expressed as mean (95% CI).

- Acute hypoxemic patients with bilateral infiltrates treated with high-flow nasal cannula presented a **similar pattern of biomarkers of inflammation and injury** to acute respiratory distress syndrome patients undergoing direct mechanical ventilation

I:HFNC in ARDS patients

Comment > Respir Care. 2015 Aug;60(8):e148-9. doi: 10.4187/respcare.04314.

Seriously, Should We Be Treating Severe ARDS With High-Flow Nasal Cannula Oxygen?--Reply

Jean-Damien Ricard [1], Jonathan Messika [1], Didier Dreyfuss [1], Karim Ben Ahmed [2], Romain Miguel-Montanes [2], Stéphane Gaudry [3], David Hajage [4]

Affiliations + expand

PMID: 26211010 DOI: 10.4187/respcare.04314

- 不建議在中度或重度的 ARDS （PaO_2 / FiO_2 < 200) 中使用 HFNC ，因為會提高病人死亡率

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.jccjournal.org

Predicting success of high-flow nasal cannula in pneumonia patients with hypoxemic respiratory failure: The utility of the ROX index☆

Oriol Roca, MD, PhD [a,b,*], Jonathan Messika, MD [c,d,e,1], Berta Caralt, MD [a,f,1], Marina García-de-Acilu, MD [a], Benjamin Sztrymf, MD, PhD [g], Jean-Damien Ricard, MD, PhD [c,d,e,2], Joan R. Masclans, MD, PhD [b,h,2]

ROX index（[氧飽和度 / FiO2] / 呼吸頻率）

J Crit Care. 2016;35:200-205

Cox proportional hazards model (Cox regression) to analyze the effect of ROX index greater than or equal to 4.88 after 12 hours of HFNC therapy and potential covariates on the risk of MV

	Hazard ratio	95% CI	*P*
Unadjusted ROX ≥4.88	0.269	0.119–0.608	.002
Adjusted by sex			
ROX ≥4.88	0.275	0.120–0.629	.002
Sex (male)	0.412	0.187–0.909	.028
Adjusted by chronic respiratory disease			
ROX ≥4.88	0.324	0.143–0.735	.007
Chronic respiratory disease	0.196	0.046–0.841	.028
Adjusted by SOFA			
ROX ≥4.88	0.291	0.128–0.660	.003
SOFA	1.127	0.970–1.309	.120
Adjusted by number of quadrants affected in chest x-ray			
ROX ≥4.88	0.316	0.135–0.740	.008
No. of quadrants affected in chest x-ray	1.193	0.813–1.751	.366
Adjusted by APACHE II			
ROX ≥4.88	0.292	0.129–0.664	.003
APACHE II	0.994	0.942–1.050	.838
Adjusted by PSI			
ROX ≥4.88	0.286	0.126–0.650	.003
PSI	0.998	0.989–1.007	.680
Adjusted by shock at HFNC onset			
ROX ≥4.88	0.259	0.115–0.588	.001
Shock at HFNC onset	2.760	0.942–8.087	.064
Adjusted by renal failure at HFNC onset			
ROX ≥4.88	0.264	0.117–0.600	.001
Renal failure at HFNC onset	0.942	0.427–2.077	.882

在 2、6 或 12 小時測得的 ROX index 需大於或等於 4.88，才具有 HFNC 的成功因素

Summary: HFNC in ARDS patients

在 Berlin definition for ARDS 輕度的病人（200 mmHg < PaO2/FiO2 < 300 mmHg），可考慮使用 HFNC 做為第一線治療，尤其 ARDS 主因是肺炎引起的病人

但在較高的 SAPS II 分 數（>46）、合併有其他器官衰竭，血行力學不穩或意識混亂的病人，有較高的失敗率

應注意病人是否有立即性插管的可能，避免延遲插管的發生

可考慮使用 ROX index（[氧飽和度 / FiO2] / 呼吸頻率）作為 HFNC 是否失敗的預測

II:HFNC in pneumonia patients

[Original Research Critical Care]

CHEST

Can High-flow Nasal Cannula Reduce the Rate of Endotracheal Intubation in Adult Patients With Acute Respiratory Failure Compared With Conventional Oxygen Therapy and Noninvasive Positive Pressure Ventilation?

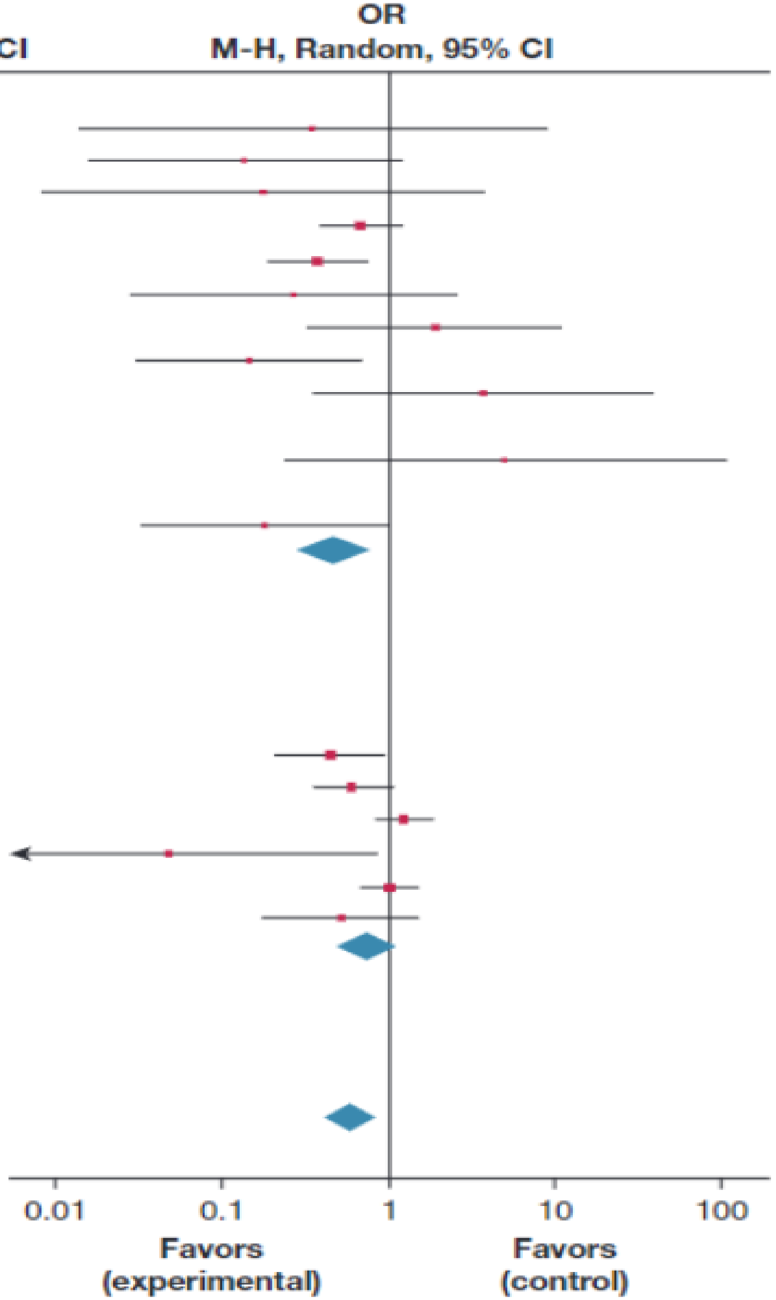
A Systematic Review and Meta-analysis

Yue-Nan Ni, MM; Jian Luo, MD; He Yu, MD; Dan Liu, MD; Zhong Ni, MD; Jiangli Cheng, MD; Bin-Miao Liang, MD; and Zong-An Liang, MD

Chest. 2017;151(4):764-775.

HFNC vs COT + HFNC vs NIPPV: intubation

Study or Subgroup	HFNC Events	HFNC Total	Control Events	Control Total	Weight	OR M-H, Random, 95% CI
1.1.1 HFNC vs COT						
Bell 2015[18]	0	48	1	52	1.2%	0.35 (0.01-8.90)
Brotfain 2014[19]	1	34	6	33	2.4%	0.14 (0.02-1.20)
Corley 2015[20]	0	81	2	74	1.3%	0.18 (0.01-3.77)
Frat 2015[15]	40	106	44	94	11.5%	0.69 (0.39-1.21)
Hernández 2016[16]	13	264	32	263	10.4%	0.37 (0.19-0.73)
Jones 2016[23]	1	165	3	138	2.3%	0.27 (0.03-2.67)
Lemiale 2015[24]	4	52	2	48	3.5%	1.92 (0.33-10.97)
Maggiore 2014[25]	2	53	11	52	4.1%	0.15 (0.03-0.70)
Nicolet 2011[27]	3	19	1	21	2.1%	3.75 (0.36-39.59)
Parke 2011[28]	0	29	0	27		Not estimable
Parke 2013[29]	2	169	0	171	1.3%	5.12 (0.24-107.43)
Rittayamai 2015[30]	0	20	0	20		Not estimable
Roca 2015[31]	13	22	16	18	3.6%	0.18 (0.03-0.99)
Subtotal (95% CI)		**1,062**		**1,011**	**43.8%**	**0.47 (0.27-0.84)**
Total events	79		118			
Heterogeneity: $Tau^2 = 0.26$; $\chi^2 = 15.19$, df = 10 ($P = .13$); $I^2 = 34\%$						
Test for overall effect: $z = 2.55$ ($P = .01$)						
1.1.2 HFNC vs NIPPV						
Coudroy 2016[21]	21	60	30	55	9.5%	0.45 (0.21-0.95)
Frat 2015[15]	40	106	55	110	11.7%	0.61 (0.35-1.04)
Hernández 2016[22]	66	290	60	314	13.3%	1.25 (0.84-1.85)
Nagata 2015[26]	0	33	10	43	1.5%	0.05 (0.00-0.85)
Stéphan 2016[32]	58	414	57	416	13.3%	1.03 (0.69-1.52)
Yoo 2016[33]	7	34	13	39	6.8%	0.52 (0.18-1.50)
Subtotal (95% CI)		**937**		**977**	**56.2%**	**0.73 (0.47-1.13)**
Total events	192		225			
Heterogeneity: $Tau^2 = 0.16$; $\chi^2 = 13.51$, df = 5 ($P = .02$); $I^2 = 63\%$						
Test for overall effect: $z = 1.40$ ($P = .16$)						
Total (95% CI)		**1,999**		**1,988**	**100.0%**	**0.60 (0.41-0.86)**
Total events	271		343			
Heterogeneity: $Tau^2 = 0.23$; $\chi^2 = 35.21$, df = 16 ($P = .004$); $I^2 = 55\%$						
Test for overall effect: $z = 2.76$ ($P = .006$)						
Test for subgroup differences: $\chi^2 = 1.41$, df = 1 ($P = .23$). $I^2 = 29.2\%$						



ICU mortality

Study or Subgroup	HFNC Events	HFNC Total	Control Events	Control Total	Weight	OR M-H, Random, 95% CI
2.1.1 HFNC vs COT						
Brotfain 2014[19]	1	34	0	33	1.5%	3.00 (0.12-76.31)
Frat 2015[15]	12	106	18	94	13.3%	0.54 (0.24-1.19)
Hernández 2016[16]	3	264	3	263	5.2%	1.00 (0.20-4.98)
Maggiore 2014[25]	6	53	5	52	7.7%	1.20 (0.34-4.20)
Roca 2015[31]	10	22	13	18	7.0%	0.32 (0.08-1.21)
Subtotal (95% CI)		**479**		**460**	**34.8%**	**0.65 (0.37-1.13)**
Total events	32		39			
Heterogeneity: $Tau^2 = 0.00$; $\chi^2 = 3.35$, df = 4 ($P = .50$); $I^2 = 0\%$						
Test for overall effect: $z = 1.53$ ($P = .13$)						
2.1.2 HFNC vs NIPPV						
Coudroy 2016[21]	9	60	20	55	11.7%	0.31 (0.13-0.76)
Frat 2015[15]	12	106	27	110	14.2%	0.39 (0.19-0.82)
Hernández 2016[22]	19	290	18	314	15.5%	1.15 (0.59-2.24)
Stéphan 2016[32]	28	414	23	416	17.4%	1.24 (0.70-2.19)
Yoo 2016[33]	3	34	8	39	6.4%	0.38 (0.09-1.55)
Subtotal (95% CI)		**904**		**934**	**65.2%**	**0.63 (0.34-1.18)**
Total events	71		96			
Heterogeneity: $Tau^2 = 0.32$; $\chi^2 = 12.21$, df = 4 ($P = .02$); $I^2 = 67\%$						
Test for overall effect: $z = 1.44$ ($P = .15$)						
Total (95% CI)		**1,383**		**1,394**	**100.0%**	**0.67 (0.44-1.01)**
Total events	103		135			
Heterogeneity: $Tau^2 = 0.17$; $\chi^2 = 15.72$, df = 9 ($P = .07$); $I^2 = 43\%$						
Test for overall effect: $z = 1.92$ ($P = .05$)						
Test for subgroup differences: $\chi^2 = 0.00$, df = 1 ($P = .96$). $I^2 = 0\%$						

