High flow nasal cannula for Acute Respiratory failure

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Respiratory failure?

Condition in which respiratory system fails in one or both of its gas exchanging functions

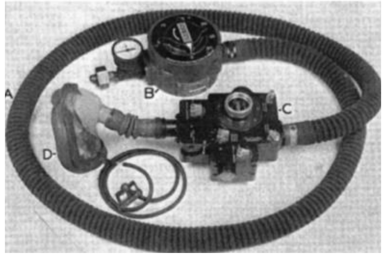
	Type I	Type II	Type III	Type IV
Mechanism of hypoxemia	Low Fio2	Hypoventilation	Shunting	Hypoperfusion or inadequate oxyg ... ipheral tissues
Location of pathological process				ar system ... sues
Clinical ↓	pertension Atelectasis Alveolar hemorrhage CO poisoning Anatomic shunts	Skeletal disorders Obesity-hypoventilation syndrome	r inflammation, Trapped lung, Subdiaphragmatic tumor or inflammation Obesity	utive) shock shock hock cellular oxidation Hypermetabolic states

- **Hypoxemia**
- **Hypercapnia**
- **Post extubation or following extubation**
- **Peri, post operation**

Murray & Nadel's textbook of respiratory medicine [electronic resource]

History

- NIV : 1940 ~




- Vs. HFNC : 2000~

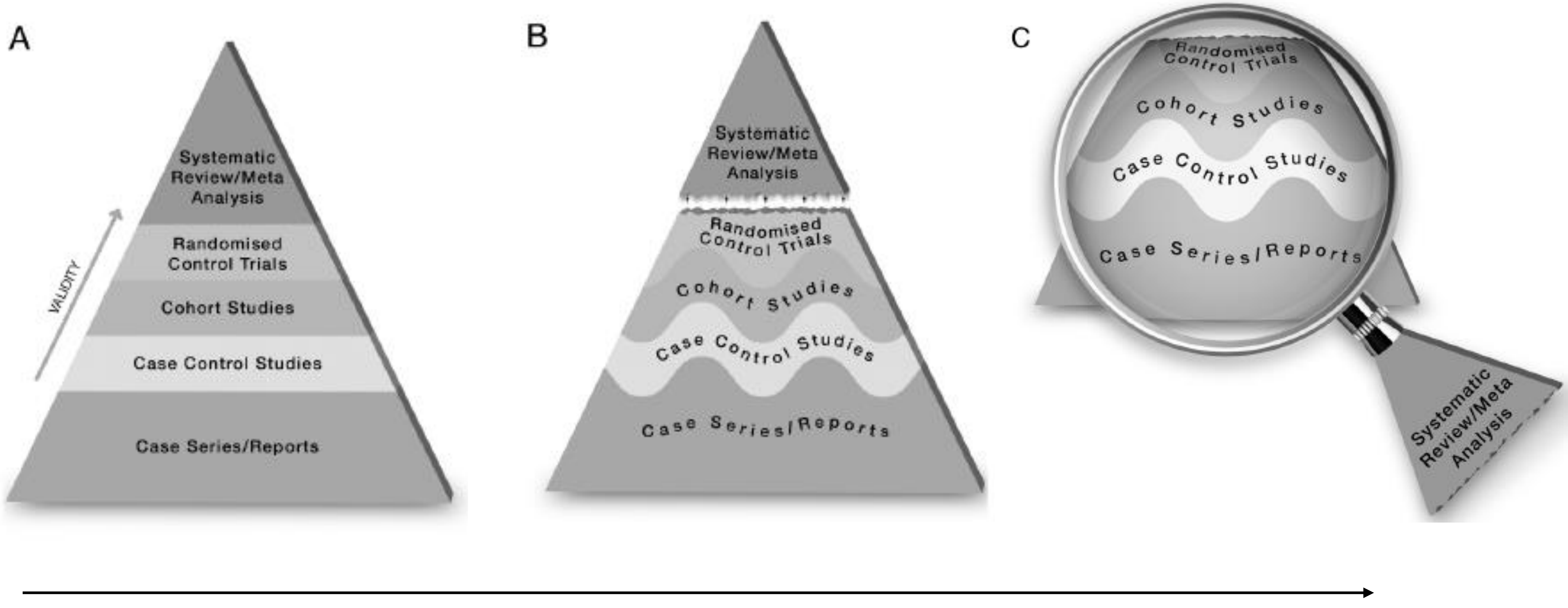

- at least not inferior
- more convenient
- fewer comlication

Ther Adv Chronic Dis. 2020; 11: 2040622320920106.

Respir Care. 2009 Jan;54(1):40-52.

Murray & Nadel's textbook of respiratory medicine [electronic resource]

Evidence pyramid



Evid Based Med. 2016 Aug;21(4):125-7.

Guidelines

CONFERENCE REPORTS AND EXPERT PANEL

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

Check for updates

AARC Clinical Practice Guideline: Management of Adult Patients With Oxygen in the Acute Care Setting

Thomas Piraino, Maria Madden, Karsten J Roberts, James Lamberti, Emily Ginier, and Shawna L Strickland

EUROPEAN RESPIRATORY JOURNAL
ERS OFFICIAL DOCUMENTS
S. OCZKOWSKI ET AL.

cannula in

Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock 2021

Guidelines (HFNC)

	ESICM (2020)	ERS (2022)	AARC (2022)	SSC (2021)
Hypoxemic respiratory failure	Strong recommenda tion (moderate)	HFNC > COT, Conditional (moderate)	Evidence level B	HFNC > NIV, Weak re commendation (low)
		HFNC > NIV, conditional (very low)		
During breaks from NIV		HFNC > COT, Conditional (low)		
Following extubation	Conditional (moderate)	HFNC > COT, conditional (low)	Evidence level B	
		NIV > HFNC (high risk of extubation failure), conditional (moderate)		
Postoperative	Conditional (moderate)	Both high and low risk respiratory c omplication, conditional (low)		
Hypercapnic respiratory failure		trial of NIV prior to use of HFNC, co nditional (low)		
Peri-intubation	No recommendation (moderate)			

Guidelines (NIV)

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

2017

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 exacerbation		No recommendation made
Immunocompromised	⊕⊕⊕	Conditional recommendation for
De novo respiratory failure		No recommendation made
Post-operative patients	⊕⊕⊕	Conditional recommendation for
Palliative care	⊕⊕⊕	Conditional recommendation for
Trauma	⊕⊕⊕	Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients (prophylaxis)	⊕⊕	Conditional recommendation for
Post-extubation respiratory failure	⊕⊕	Conditional recommendation against
Weaning in hypercapnic patients	⊕⊕⊕	Conditional recommendation for

Guidelines (NIV)

2020

Long-Term Noninvasive Ventilation in Chronic Stable Hypercapnic Chronic Obstructive Pulmonary Disease
An Official American Thoracic Society Clinical Practice Guideline

1. Suggest the use of nocturnal NIV in addition to usual care for patients with chronic stable hypercapnic COPD (conditional , moderate)

2. suggest that patients with chronic stable hypercapnic COPD undergo screening for obstructive sleep apnea before initiation of long-term NIV (conditional recommendation, very low)

3. suggest not initiating long-term NIV during an admission for acute on chronic hypercapnic respiratory failure, favoring instead reassessment forNIV at 2–4 weeks after resolution (conditional recommendation, low).

2020

GUIDELINES/POSITION STATEMENTS

ISCCM Guidelines for the Use of Non-invasive Ventilation in Acute Respiratory Failure in Adult ICUs

Hypoxemic respiratory failure

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 4, 2015 VOL. 372 NO. 23

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

Multicenter, open-label, random
Hypoxemic respiratory failure without hypercapnia