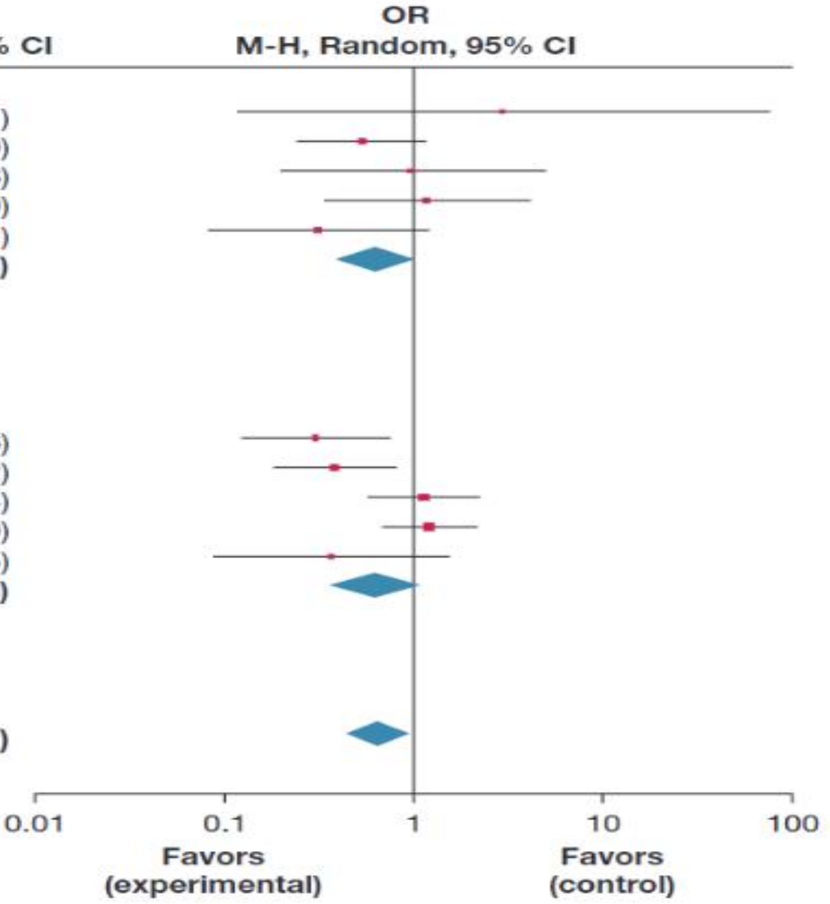


Figure 6 – *ICU mortality. See Figure 4 and 5 legends for expansion of abbreviations.*

Chest. 2017;151(4):764-775

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
3.1.1 HFNC vs COT								
Brotfain 2014[19]	10.7	6.2	34	10.5	7.3	33	8.8%	0.20 (–3.05 to 3.45)
Hernández 2016[16]	6	24.87	264	6	28.96	263	4.4%	0.00 (–4.61 to 4.61)
Jones 2016[23]	4.5	7.21	165	4.9	6.89	138	36.6%	–0.40 (–1.99 to 1.19)
Maggiore 2014[25]	11.7	10.2	53	10.4	8.5	52	7.2%	1.30 (–2.29 to 4.89)
Nicolet 2011[27]	6	4	19	5.5	3	21	19.0%	0.50 (–1.71 to 2.71)
Parke 2013[29]	33.4	22.8	169	28.9	24	171	3.7%	4.50 (–0.48 to 9.48)
Roca 2015[31]	14	26.32	22	9	44.37	18	0.2%	5.00 (–18.26 to 28.26)
Subtotal (95% CI)			**726**			**696**	**79.9%**	**0.30 (–0.78 to 1.37)**
Heterogeneity: $\chi^2 = 3.99$, df = 6 ($P = .68$); $I^2 = 0\%$								
Test for overall effect: $Z = 0.54$ ($P = .59$)								
3.1.2 HFNC vs NIPPV								
Coudroy 2016[21]	7	9.88	60	8	15.14	55	4.2%	–1.00 (–5.72 to 3.72)
Hernández 2016[22]	3	21.72	290	4	31.64	314	5.0%	–1.00 (–5.30 to 3.30)
Nagata 2015[26]	6	11.72	33	4	13.38	43	2.9%	2.00 (–3.66 to 7.66)
Stéphan 2016[32]	6	31.22	414	6	31.14	416	5.2%	0.00 (–4.24 to 4.24)
Yoo 2016[33]	13.4	10.3	34	20.6	14.2	39	2.9%	–7.20 (–12.84 to –1.56)
Subtotal (95% CI)			**831**			**867**	**20.1%**	**–1.21 (–3.35 to 0.94)**
Heterogeneity: $\chi^2 = 5.89$, df = 4 ($P = .21$); $I^2 = 32\%$								
Test for overall effect: $Z = 1.10$ ($P = .27$)								
Total (95% CI)			**1,557**			**1,563**	**100.0%**	**–0.01 (–0.97 to 0.96)**
Heterogeneity: $\chi^2 = 11.39$, df = 11 ($P = .41$); $I^2 = 3\%$								
Test for overall effect: $Z = 0.01$ ($P = .99$)								
Test for subgroup differences: $\chi^2 = 1.51$, df = 1 ($P = .22$). $I^2 = 33.8\%$								

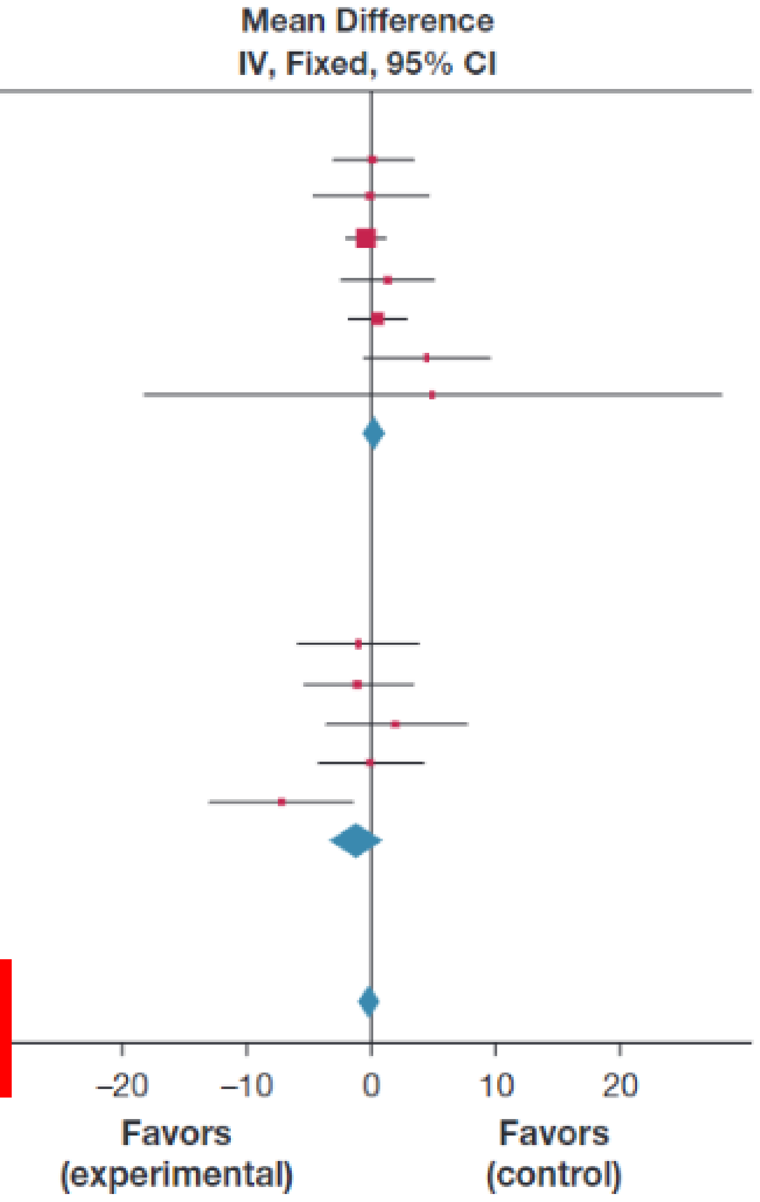


Figure 7 – *ICU length of stay. IV = inverse variance. See Figure 4 legend for expansion of other abbreviations.*

Chest. 2017;151(4):764-775

Compared with COT, HFNC could reduce the rate of endotracheal intubation in patients with ARF

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

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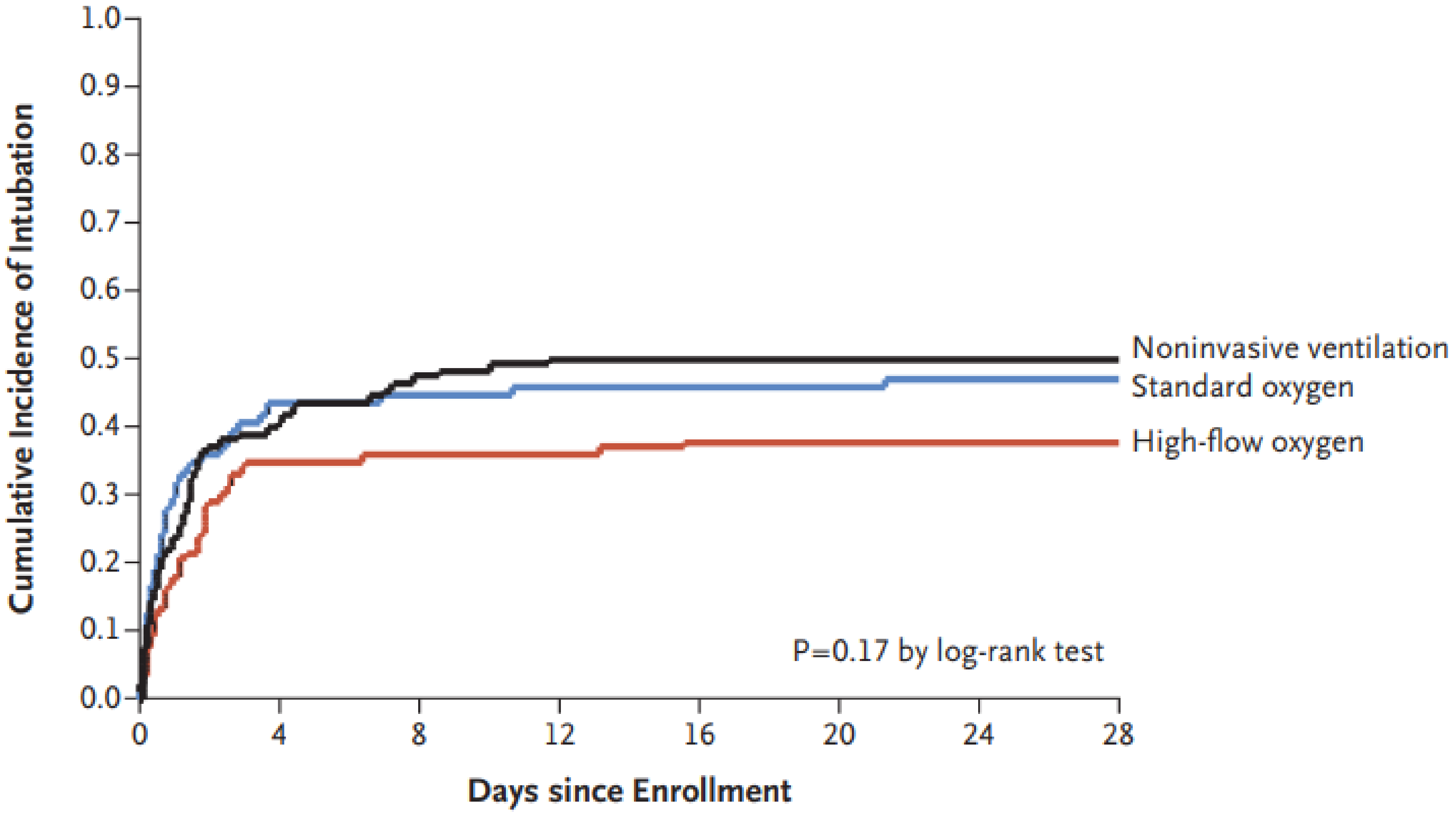
*The primary outcome was the proportion of patients intubated at day 28

*P/F ratio < 300, without hypercapnia

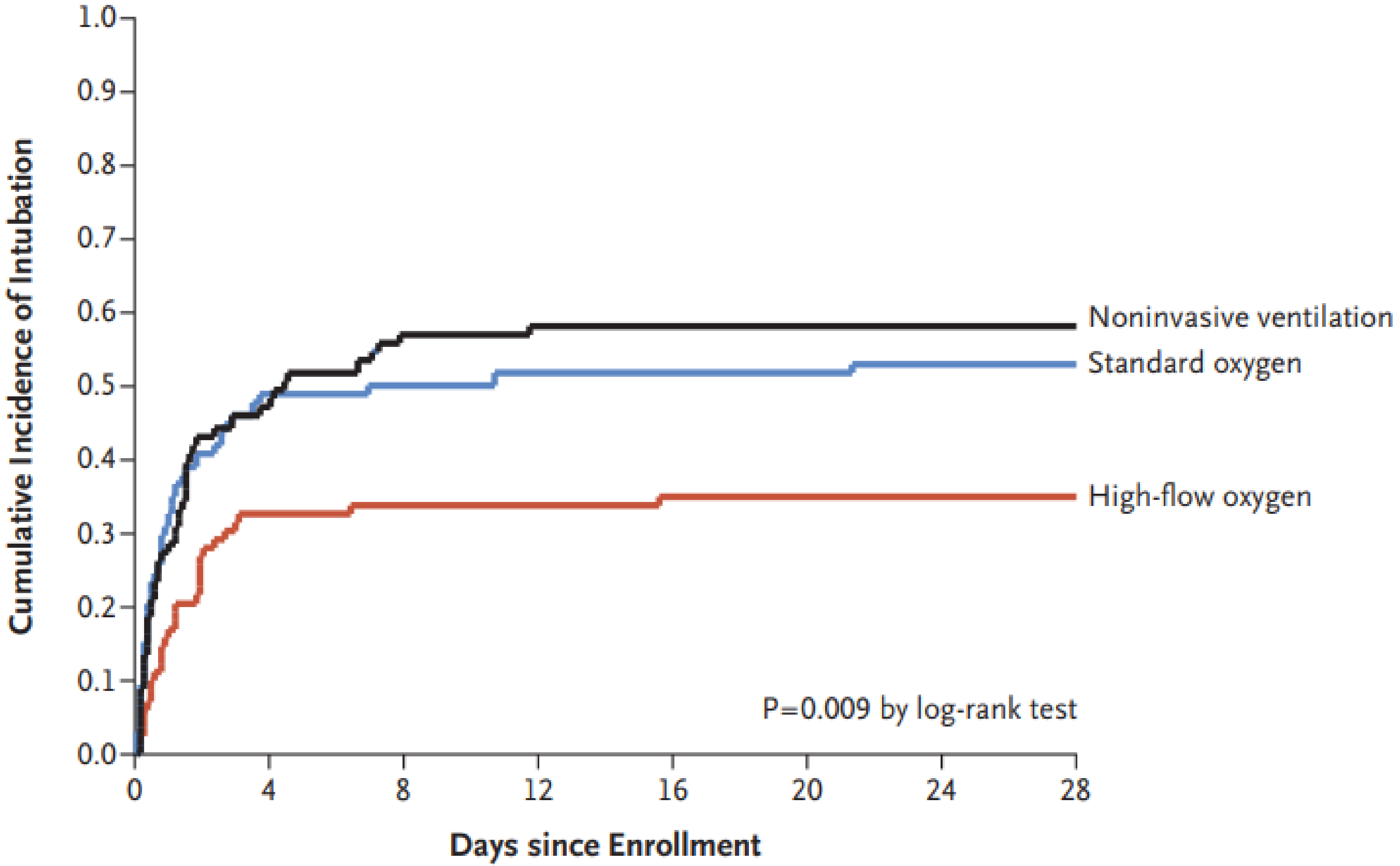
A Overall Population



No. at Risk

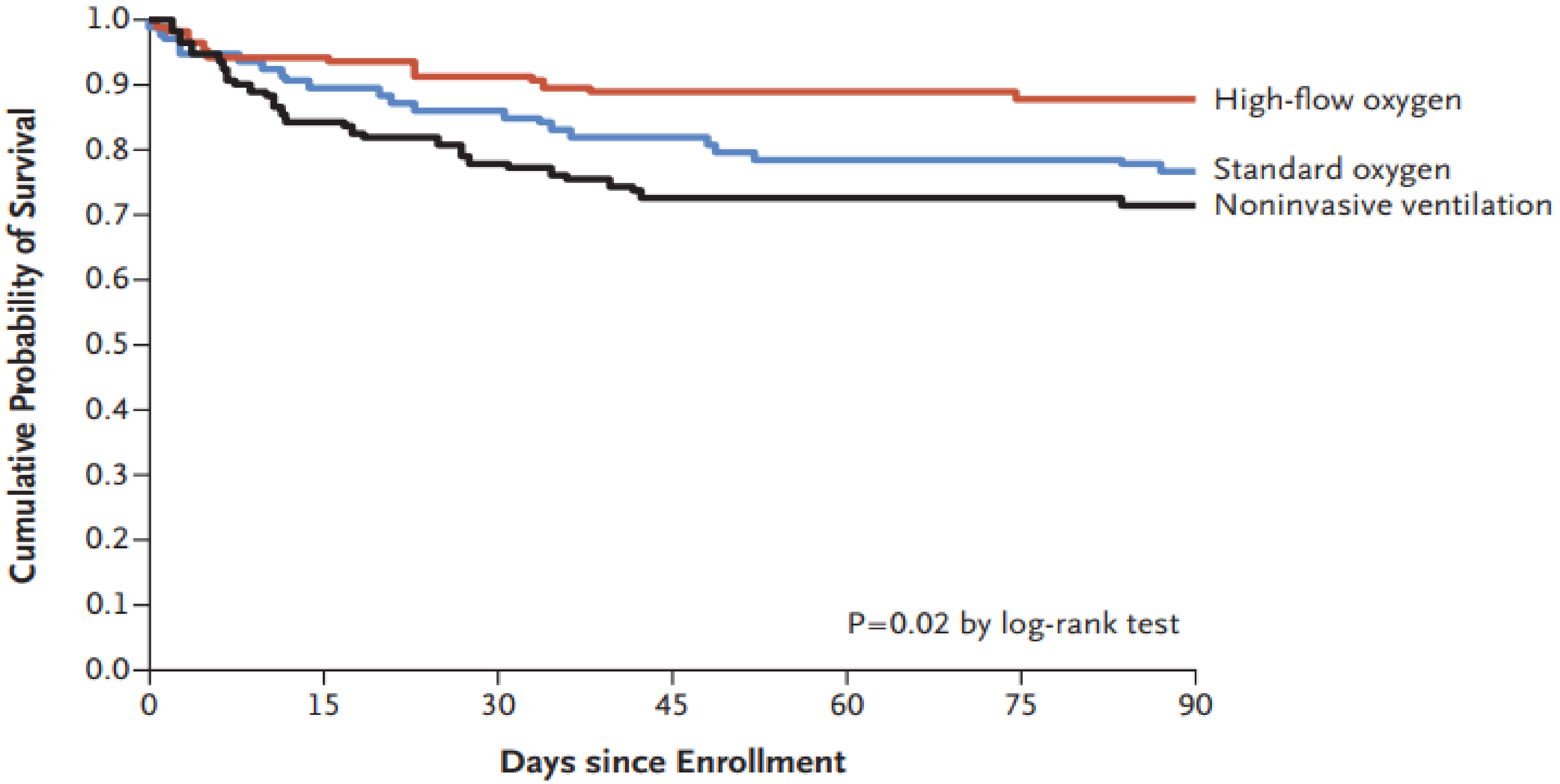
High-flow oxygen	106	68	67	67	65	65	65	65
Standard oxygen	94	52	50	49	49	49	48	48
Noninvasive ventilation	110	64	57	53	53	53	53	52

B Patients with a $PaO_2:FiO_2$ ≤200 mm Hg



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



No. at Risk

High-flow oxygen	106	100	97	94	94	93	93
Standard oxygen	94	84	81	77	74	73	72
Noninvasive ventilation	110	93	86	80	79	78	77

Figure 3. Kaplan–Meier Plot of the Probability of Survival from Randomization to Day 90.

Expert suggestions for HFNC in patients with pneumonia

- 儘管尚無直接證據表明在肺炎患者中可使用 HFNC，但許多針對急性低血氧性呼吸衰竭的研究都包括了肺炎患者。因此，HFNC 可被視為肺炎患者的前線治療。

III:HFNC in heart failure patients

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HVNI *vs* NIPPV in the treatment of acute decompensated heart failure: Subgroup analysis of a multi-center trial in the ED

Check for updates

Steven T. Haywood, MD [a,b,*], Jessica S. Whittle, MD PhD [a,b], Leonithas I. Volakis, PhD [c], George Dungan II, MPhil Med [c,d], Michael Bublewicz, MD [e], Joseph Kearney, MD [f], Terrell Ashe, RRT [g], Thomas L. Miller, PhD [c,h,i], Pratik Doshi, MD [e,j]

*HVNI=22; NIPPV=20

*The primary outcome was therapy failure at 72 h after enrolment

Table 2
Primary study outcomes of ADHF subgroup.Statistical significance ($p < 0.05$) was determined by Fisher's Exact test. All categories and groups analyzed reported sample size $N = 22$ (HVNI) and $N = 20$ (NIPPV)

Characteristic	HVNI (N = 22)		NIPPV (N = 20)		p-Value
Success	No. (%)		No. (%)		1.000
No	1	(4.5)	0	(0)	
Yes	21	(95.5)	20	(100)	
Intubation					1.000
No	22	(100)	20	(100)	
Crossover					1.000
No	21	(95.5)	20	(100)	
Yes	1	(4.5)	0	(0)	

ADHF: Acute Decompensated Heart Failure.

Much comfort/tolerance; less monitoring

Table 4

Clinician perception scores of ADHF subgroup.Data presented as median (IQR) & range (min–max) for each characteristic. All categories and groups analyzed reported sample size $N = 20$. Statistical significance ($p < 0.05$) was determined by Wilcoxon Rank Sum test.

Characteristic	HVNI (N = 20)			NIPPV (N = 20)			p-Value
	Median (IQR)		[Range]	Median (IQR)		[Range]	
Patient respiratory response (1-insufficient, 3-adequate, 5-excellent)	5	(4–5)	[2–5]	4	(3–5)	[2–5]	0.081
Patient comfort/tolerance (1-insufficient, 3-adequate, 5-excellent)	5	(5–5)	[3–5]	3	(3–4)	[2–5]	<0.001
Technical & clinical difficulties (1-frequent, 3-occasional, 5-excellent)	5	(5–5)	[3–5]	5	(3–5)	[3–5]	0.979
Simplicity of use (1-complex, 3-typical, 5-simple)	5	(4–5)	[3–5]	3	(3–5)	[3–5]	0.004
Monitoring required (1-complex, 3-typical, 5-simple)	5	(3–5)	[1–5]	3	(3–4.5)	[2–5]	0.036

- this subgroup analysis suggests HVNI may be **non-inferior to** NIPPV in patients with respiratory failure secondary to ADHF that do not need emergent intubation

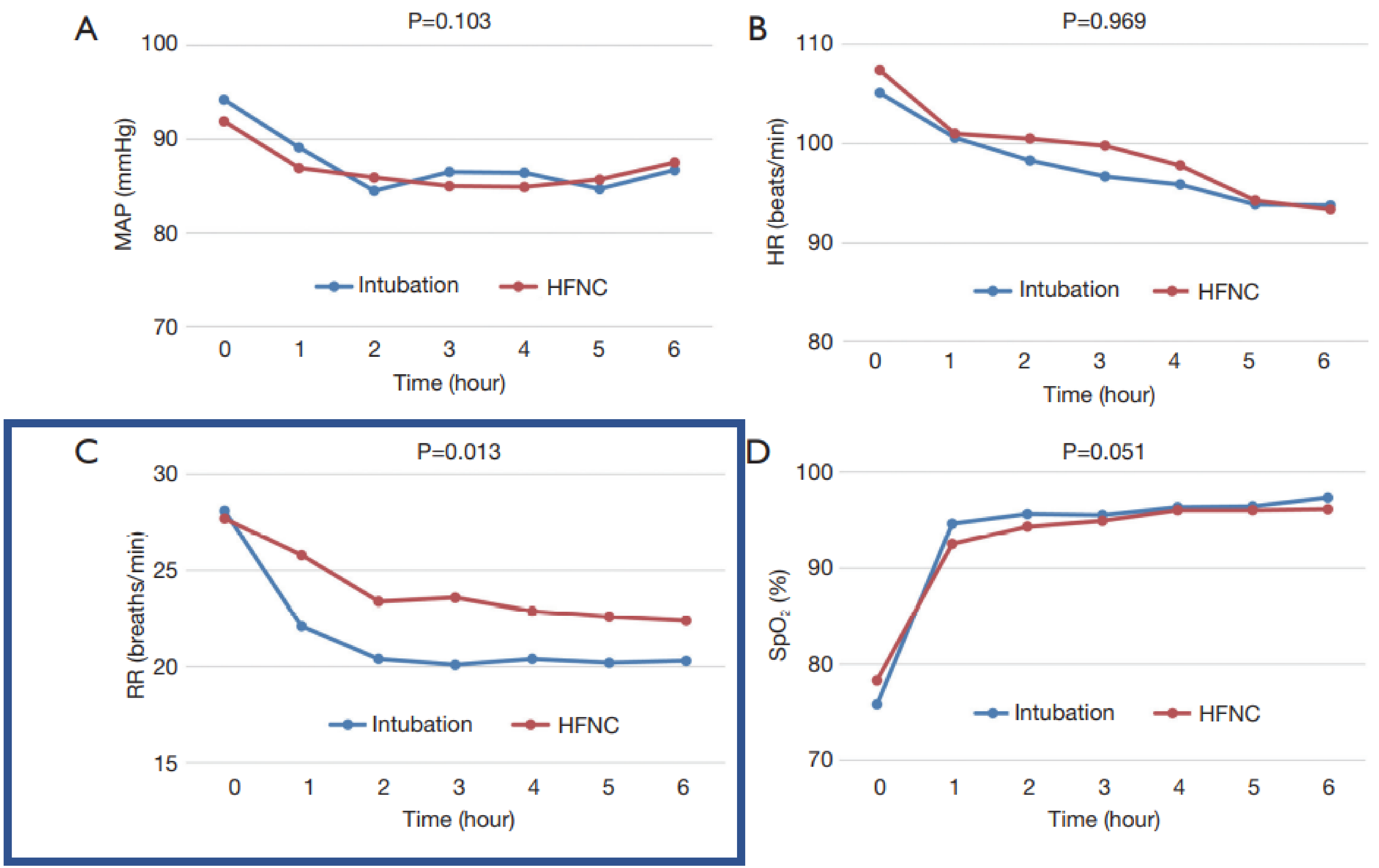
Original Article

Clinical efficacy of high-flow oxygen therapy through nasal cannula in patients with acute heart failure

Min Gyu Kang[1], Kyehwan Kim[1], Sunmi Ju[1], Hyun Woong Park[1], Seung Jun Lee[2], Jin-Sin Koh[1], Seok-Jae Hwang[1], Jin-Yong Hwang[1], Jae Seok Bae[3], Jong-Hwa Ahn[3], Jeong Yoon Jang[3], Yongwhi Park[3], Young-Hoon Jeong[3], Choong Hwan Kwak[3], Jeong Rang Park[1]

Primary outcomes: the physiological responses and in-hospital clinical outcomes between two groups.