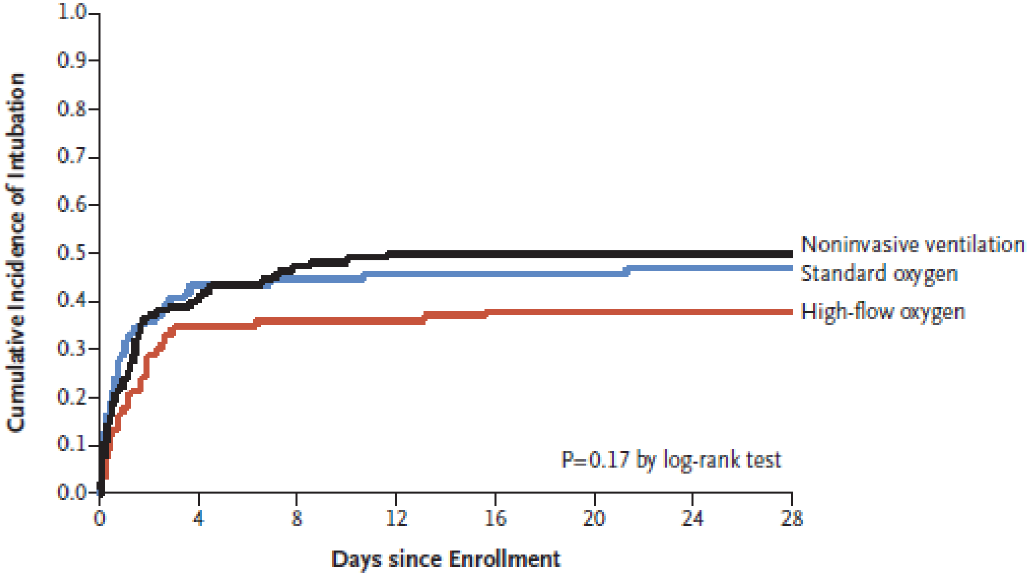
Total n= 310 patients
HFNC (n=106) vs. standard O2 (n=94) vs. NIV (n=110)

Primary: intubation at day 28
Secondary: all cause ICU mortality, 90 days, VFD

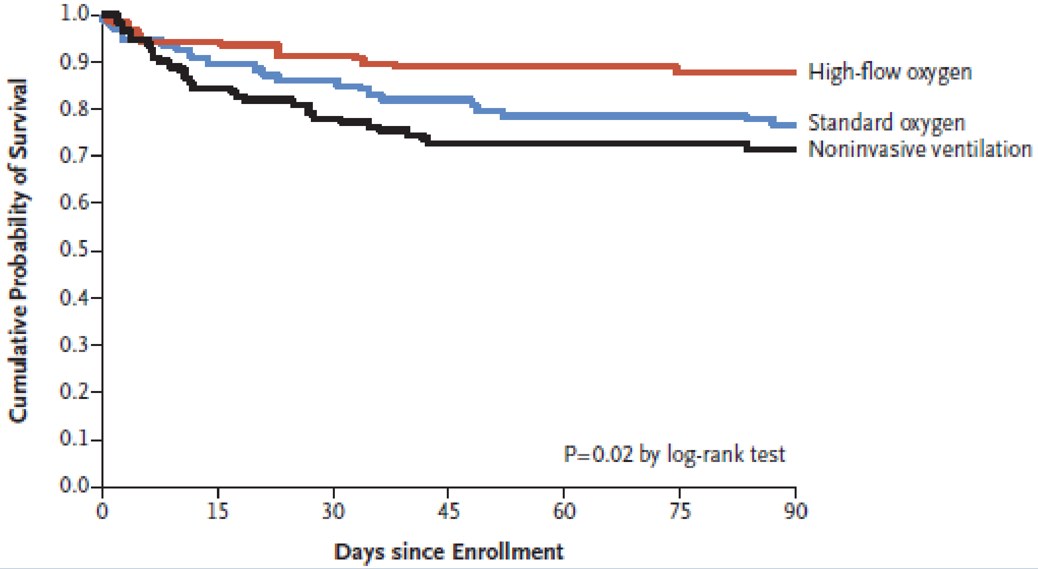
	HFNC	Standard	NIV	P-value	ST vs. HFNC	NIV vs. HFNC
SAPS II	25±9	24±9	27±9			
Bilateral infiltrates	79 (75)	80 (85)	85 (77)			
Intubation at 28day	40 (38%)	44 (47%)	55 (50%)	0.18	1.45 (0.83–2.55)	1.65 (0.96–2.84)
Intubation with PF ≤200 mm Hg	29/83 (35%)	35 /74 (53%)	47/81 (55%)	0.009	2.07 (1.09–3.94)	2.57 (1.37–4.84)
VFD	24±8	22±10	19±12	0.02		
VFD with PF ≤200	24±8	21±10	18±12	<0.001		
ICU mortality	12 (11%)	18 (19%)	27 (25%)	0.047	1.85 (0.84–4.09)	2.55 (1.21–5.35)
90 days mortality	13 (12%)	22 (23%)	31 (28%)	0.02	2.01 (1.01–3.99)	2.50 (1.31–4.78)

N Engl J Med . 2015 Jun 4;372(23):2185-96.