J Thorac Dis 2019 Feb;11(2):410-417



A
P=0.103
MAP (mmHg)
100
90
80
70
Intubation
HFNC
0
1
2
3
4
5
6
Time (hour)
B
P=0.969
HR (beats/min)
110
100
90
80
Intubation
HFNC
0
1
2
3
4
5
6
Time (hour)
C
P=0.013
RR (breaths/min)
30
25
20
15
Intubation
HFNC
0
1
2
3
4
5
6
Time (hour)
D
P=0.051
SpO2 (%)
100
90
80
70
Intubation
HFNC
0
1
2
3
4
5
6
Time (hour)

No difference !

Table 2 In-hospital clinical outcomes

Variables	Total (n=149)	Intubation group (n=73)	HFNC group (n=76)	P value
Hospital stay (days)	9 [6–14]	9 [7–16]	9 [6–14]	0.353
Vasopressor use	88 (59.1)	30 (41.1)	20 (26.3)	0.051
Renal replacement therapy	13 (8.7)	6 (8.2)	7 (9.2)	0.830
Sustained ventricular arrhythmia	13 (8.7)	8 (11.0)	5 (6.6)	0.344
Hospital acquired pneumonia	17 (11.4)	10 (13.7)	7 (9.2)	0.389
All-cause death	11 (7.4)	7 (9.6)	4 (5.3)	0.313
Cardiac death	9 (6.0)	6 (8.2)	3 (3.9)	0.274
Requiring intubation*	–	–	10 (13.2)	–

Continuous variables are presented as median (interquartile range) and categorical variables are expressed as a number (%). *, data of HFNC group. HFNC, high-flow oxygen therapy through nasal cannula.

J Thorac Dis 2019 Feb;11(2):410-417

This study showed HFNC group had a similar result of improvement of oxygen saturation and in-hospital clinical outcomes compared with intubation group in AHF.

Expert consensus of HFNC for HF patients

- 心衰竭併呼吸衰竭，臨床評估可先使用非侵襲性機械通氣輔助時 ，選擇 HFNC 與 NIPPV 效果相當。
- 低血氧者若血行動力穩定且意識清楚，可考慮以 HFNC 取代插管，兩者無顯著死亡率差異。

Part II:HFNC in patients with acute hypercapnic resp failure

I: mild to moderate hypercapnic resp failure

II: AECOPD

.

I: mild to moderate hypercapnic resp failure

Review Article

High-Flow Nasal Cannula in Hypercapnic Respiratory Failure: A Systematic Review and Meta-Analysis

Yongkang Huang, Wei Lei, Wenyu Zhang, and Jian-an Huang

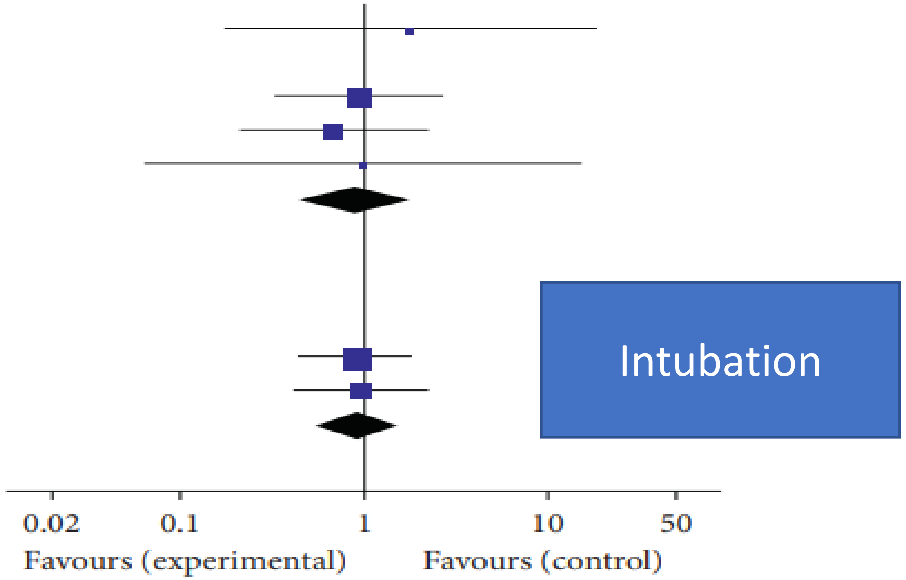
> 16 years old

$PaCO_2$ > 45 mmHg

621 patients ; 6 RCT and 2 cohort study

Can Respir J . 2020 Oct 29;2020:7406457

Intubation						
1.1.1. RCTs						
Jing, G., et al., 2018	2	22	1	20	7.7	1.82 [0.18, 18.55]
Papachatzakis, Y., et al., 2020	0	20	0	20		Not estimable
Tan, D., et al, 2020	6	44	6	42	45.4	0.95 [0.33, 2.73]
Wang, J., et al., 2019	4	23	5	20	39.5	0.70 [0.22, 2.24]
Yu, Z.,et al., 2019	1	36	1	36	7.4	1.00 [0.07, 15.38]
Subtotal (95% CI)		*145*		*138*	*100.0*	*0.92 [0.45, 1.88]*
Total events	*13*		*13*			
Heterogeneity: $chi^2 = 0.56$, $df = 3$ ($P = 0.91$); $I^2 = 0\%$						
Test for overall effect: $Z = 0.22$ ($P = 0.82$)						
1.1.2. Cohort studies						
Lee, M.K., et al., 2018	11	44	12	44	58.4	0.92 [0.45, 1.85]
Sun, J., et al., 2019	8	39	9	43	41.6	0.98 [0.42, 2.29]
Subtotal (95% CI)		*83*		*87*	*100.0*	*0.94 [0.55, 1.62]*
Total events	*19*		*21*			
Heterogeneity: $chi^2 = 0.01$, $df = 1$ ($P = 0.91$); $I^2 = 0\%$						
Test for overall effect: $Z = 0.21$ ($P = 0.83$)						



Mortality						
2.1.1. RCTs						
Jing, G., et al., 2018	5	22	5	22	25.8	1.00 [0.24, 4.10]
Papachatzakis, Y., et al., 2020	3	36	2	36	12.2	1.55 [0.24, 9.85]
Tan, D., et al, 2020	7	44	5	42	28.7	1.40 [0.41, 4.81]
Wang, J., et al., 2019	6	23	4	20	21.1	1.41 [0.34, 5.94]
Yu, Z.,et al., 2019	3	36	2	36	12.2	1.55 [0.24, 9.85]
Subtotal (95% CI)		*161*		*156*	*100.0*	*1.33 [0.68, 2.60]*
Total events	*24*		*18*			
Heterogeneity: $chi^2 = 0.22$, $df = 4$ ($P = 0.99$); $I^2 = 0\%$						
Test for overall effect: $Z = 0.85$ ($P = 0.40$)						
2.1.2. Cohort studies						
Lee, M.K., et al., 2018	7	44	8	44	58.2	0.85 [0.28, 2.59]
Sun, J., et al., 2019	6	39	6	43	41.8	1.12 [0.33, 3.82]
Subtotal (95% CI)		*83*		*87*	*100.0*	*0.96 [0.42, 2.20]*
Total events	*13*		*14*			
Heterogeneity: $chi^2 = 0.11$, $df = 1$ ($P = 0.74$); $I^2 = 0\%$						
Test for overall effect: $Z = 0.09$ ($P = 0.93$)						

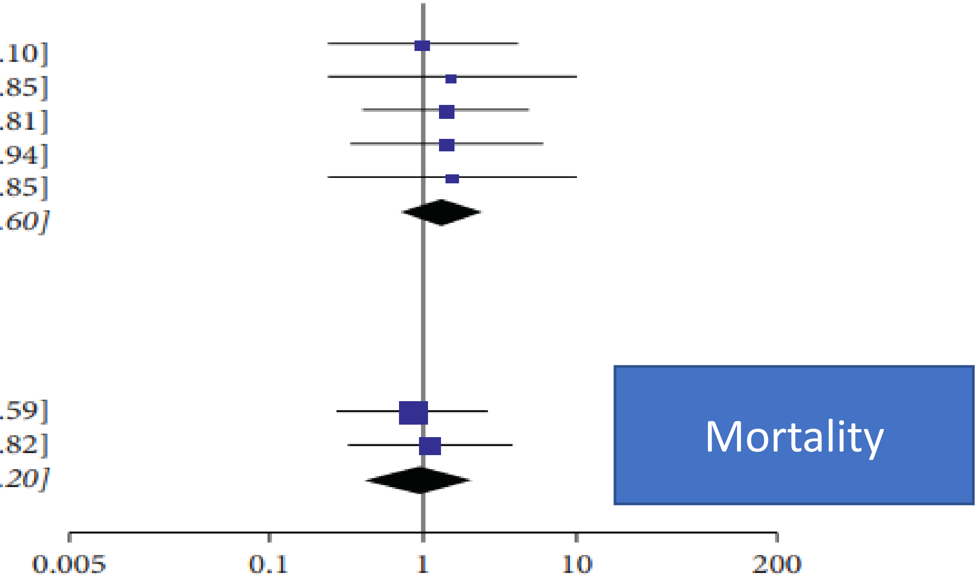
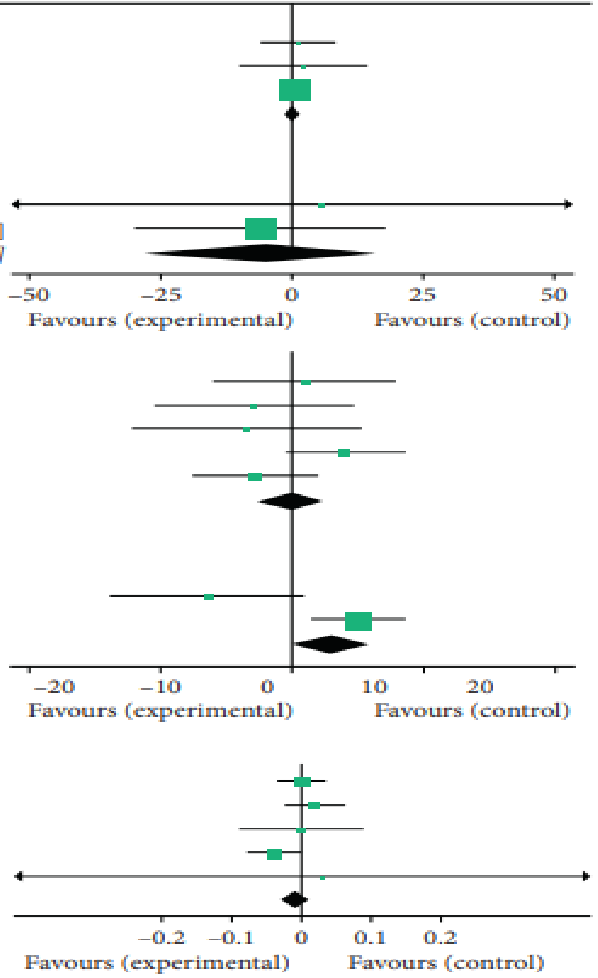


FIGURE 3: Intubation and mortality.

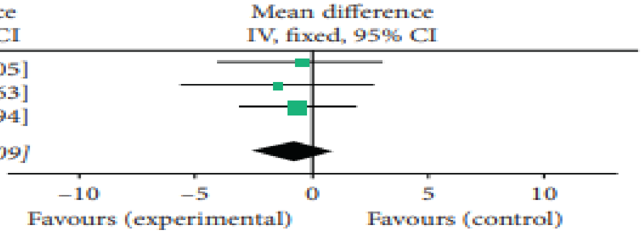
Study or subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight (%)	Mean difference IV, fixed, 95% CI
3.1.1. PaO_2								
Cong, L., et al., 2019	19.06	23.88	84	17.91	23.26	84	4.7	1.15 [−5.98, 8.28]
Papachatzakis, Y., et al., 2020	2.7	15.616	20	0.4	22.36	20	1.7	2.30 [−9.65, 14.25]
Yu, Z., et al., 2019	24.47	3.42	36	24.19	3.46	36	93.7	0.28 [−1.31, 1.87]
Subtotal (95% CI)			*140*			*140*	*100.0*	*0.35 [−1.18, 1.89]*
Heterogeneity: $chi^2 = 0.16$, $df = 2$ ($P = 0.92$); $I^2 = 0\%$								
Test for overall effect: $Z = 0.45$ ($P = 0.65$)								
3.1.2. PaO_2/FiO_2								
Jing, G., et al., 2018	5.1	150.76	22	−0.6	129.58	20	7.4	5.70 [−79.12, 90.52]
Tan, D., et al., 2020	−10.8	58.78	44	−4.9	54.35	42	92.6	−5.90 [−29.81, 18.01]
Subtotal (95% CI)			*66*			*62*	*100.0*	*−5.05 [−28.06, 17.97]*
Heterogeneity: $chi^2 = 0.07$, $df = 1$ ($P = 0.80$); $I^2 = 0\%$								
Test for overall effect: $Z = 0.43$ ($P = 0.67$)								
Test for subgroup differences: $chi^2 = 0.21$, $df = 1$ ($P = 0.65$); $I^2 = 0\%$								
3.2.1. $PaCO_2$ RCTs								
Cong, L., et al., 2019	−8.94	22.79	84	−9.85	22.89	84	14.2	0.91 [−6.00, 7.82]
Jing, G., et al., 2018	2.3	7.94	22	5.2	15.34	20	12.1	−2.90 [−10.40, 4.60]
Papachatzakis, Y., et al., 2020	−8.8	13.79	20	−5.3	14.15	20	9.1	−3.50 [−12.16, 5.16]
Tan, D., et al., 2020	3.5	9.86	44	−0.5	11.12	42	34.3	4.00 [−0.45, 8.45]
Yu, Z.,et al., 2019	−16.53	10.91	36	−13.72	9.52	36	30.3	−2.81 [−7.54, 1.92]
Subtotal (95% CI)			*206*			*202*	*100.0*	*−0.02 [−2.62, 2.59]*
Heterogeneity: $chi^2 = 5.73$, $df = 4$ ($P = 0.22$); $I^2 = 30\%$								
Test for overall effect: $Z = 0.01$ ($P = 0.99$)								
3.2.2. $PaCO_2$_Cohort studies								
Lee, M.K., et al., 2018	−9.4	18.92	44	−3	16.28	44	18.1	−6.40 [−13.78, 0.98]
Sun, J., et al., 2019	−5	8.93	39	−10	6.82	43	81.9	5.00 [1.53, 8.47]
Subtotal (95% CI)			*83*			*87*	*100.0*	*2.94 [−0.20, 6.07]*
Heterogeneity: $chi^2 = 7.52$, $df = 1$ ($P = 0.006$); $I^2 = 87\%$								
Test for overall effect: $Z = 1.84$ ($P = 0.07$)								
3.3.1. pH_RCTs								
Cong, L., et al., 2019	0.09	0.12	84	0.09	0.108	84	36.5	0.00 [−0.03, 0.03]
Jing, G., et al., 2018	0	0.058	22	−0.02	0.078	20	24.8	0.02 [−0.02, 0.06]
Papachatzakis, Y., et al., 2020	0	0.141	20	0	0.141	20	5.7	0.00 [−0.09, 0.09]
Tan, D., et al., 2020	−0.04	0.086	44	0	0.086	42	32.9	−0.04 [−0.08, −0.00]
Yu, Z.,et al., 2019	−0.91	1.031	36	−0.94	1.031	36	0.2	0.03 [−0.45, 0.51]
Subtotal (95% CI)			*206*			*202*	*100.0*	*−0.01 [−0.03, 0.01]*
Heterogeneity: $chi^2 = 4.95$, $df = 4$ ($P = 0.29$); $I^2 = 19\%$								
Test for overall effect: $Z = 0.77$ ($P = 0.44$)								



(a)

ABG

Study or subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight (%)	Mean difference IV, fixed, 95% CI
Jing, G., et al., 2018	3.1	5.347	22	3.6	6.282	20	27.1	−0.50 [−4.05, 3.05]
Tan, D., et al., 2020	2	9.531	44	3.5	9.97	42	20.0	−1.50 [−5.63, 2.63]
Yu, Z.,et al., 2019	−13	5.441	36	−12.4	5.544	36	52.9	−0.60 [−3.14, 1.94]
Total (95% CI)			*102*			*98*	*100.0*	*−0.75 [−2.60, 1.09]*
Heterogeneity: $chi^2 = 0.16$, $df = 2$ ($P = 0.92$); $I^2 = 0\%$								
Test for overall effect: $Z = 0.80$ ($P = 0.42$)								



(b)

Resp Rate

Figure 4: (a) Blood gas analysis. (b) Respiratory rate.

- HFNC may be an effective and safe alternative to prevent endotracheal intubation and mortality when NIV is unsuitable in mild-to-moderate hypercapnia.

II: AECOPD

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High-flow nasal cannula for acute exacerbation of chronic obstructive pulmonary disease: A systematic review and meta-analysis

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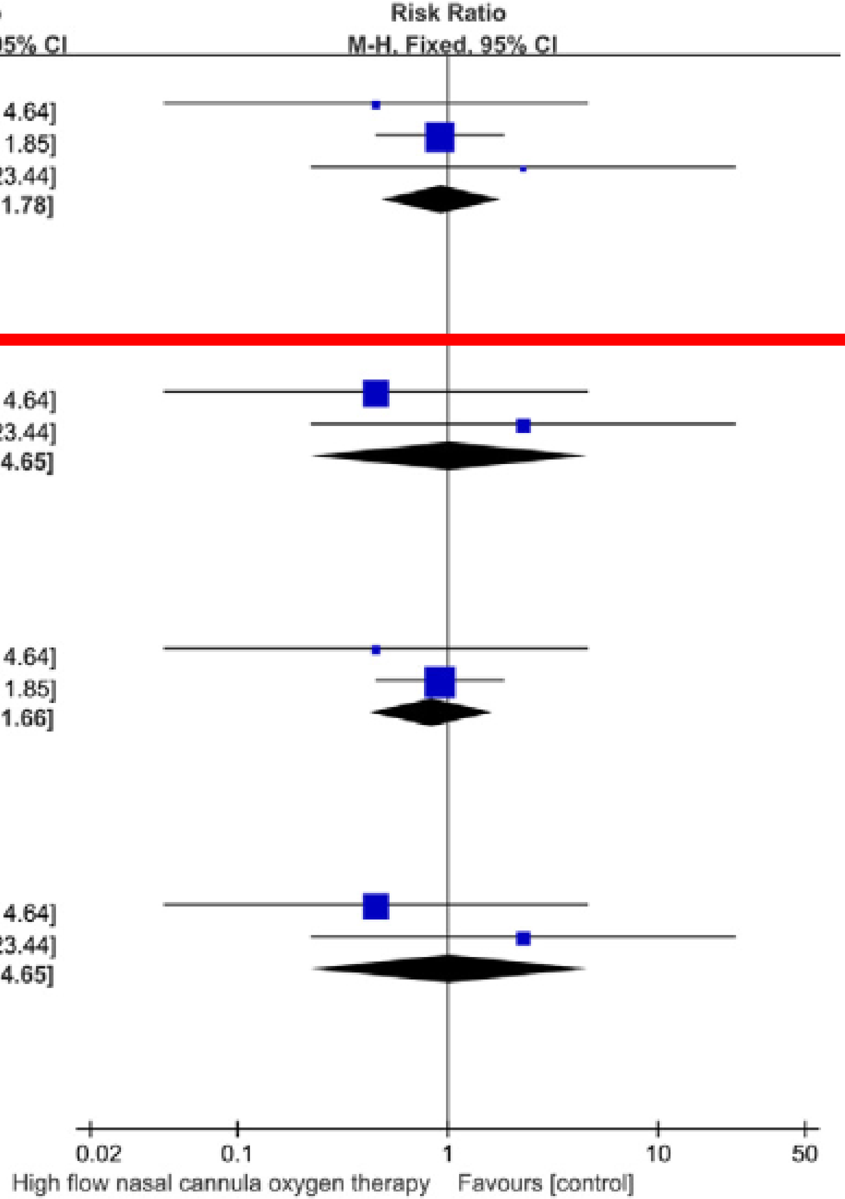
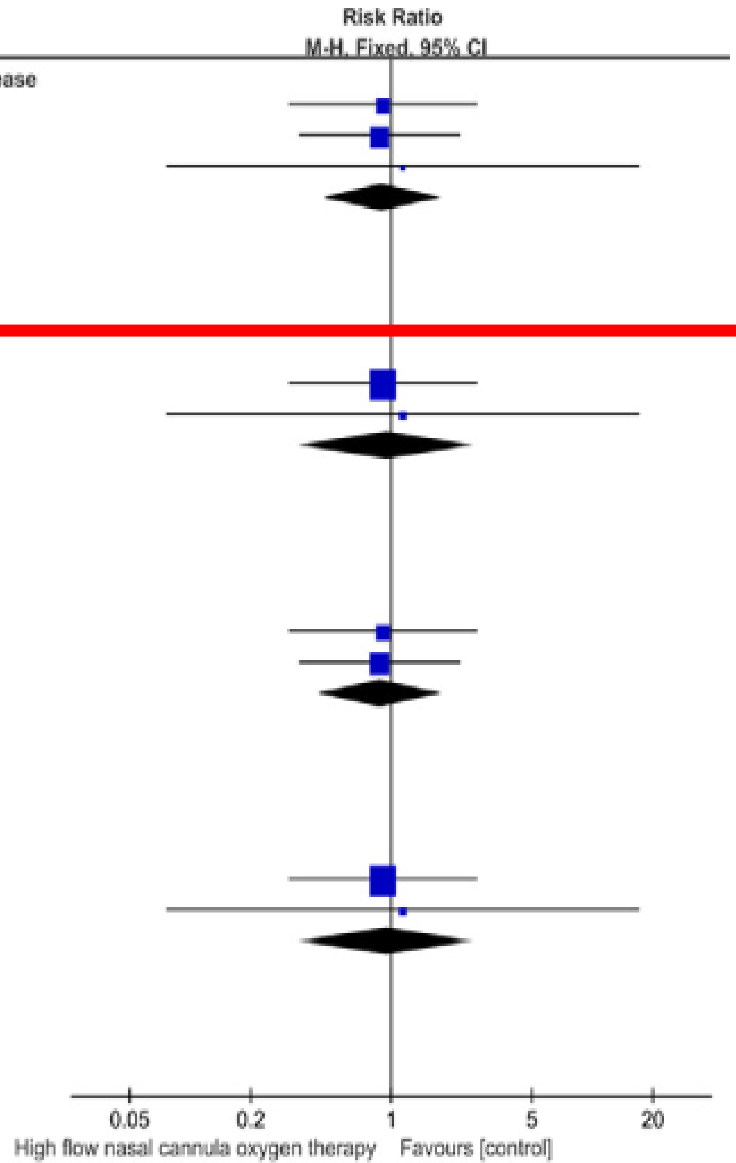
Study or Subgroup	High flow nasal cannula oxygen therapy Events	Total	Non-invasive ventilation Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 High flow nasal cannula oxygen therapy vs non-invasive ventilation in intubation						
Jing, G. Q.2019	1	22	2	20	13.9%	0.45 [0.04, 4.64]
Myoung Kyu Lee 2018	11	44	12	44	79.8%	0.92 [0.45, 1.85]
Zhang, JC 2018	2	21	1	24	6.2%	2.29 [0.22, 23.44]
Subtotal (95% CI)		**87**		**88**	**100.0%**	**0.94 [0.49, 1.78]**
Total events	14		15			
Heterogeneity: Chi² = 0.94, df = 2 (P = 0.62); I² = 0%						
Test for overall effect: Z = 0.20 (P = 0.84)						
1.1.2 Sensitivity analysis						
Jing, G. Q.2019	1	22	2	20	69.2%	0.45 [0.04, 4.64]
Zhang, JC 2018	2	21	1	24	30.8%	2.29 [0.22, 23.44]
Subtotal (95% CI)		**43**		**44**	**100.0%**	**1.02 [0.22, 4.65]**
Total events	3		3			
Heterogeneity: Chi² = 0.93, df = 1 (P = 0.34); I² = 0%						
Test for overall effect: Z = 0.02 (P = 0.98)						
1.1.3 Paitents with hypercapnia						
Jing, G. Q.2019	1	22	2	20	14.9%	0.45 [0.04, 4.64]
Myoung Kyu Lee 2018	11	44	12	44	85.1%	0.92 [0.45, 1.85]
Subtotal (95% CI)		**66**		**64**	**100.0%**	**0.85 [0.43, 1.66]**
Total events	12		14			
Heterogeneity: Chi² = 0.32, df = 1 (P = 0.57); I² = 0%						
Test for overall effect: Z = 0.48 (P = 0.63)						
1.1.4 Weaning patients from invasive ventilation						
Jing, G. Q.2019	1	22	2	20	69.2%	0.45 [0.04, 4.64]
Zhang, JC 2018	2	21	1	24	30.8%	2.29 [0.22, 23.44]
Subtotal (95% CI)		**43**		**44**	**100.0%**	**1.02 [0.22, 4.65]**
Total events	3		3			
Heterogeneity: Chi² = 0.93, df = 1 (P = 0.34); I² = 0%						
Test for overall effect: Z = 0.02 (P = 0.98)						