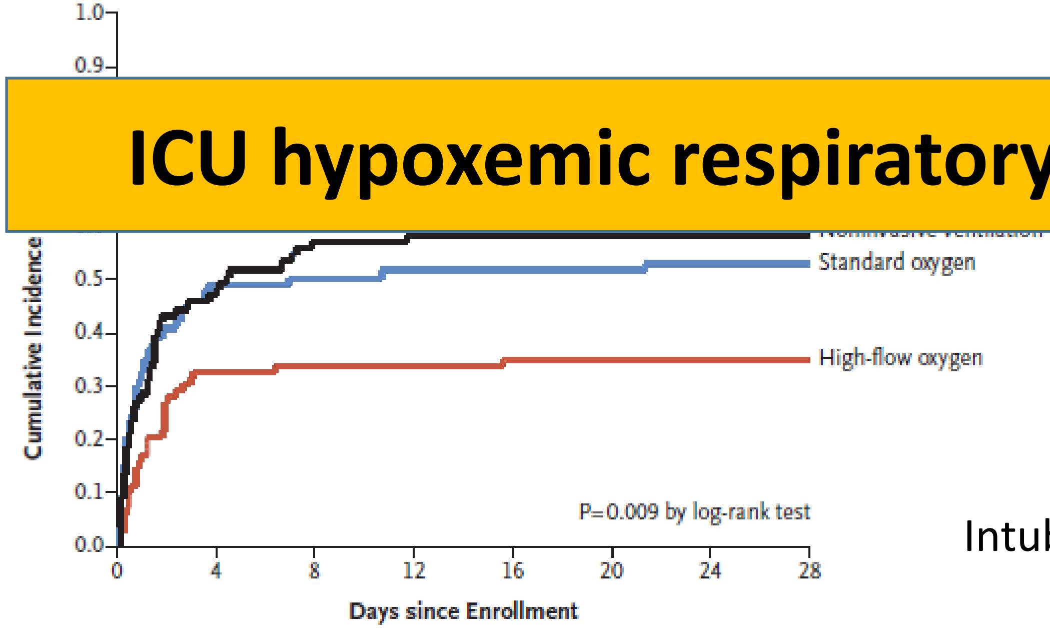
Intubation in all patients



Day 90 , survival



ICU hypoxemic respiratory failure 환자에게 사용가능!!!!



Intubation in PF < 200

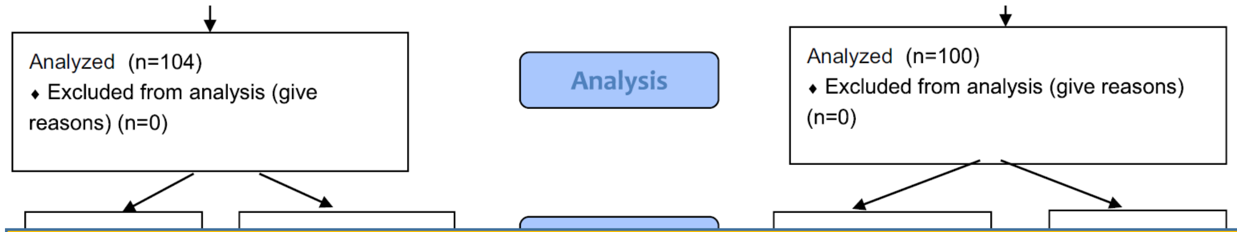
N Engl J Med 2015;372:2185-96.

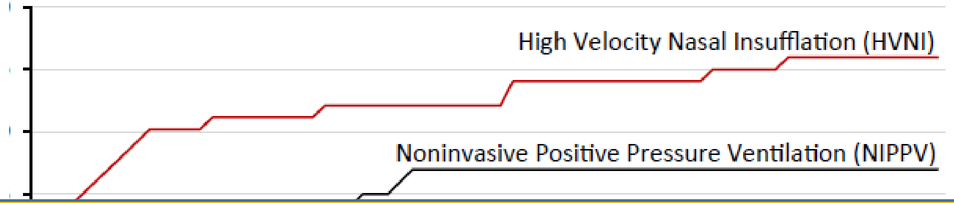
PULMONARY/ORIGINAL RESEARCH

High-Velocity Nasal Insufflation in the Treatment of Respiratory Failure: A Randomized Clinical Trial

Multicenter, randomized trial
EM patients with respiratory failure requiring NIV
Inferiority
Primary: therapy failure at 72 hours

	HFNC (n=104)	NIV (n=100)	% Risk Difference (95% CI)
Age (SD),	63.4 (13.6)	63.3 (14.8)	
APACHE II score (SD)	31.2 (6.3)	30.7 (6.5)	
Intubation at 72 h, No. (%)*	7/104 (6)	13/100 (13)	–7 (–14 to 2)





EM의 미분류된 hypoxemic respiratory failure 환자에게 최초 산소 공급 방법으로 HFNC 사용가능!!!!