Test for subgroup differences: Chi² = 0.09, df = 3 (P = 0.99), I² = 0%



HFNC versus NIV for intubation

Study or Subgroup	High flow nasal cannula oxygen therapy Events	Total	non-invasive ventilation Events	Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.2.1 High flow nasal cannula oxygen therapy vs non-invasive ventilation in mortality for patient of acute exacerbations of chronic obstructive pulmonary disease						
Jing, G. Q.2019	5	22	5	20	37.0%	0.91 [0.31, 2.68]
Myoung Kyu Lee 2018	7	44	8	44	56.5%	0.88 [0.35, 2.21]
Zhang, JC 2018	1	21	1	24	6.6%	1.14 [0.08, 17.16]
Subtotal (95% CI)		**87**		**88**	**100.0%**	**0.91 [0.46, 1.79]**
Total events	13		14			
Heterogeneity: Chi² = 0.03, df = 2 (P = 0.98); I² = 0%						
Test for overall effect: Z = 0.29 (P = 0.77)						
1.2.2 Sensitivity analysis						
Jing, G. Q.2019	5	22	5	20	84.9%	0.91 [0.31, 2.68]
Zhang, JC 2018	1	21	1	24	15.1%	1.14 [0.08, 17.16]
Subtotal (95% CI)		**43**		**44**	**100.0%**	**0.94 [0.34, 2.59]**
Total events	6		6			
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.88); I² = 0%						
Test for overall effect: Z = 0.11 (P = 0.91)						
1.2.3 Paitents with hypercapnia						
Jing, G. Q.2019	5	22	5	20	39.6%	0.91 [0.31, 2.68]
Myoung Kyu Lee 2018	7	44	8	44	60.4%	0.88 [0.35, 2.21]
Subtotal (95% CI)		**66**		**64**	**100.0%**	**0.89 [0.44, 1.80]**
Total events	12		13			
Heterogeneity: Chi² = 0.00, df = 1 (P = 0.96); I² = 0%						
Test for overall effect: Z = 0.33 (P = 0.74)						
1.2.4 Weaning patients from invasive ventilation						
Jing, G. Q.2019	5	22	5	20	84.9%	0.91 [0.31, 2.68]
Zhang, JC 2018	1	21	1	24	15.1%	1.14 [0.08, 17.16]
Subtotal (95% CI)		**43**		**44**	**100.0%**	**0.94 [0.34, 2.59]**
Total events	6		6			
Heterogeneity: Chi² = 0.02, df = 1 (P = 0.88); I² = 0%						
Test for overall effect: Z = 0.11 (P = 0.91)						



HFNC versus NIV for MORTALITY

Test for subgroup differences: Chi² = 0.02, df = 3 (P = 1.00), I² = 0%

Fig. 5. HFNC versus NIV in mortality of AECOPD patients. M–H, Mantel–Haenszel method; CI, confidence interval.

- Conclusion: For AECOPD patients, low-quality evidence indicates that **HFNC does not increase intubation and mortality risks compared to NIV.**

Expert consensus

- 對於輕度到中度的高碳酸血症病人，HFNC 在防止氣管內管插管和死亡率方面與 NIPPV 沒有顯著差異。HFNC 在 pH 值變化、改善氧合、清除二氧化碳、減輕呼吸困難和 ICU 天數方面與 NIPPV 有相同的效益。在病人的舒適度和治療相關併 發症方面，使用 HFNC 優於 NIPPV。
- 針對 AECOPD 病人，HFNC 和 NIPPV 在插管風險、 死 亡 率、PaCO2、pH、呼吸速率和使用裝置時間方面沒有差異。HFNC 可能比 NIPPV 有更低的 ICU 天數和更為舒適。在 PaCO2 和 pH 值方面，HFNC 和 COT 之間也沒有差異，但使用 HFNC 病人的呼吸速率可能會比 COT 低。

Part III: HFNC in post-extubation care

I: HFNC in post-extubation resp failure

II:HFNC in post-thoracic or post-cardiovascular surgery high risk patients

Intensive Care Med
https://doi.org/10.1007/s00134-020-06312-y

CONFERENCE REPORTS AND EXPERT PANEL

The role for high flow nasal cannula as a respiratory support strategy in adults: a clinical practice guideline

Intensive Care Med. 2020;46(12):2226-2237

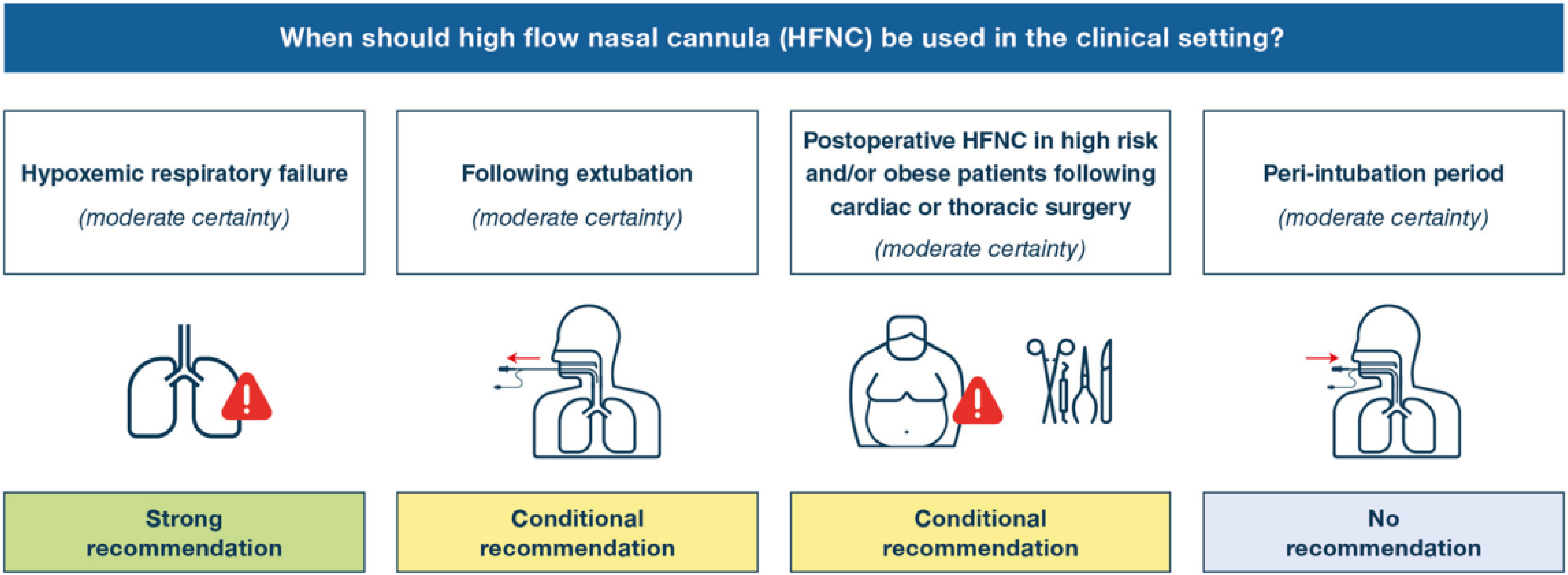


Fig. 1 Scheme of recommendations

•Intensive Care Med. 2020;46(12):2226-2237

I: HFNC in post-extubation resp failure

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

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

A Randomized Clinical Trial

Gonzalo Hernández, MD, PhD; Concepción Vaquero, MD; Paloma González, MD; Carles Subira, MD; Fernando Frutos-Vivar, MD; Gemma Rialp, MD; Cesar Laborda, MD; Laura Colinas, MD; Rafael Cuena, MD; Rafael Fernández, MD, PhD

for 24 hours after extubation

•. JAMA 2016 Apr 5;315(13):1354-61

Low risk for reintubation definitions:

- younger than 65 years;
- Acute Physiology and Chronic Health Evaluation II score less than 12 on day of extubation;
- body mass index less than 30;
- adequate secretions management;
- simple weaning;
- 0 or 1 comorbidity; and
- absence of heart failure, moderate-to-severe chronic obstructive pulmonary disease, airway patency problems, and prolonged mechanical ventilation

Characteristic	(n = 264)	(n = 263)
Age, mean (SD), y	51 (13.1)	51.8 (12.2)
Men	164 (62.1)	153 (58.2)
APACHE II at ICU admission, median (IQR)[b]	14 (9-16)	13 (9-17)
APACHE II at extubation, median (IQR)[b]	7 (6-9)	7 (5-9)
Length of mechanical ventilation before extubation, median (IQR), d	1 (1-3)	2 (1-4)
Corticosteroids >12 h before extubation	6 (2.7)	7 (3.2)
Comorbidities[c]		
Arterial hypertension	43 (16.3)	37 (14.1)
Neurologic disease	20 (7.6)	34 (12.9)
Other respiratory disease	24 (9.1)	25 (9.5)
Heart disease	20 (7.6)	23 (8.7)
Cancer	23 (8.7)	18 (6.8)
Body mass index >25[d]	21 (8)	14 (5.3)
Diabetes mellitus	16 (6.1)	14 (5.3)
Hepatic disease	11 (4.2)	9 (3.4)
Mild COPD	8 (3)	5 (1.9)
Renal failure	3 (1.1)	4 (1.5)
Other comorbid conditions	15 (5.7)	20 (7.6)
Diagnosis at Admission[e]		
Medical	175 (66.3)	196 (74.5)
Respiratory primary failure	43 (16.3)	44 (16.7)
ARDS[f]	4 (1.5)	11 (4.2)
Respiratory tract infection	11 (4.2)	10 (3.8)
Exacerbated COPD	3 (1.1)	2 (.8)
Airway patency problem	10 (3.8)	6 (2.3)
Other	15 (5.7)	15 (5.7)
Nonrespiratory primary failure	132 (50)	152 (57.8)
Cardiologic	21 (8)	21 (8)
Neurologic	69 (26.1)	86 (32.7)
Other	42 (15.9)	45 (17.1)
Trauma	44 (16.7)	39 (14.8)
Traumatic brain injury	31 (11.7)	17 (6.5)
Surgical	131 (49.6)	120 (45.6)
Scheduled surgery	45 (17)	35 (13.3)
Urgent surgery	86 (32.6)	85 (32.3)
Physiologic Variables From Spontaneous Breathing Trial Prior to Extubation		

Table 2. Primary and Secondary Outcomes

Variable	Oxygen Therapy: High-Flow (n = 264)	Oxygen Therapy: Conventional (n = 263)	Difference Between Groups (95% CI)	*P* Value
Primary Outcome				
All-cause reintubation, No. (%)	13 (4.9)	32 (12.2)	7.2 (2.5 to 12.2)	.004[a]
Secondary Outcomes				
Postextubation respiratory failure, No. (%)	22 (8.3)	38 (14.4)	6.1 (0.7 to 11.6)	.03[a]
Respiratory infection, No. (%)	6 (2.3)	13 (4.9)	2.7 (−0.6 to 6.2)	.07[a]
Ventilator-associated tracheobronchitis	3 (1.1)	7 (2.6)	1.5 (−1.0 to 4.4)	.22[a]
Ventilator-associated pneumonia	3 (1.1)	6 (2.3)	1.2 (−1.3 to 3.9)	.31[a]
Causes of postextubation respiratory failure, No. (%)				
Respiratory acidosis[c]	1 (4.5)	4 (10.5)		.10[b]
Hypoxia[c]	7 (31.8)	6 (15.8)		
Unbearable dyspnea	9 (40.9)	14 (28.9)		
Decreased level of consciousness	2 (9)	0		
Inability to clear secretions	3 (13.6)	14 (36.8)		
Reasons for reintubation, No. (%)				
Respiratory causes for reintubation				
Cardiorespiratory arrest	0	1 (0.4)		.02[b]
Agitation	1 (0.4)	0		
Inability to clear secretions	0	5 (1.9)		
Hemodynamic impairment[d]	1 (0.4)	1 (0.4)		
Persistent postextubation respiratory failure	2 (0.8)	16 (6)		

- Among extubated patients at low risk for reintubation, the use of high-flow nasal cannula oxygen compared with conventional oxygen therapy reduced the risk of reintubation within 72 hours

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

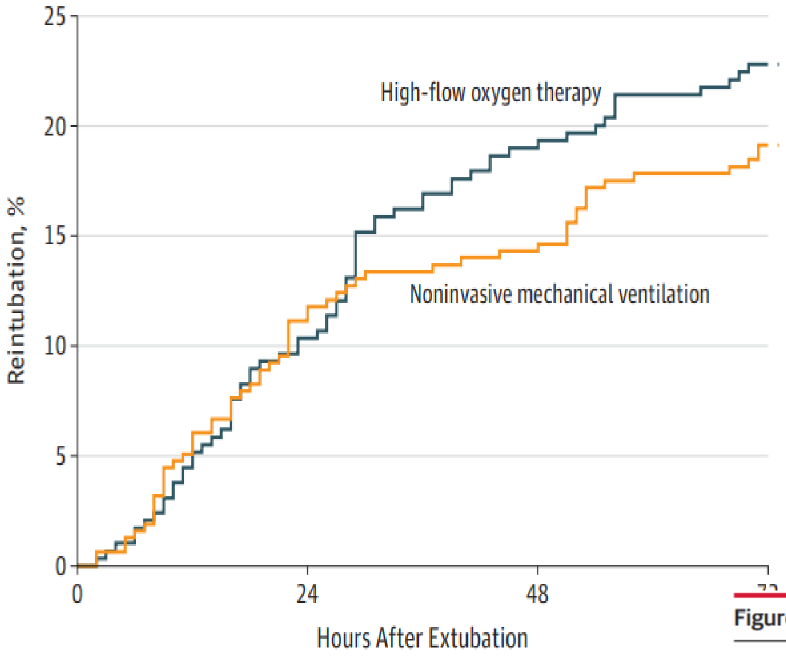
Effect of Postextubation High-Flow Nasal Cannula vs Noninvasive Ventilation on Reintubation and Postextubation Respiratory Failure in High-Risk Patients

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

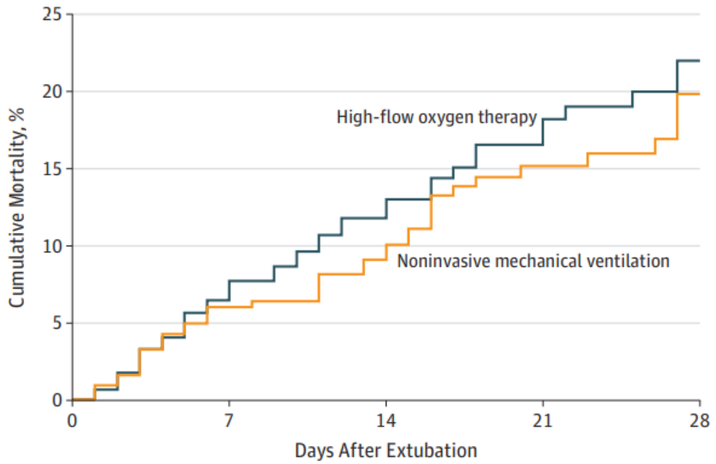
• JAMA 2016 Oct 18;316(15):1565-1574

Figure 2. Kaplan-Meier Analysis of Time From Extubation to Reintubation



No. at risk			
High-flow oxygen therapy	290	260	234
Noninvasive mechanical ventilation	314	279	269

Figure 3. Kaplan-Meier Analysis of Time From Extubation to Death



No. at risk					
High-flow oxygen therapy	282	223	144	101	78
Noninvasive mechanical ventilation	309	261	187	112	79

Patients censored in the first 24 hours are not included.

- Among high-risk adults who have undergone extubation, high-flow conditioned oxygen therapy was not inferior to NIV for preventing reintubation and postextubation respiratory failure. High-flow conditioned oxygen therapy may offer advantages for these patients.

Expert consensus

已有實證支持預防拔管後呼吸衰竭使用 HFNC 優於 COT

但不支持也不反對 HFNC 優於 NIPPV，尤其當病人已接受 NIPPV 治療時。

II:HFNC in post-thoracic or post-cardiovascular surgery high risk patients

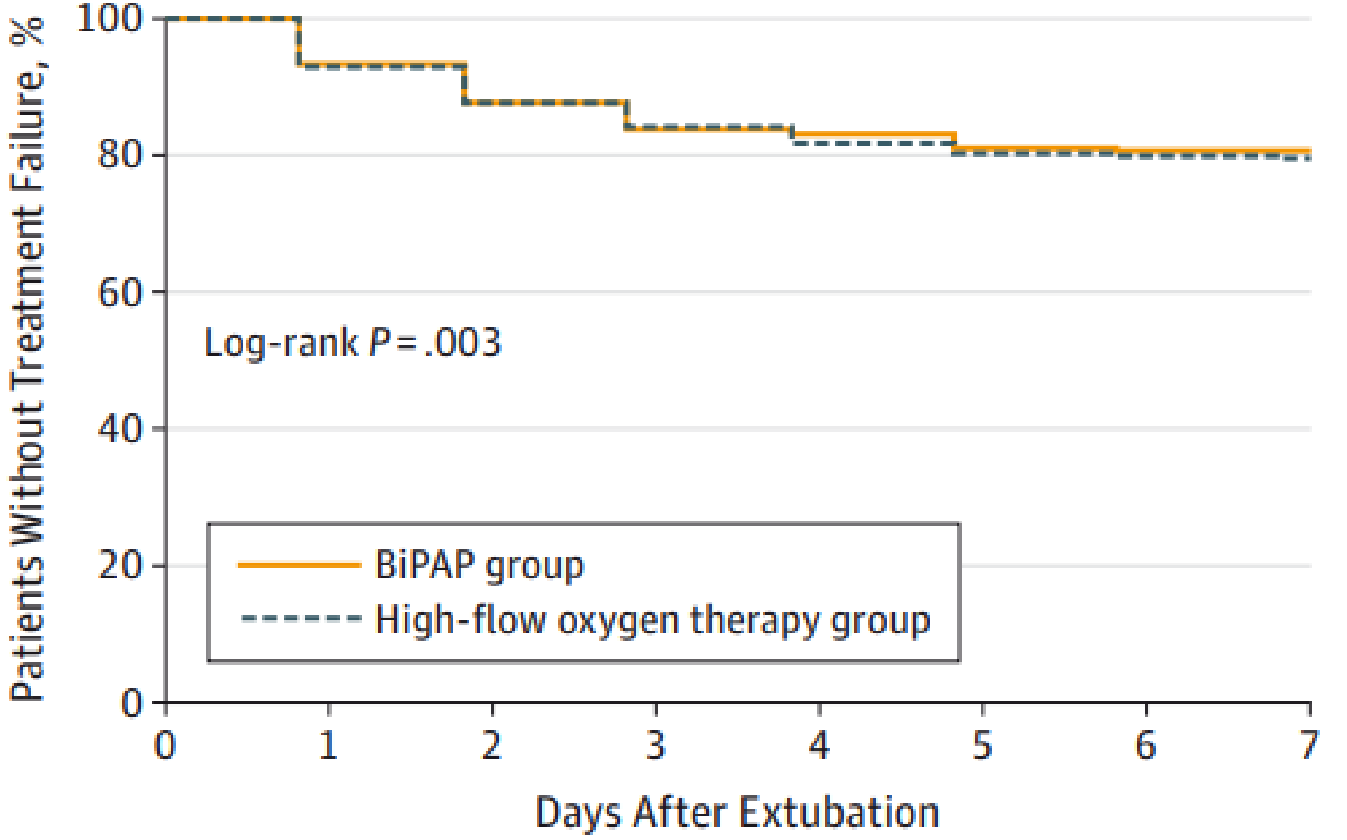
Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

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

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

The primary outcome was treatment failure, defined as reintubation, switch to the other study treatment, or premature treatment discontinuation (patient request or adverse effects, including gastric distention).

Figure 2. Postoperative Patients Without Treatment Failure After Extubation



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

- Among cardiothoracic surgery patients with or at risk for respiratory failure, the use of high-flow nasal oxygen therapy compared with intermittent BiPAP **did not result in a worse rate of treatment failure.** The findings support the use of high-flow nasal oxygen therapy in similar patients.

Expert consensus

- 在接受心臟和胸腔大手術的高風險族群或肥胖病人中，術後預防性使用 HFNC 可能優於 COT。
- 但與 NIPPV 相比，術後使用 HFNC 並無優勢也無不利影響。
- 目前並無足夠證據建議在其他手術後預防性使用 HFNC 有幫助

Part IV: HFNC in palliative care

› Respir Care. 2013 Apr;58(4):597-600. doi: 10.4187/respcare.01887.

High-flow nasal cannula therapy in do-not-intubate patients with hypoxemic respiratory distress

Steve G Peters [1], Steven R Holets, Peter C Gay

Affiliations + expand

PMID: 22781059 DOI: 10.4187/respcare.01887

Free article

Respir Care 2013 Apr;58(4):597-600. R

Table 1. Subject Characteristics ($n = 50$)

Male	25
Female	25
Age, mean y	73
Age range, y	27–96
Diagnosis for hypoxemic respiratory failure, no. (hospital mortality %)	
Pulmonary fibrosis	15 (73.3)
Pneumonia	15 (46.7)
COPD	12 (33.3)
Congestive heart failure	3 (33.3)
Solid malignancy	7 (57)
Hematologic malignancy	7 (71.4)
Sepsis	2 (50)
Pulmonary embolism	2 (50)
Myocardial infarct	1 (0)
Hemorrhage	1 (100)

Table 2. Outcome of High-Flow Nasal Oxygen in 50 Subjects* With Do-Not-Intubate Status

	Pre-HFNC	Post-HFNC	*P*
Breathing frequency, breaths/min	30.6	24.7	< .001
O_2 saturation	89.1	94.7	< .001

* 41/50 (82%) were maintained on high-flow nasal cannula (HFNC). 9/50 (18%) escalated to noninvasive ventilation. Overall hospital mortality was 60%. The mean HFNC F_{IO_2} was 0.67 (range 0.3–1.0). The mean HFNC flow was 42.6 L/min (range 30–60 L/min).

HFNC was initiated at a mean FIO2 of 0.67 (range 0.30 –1.0) and flow of 42.6 L/min (range 30 – 60 L/min).

- HFNC can provide adequate oxygenation for many patients with hypoxemic respiratory failure and may be an alternative to NIV for DNI patients.

HFNC effects on ILD patients with DNI

Efficacy and Tolerability of High-Flow Nasal Cannula Oxygen Therapy for Hypoxemic Respiratory Failure in Patients with Interstitial Lung Disease with Do-Not-Intubate Orders: A Retrospective Single-Center Study

Takafumi Koyauchi[a] Hirotsugu Hasegawa[a] Kei Kanata[a] Takuya Kakutani[a] Yusuke Amano[a] Yuichi Ozawa[a] Takashi Matsui[a] Koshi Yokomura[a] Takafumi Suda[b]

[a]Department of Respiratory Medicine, Respiratory Disease Center, Seirei Mikatahara General Hospital, Hamamatsu, Japan; [b]Second Division, Department of Internal Medicine, Hamamatsu University School of Medicine, Hamamatsu, Japan

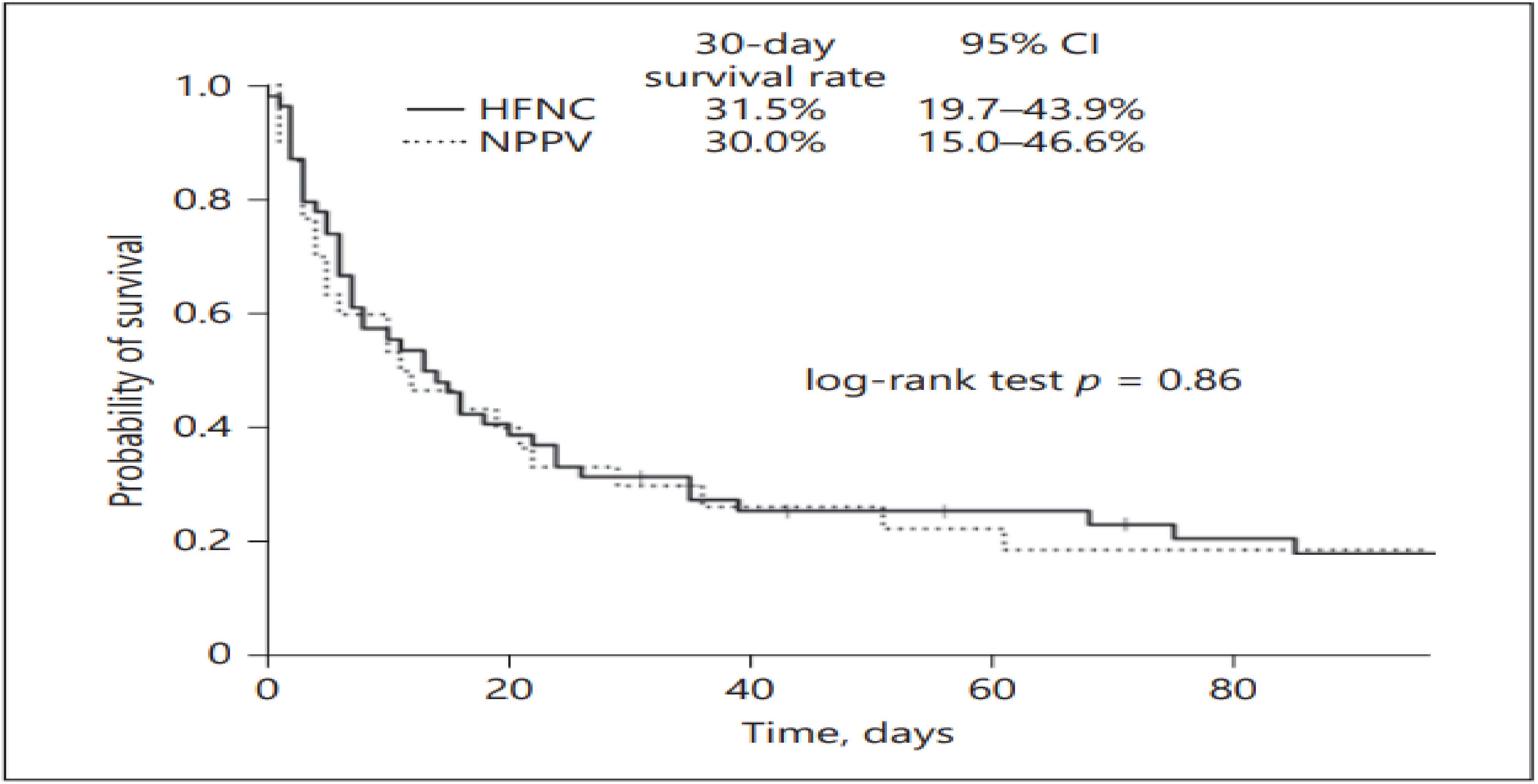


Fig. 2. Kaplan-Meier survival curves for patients with hypoxemic respiratory failure associated with interstitial lung disease treated with HFNC oxygen therapy or NPPV. HFNC, high-flow nasal cannula; NPPV, noninvasive positive pressure ventilation; CI, confidence interval.