Ann Emerg Med . 2018 Jul;72(1):73-83.e5.

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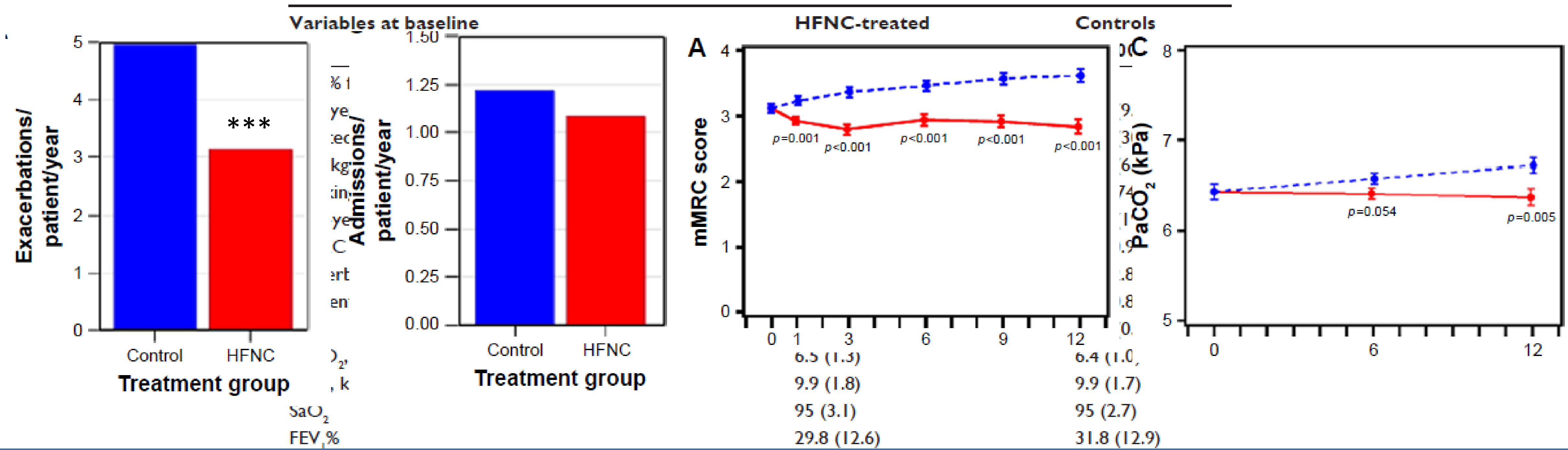
International Journal of COPD
Dovepress
open access to scientific and medical research
Open Access Full Text Article
CLINICAL TRIAL REPORT

Long-term effects of oxygen-enriched high-flow nasal cannula treatment in COPD patients with chronic hypoxemic respiratory failure

Four centers, randomized 1:1
COPD with chronic hypoxemic respiratory failure

Total 200 patients
HFNC : flow 20L/min, for 8 hours/day,



Chronic hypoxemic respiratory failure 환자에게 사용가능!!!!

Int J Chron Obstruct Pulmon Dis . 2018 Apr 16;13:1195-1205.

SYSTEMATIC REVIEW

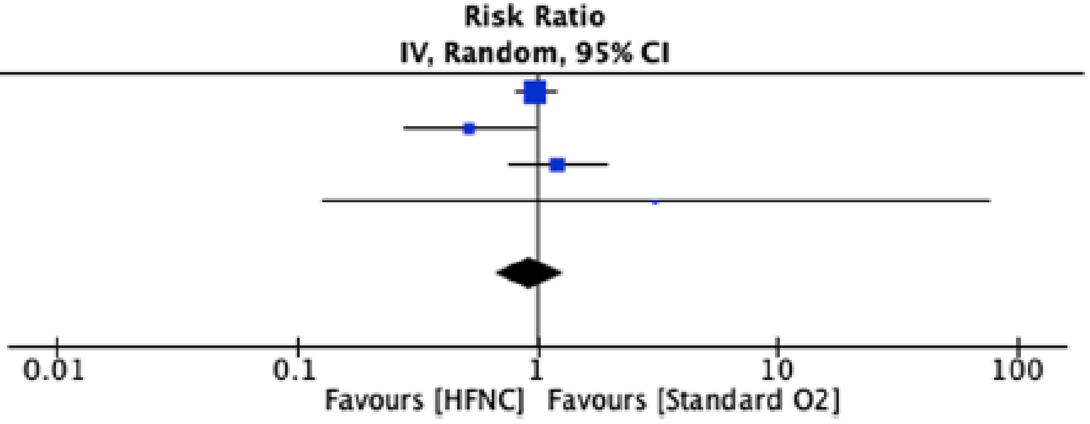
High flow nasal cannula compared with conventional oxygen therapy for acute hypoxemic respiratory failure: a systematic review and meta-analysis

from January 1st 2007 through October 25, 2018.
9 RCTs included

Mortality

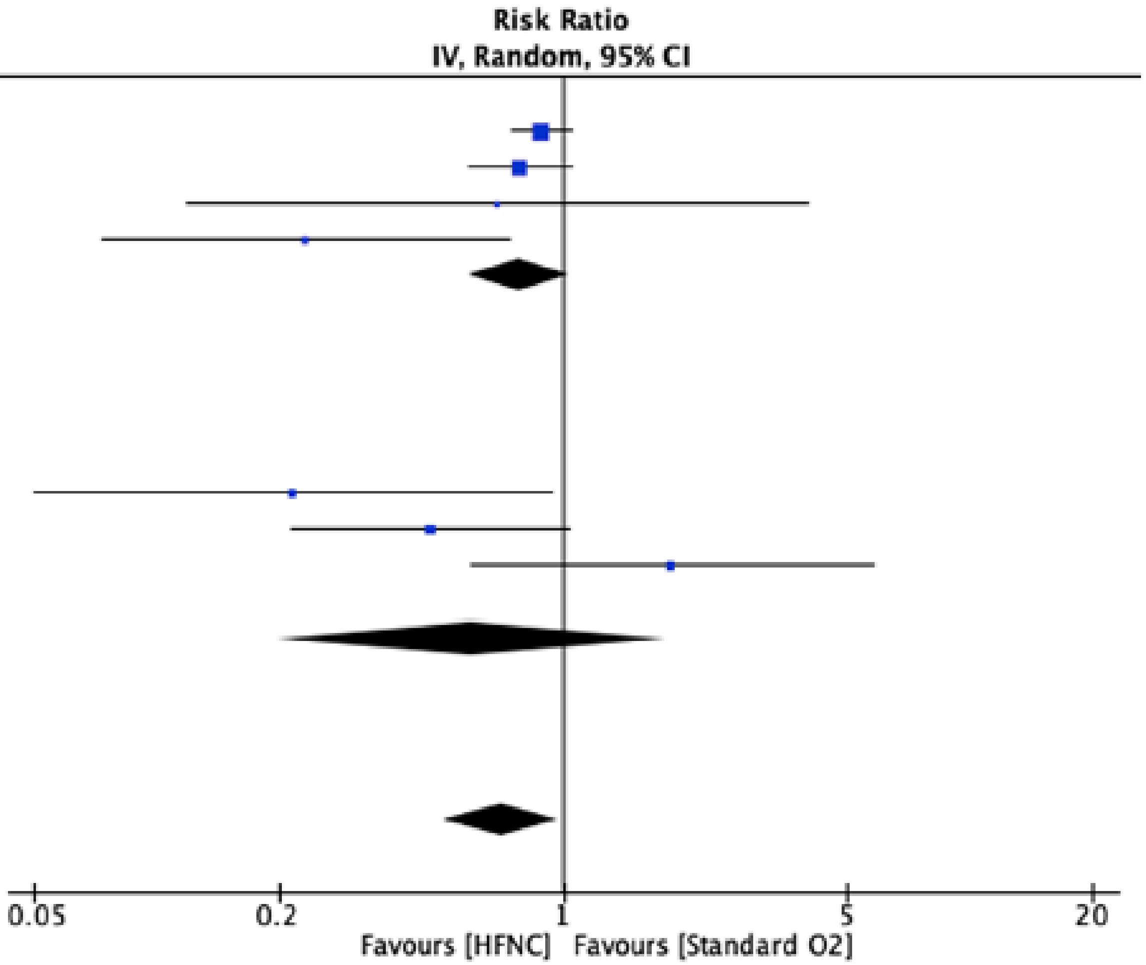
Study or Subgroup	HFNC Events	HFNC Total	Standard O2 Events	Standard O2 Total	Weight	Risk Ratio IV, Random, 95% CI
Azoulay 2018	138	388	140	388	51.8%	0.99 [0.82, 1.19]
Frat 2015	13	106	22	94	19.3%	0.52 [0.28, 0.98]
Jones 2016	35	165	24	138	27.8%	1.22 [0.76, 1.95]
Makdee 2017	1	63	0	65	1.1%	3.09 [0.13, 74.55]
Total (95% CI)		**722**		**685**	**100.0%**	**0.94 [0.67, 1.31]**
Total events	187		186			