Table 2. Outcomes in patients with hypoxemic respiratory failure associated with interstitial lung disease

Outcome	HFNC group ($n = 54$)	NPPV group ($n = 30$)	p value
In-hospital mortality	43 (79.6)	25 (83.3)	0.78
Temporary interruption at the patient's request	2 (3.7)	7 (23.3)	0.009
Discontinuation at the patient's request	0 (0)	3 (10.0)	0.043
Adverse events	1 (1.9)	7 (23.3)	0.003
Number of days from the last meal to death	2 (1–5) ($n = 43$)	4 (2–8) ($n = 25$)	0.037
Number of days from the last conversation to death	1 (1–2) ($n = 43$)	2 (1–4) ($n = 25$)	0.042

Each parameter is expressed as n (%) or median (interquartile range). Parameters in each group were compared using Fisher's exact test or Mann-Whitney U test. HFNC, high-flow nasal cannula oxygen therapy; NPPV, noninvasive positive pressure ventilation.

Table 3. Changes in respiratory rate and dyspnea scale scores before and after beginning HFNC or NPPV

	HFNC			NPPV		
	pre-HFNC	post-HFNC	*p* value	pre-NPPV	post-NPPV	*p* value
Respiratory rate, breaths/min	28.0 (7.0)	23.8 (4.3)	0.0001	31.2 (8.1)	32.6 (8.9)	0.34
STAS-J dyspnea score	1.14 (0.72)	0.90 (0.57)	0.07	1.37 (0.69)	1.30 (0.82)	0.69

Each parameter is expressed as mean (standard deviation). Parameters in each group were compared with the paired *t* test. HFNC, high-flow nasal cannula oxygen therapy; NPPV, noninvasive positive pressure ventilation; STAS-J, Japanese version of the Support Team Assessment Schedule.

對於 DNI 病人，HFNC 能有效治療低血氧，並顯著改善呼吸困難症狀。與 NIPPV 相較，病人對 HFNC 的耐受性較高，亦較能進食與溝通。在緩和療護中，我們推薦使用 HFNC 來治療低血氧和改善呼吸困難症狀。

對於已經使用 HFNC 的重症末期 COVID 病人，在充分與病人及家屬討論病情後，可以參考國外的流程，在緩和醫療及團隊照護共識下，依照病人的最大利益，評估逐步地脫離 HFNC，進行安寧緩和照護

Part V:Special Consideration in COVID-19 Era

› Am J Respir Crit Care Med. 2020 Oct 1;202(7):1039-1042. doi: 10.1164/rccm.202005-2007LE.

High-Flow Nasal Cannula in Critically Ill Patients with Severe COVID-19

Alexandre Demoule [1], Antoine Vieillard Baron [2], Michael Darmon [3], Alexandra Beurton [1], Guillaume Géri [2], Guillaume Voiriot [1], Thibault Dupont [3], Lara Zafrani [3], Lola Girodias [2], Vincent Labbé [1], Martin Dres [1], Muriel Fartoukh [1], Elie Azoulay [3]

Affiliations + expand

PMID: 32758000 PMCID: PMC7528777 DOI: 10.1164/rccm.202005-2007LE

Table 1. Factors Associated with the Use of HFNC

	No HFNC (*n* = 233)	HFNC (*n* = 146)	*P* Value
Patients characteristics			
Age, yr	63 (53–69)	60 (53–67)	0.249
Sex, F	57 (25)	31 (21)	0.549
Body mass index, kg/m^{-2}	28 (25–32)	27 (25–30)	0.213
Comorbidities			
COPD	13 (6)	7 (5)	0.923
Asthma	12 (5)	11 (8)	0.468
Diabetes	72 (31)	42 (29)	0.745
High blood pressure	121 (52)	67 (46)	0.299
Chronic heart failure	22 (10)	10 (7)	0.488
Immunosuppression	49 (21)	19 (13)	0.060
On ICU admission			
Time since disease onset, d	8 (5–10)	10 (7–12)	<0.001
Time since hospital admission, d	1 (0–3)	1 (0–3)	0.599
Body temperature, °C	37.9 (37.0–38.7)	38.0 (37.4–38.7)	0.146
Oxygen flow, L/min^{-1}	15 (8–15)	15 (9–15)	0.045
Number of quadrants involved on chest X-ray	4 (2–4)	4 (2–4)	0.658
Pa_{O_2}/Fi_{O_2} at Day 1 (worst value), mm Hg	130 (97–195)	126 (86–189)	0.433
Leukocytes, G/L^{-1}	8.08 (5.49–11.30)	8.09 (5.70–10.79)	0.537
Lymphocytes, G/L^{-1}	0.80 (0.59–1.16)	0.70 (0.54–1.03)	0.056
D-dimer, IU	1,908 (830–3,968)	1,500 (920–2,770)	0.194
Lactate, $mmol/L^{-1}$	1.2 (1.0–1.8)	1.4 (1.0–1.7)	0.292
SOFA at Day 1	6 (3–9)	4 (3–5)	<0.001
Oxygenation/ventilation strategy			
CPAP	3 (1)	3 (2)	0.873
NIV	18 (8)	9 (6)	0.703
Duration of HFNC therapy, d	0	4 (2–6)	—
Before intubation*			
Respiratory rate, min^{-1}	33 (26–36)	30 (25–32)	0.089
Sp_{O_2}, %	94 (88–97)	97 (95–100)	0.010
Fi_{O_2}, %	66 (49–66)	100 (90–100)	0.008
Organ failure and support during ICU stay			
Vasopressors	123 (53)	42 (29)	<0.001
Acute kidney injury	139 (60)	56 (40)	<0.001
Renal replacement therapy	57 (25)	17 (12)	0.003
Outcome variables			
Invasive mechanical ventilation at Day 28	175 (75)	82 (56)	<0.001
ICU mortality	68 (34)	30 (25)	0.117
Mortality at Day 28	70 (30)	30 (21)	0.055
Mortality at Day 60	72 (31)	31 (21)	0.052

- 在使用氧氣下仍有低血氧現象的新冠肺炎病人，建議使用濕化高流量氧氣治療，優先於非侵襲性正壓呼吸器（Noninvasive Positive Pressure Ventilators, NIPPV）。
- 新冠肺炎病人使用高流量氧氣鼻導管必須在有經驗的單位與 人員監控下執行，而且在病情惡化或治療反應不佳時，他們必須有能力執行緊急插管。
- 因考量可能增加新冠肺炎院內感染風險，使用高流量氧氣鼻導 管仍應力行空氣傳播感控原則，包括嚴格使用個人防護裝備、 定期洗手、在負壓隔離室使用、並於鼻導管外加外科口罩

Take home message -1

- 使用非重複吸入式氧氣面罩 10 L/min 仍無法維持 SpO2 > 92% 或每分鐘呼吸次數≧ 25 次。
- WHO 建議 COVID-19 病人出現輕度氧合能力缺失，即 P/F（PaO2 / FiO2）ratio 介 於 200 mmHg ~ 300 mmHg，可能可以使用 HFNC。

Take home message -2

- 不建議使用 HFNC
- 1. 使用呼吸輔助肌、胸腹部不協調等呼吸窘迫徵象者
- 2. 上呼吸道阻塞者
- 3. 缺乏保護上呼吸道能力，有吸入性肺炎風險者
- 4. 嚴重低血氧，包括 P/F ratio < 100 mmHg
- 5. 高碳酸血症，其中 pH < 7.25 且 PaCO2 > 50 mmHg
- 6. 臉部創傷，無法配戴鼻導管者
- 7. 無法配合使用者

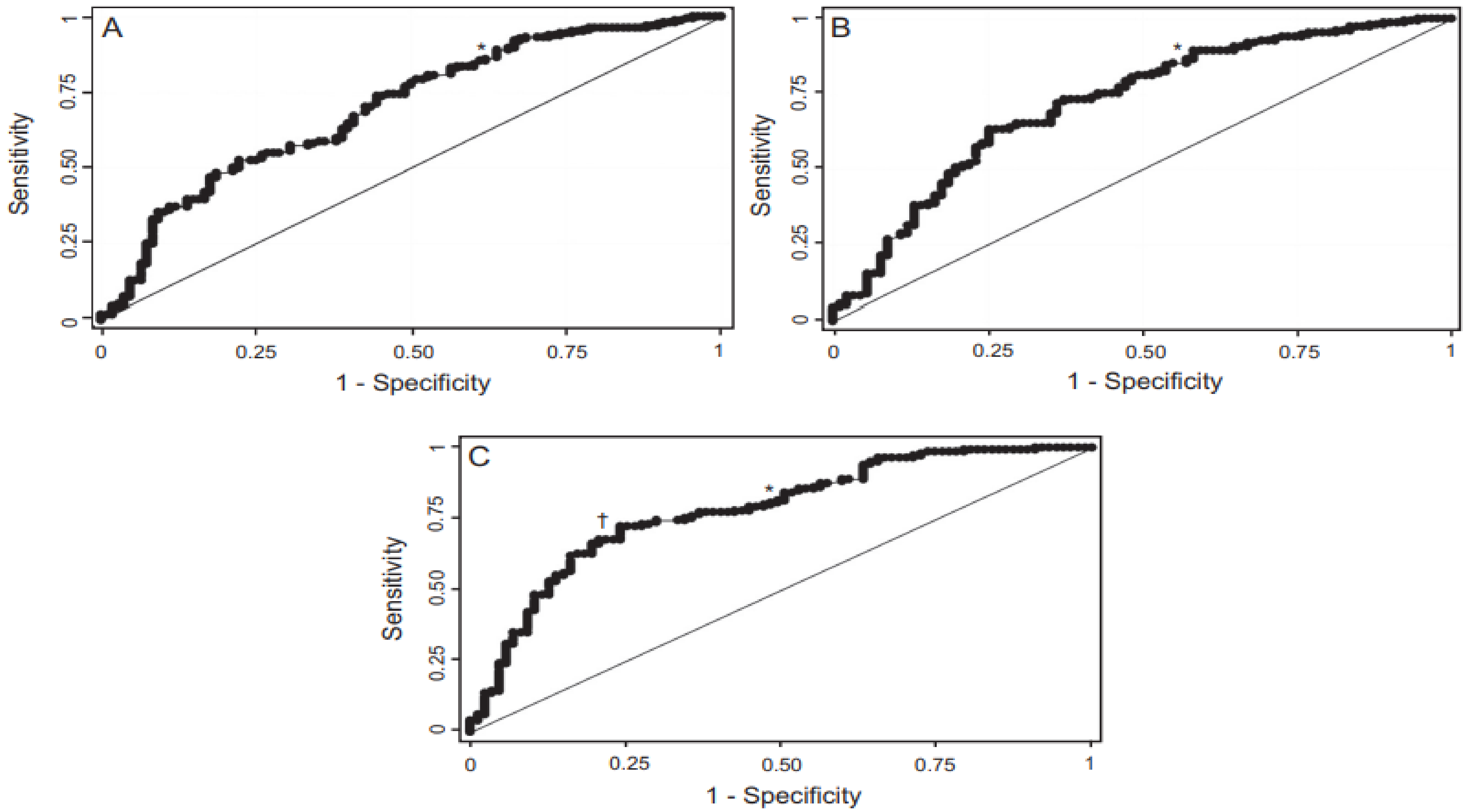
Take home message -3

- 初始設定
- 1. 依照選擇的高流量氧氣設備組裝管路，加熱潮溼器加入無菌蒸餾水。
- 2. 設定加熱潮溼器 37℃，確保在該溫度時達相對濕度 100%。
- 3. 鼻導管連接加熱管路，導管置入病人鼻孔，確認未彎折並繫帶固定。
- 4. 設定流速至少 50 L/min，氧氣濃度保持在 SpO2>92%，並依照病人舒適性及臨床評估調整

Take home message -4

- 用於空氣傳染疾病病人，先將鼻導管放入鼻孔，依序將外科口罩完整覆蓋病人口鼻，才可開啟 HFNC；暫停使用時，應先關閉 HFNC 或進入待機模式後才可取下鼻導管，避免氣霧逸散。
- 治療期間病人無法緊閉嘴巴，變動性氣道正壓將會減低，使提供穩定氣道能力大幅下降
- 以 ROX index 預測 HFNC 成功率： (1) ROX index > 4.88，預測 HFNC 成功。 (2) ROX index < 3.85，建議立即插管。 (3) ROX index 介於 3.85 ~ 4.77，病人需密切監視，建議轉入加護病房。

- Thanks for your listening


A
B
C
Sensitivity
1 - Specificity
0
0.25
0.50
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