Heterogeneity: $Tau^2 = 0.05$; $Chi^2 = 5.17$, df = 3 (P = 0.16); $I^2 = 42\%$
Test for overall effect: Z = 0.38 (P = 0.70)



Escalation

Study or Subgroup	HFNC Events	HFNC Total	Standard O2 Events	Standard O2 Total	Weight	Risk Ratio IV, Random, 95% CI
1.5.1 Low or Probably Low ROB						
Azoulay 2018	150	388	170	388	36.0%	0.88 [0.75, 1.04]
Frat 2015	45	106	51	94	30.4%	0.78 [0.59, 1.04]
Makdee 2017	2	63	3	65	3.2%	0.69 [0.12, 3.98]
Parke 2011	3	29	12	27	6.8%	0.23 [0.07, 0.74]
Subtotal (95% CI)		**586**		**574**	**76.4%**	**0.78 [0.59, 1.03]**
Total events	200		236			
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 5.38$, df = 3 (P = 0.15); $I^2 = 44\%$						
Test for overall effect: Z = 1.75 (P = 0.08)						
1.5.2 High or Probably High ROB						
Bell 2015	2	48	10	52	4.5%	0.22 [0.05, 0.94]
Jones 2016	9	165	16	138	12.2%	0.47 [0.21, 1.03]
Lemiale 2015	8	52	4	48	6.9%	1.85 [0.59, 5.74]
Rittayamai 2015	0	20	0	20		Not estimable
Subtotal (95% CI)		**285**		**258**	**23.6%**	**0.60 [0.20, 1.81]**
Total events	19		30			
Heterogeneity: $Tau^2 = 0.63$; $Chi^2 = 5.99$, df = 2 (P = 0.05); $I^2 = 67\%$						
Test for overall effect: Z = 0.91 (P = 0.36)						
Total (95% CI)		**871**		**832**	**100.0%**	**0.71 [0.51, 0.98]**
Total events	219		266			
Heterogeneity: $Tau^2 = 0.07$; $Chi^2 = 12.52$, df = 6 (P = 0.05); $I^2 = 52\%$						
Test for overall effect: Z = 2.07 (P = 0.04)						
Test for subgroup differences: $Chi^2 = 0.20$, df = 1 (P = 0.66), $I^2 = 0\%$						



Intensive Care Med. 2019 May;45(5):563-572.

Hypercapnic respiratory failure

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Outcomes	HFNC (n=39)	NIV (n=43)	*P*-value
Treatment failure, n(%)	11(28.2)	17(39.5)	0.268
Invasive ventilation, n(%)	8(20.5)	9(20.9)	1.0
Treatment switch, n(%)	3(7.7)	8(18.6)	0.148
28-day mortality, n(%)	6(15.4)	6(14.0)	0.824
Airway care interventions,/day*	5(4–7)	8(7–10)	<0.001
Duration of device application, hours*	16.0±3.9	11.7±3.1	<0.001
Respiratory frequency,/min #	22.3±3.1	23.5±2.9	0.064
$PaCO_2$, mm Hg#	51(48–56)	49(46–52)	0.078
PaO_2/FiO_2, mm Hg #	179 (172–192)	187 (174–207)	0.083
Respiratory support duration, days	5(4–7)	6(5–8)	0.148
Nasal facial skin breakdown after treatment, n(%)	2(5.1)	9(20.9)	0.036
Length of stay in ICU, days	7(6–8)	8(6–10)	0.149
Length of stay in hospital, days	9(7–11)	10(7–12)	0.207

enter, retrospective, emergency ICU
ith moderate hypercapnic ARF (pH 7.25–7.35, PaCO2>50

=39) vs. NIV (n=43)

	HFNC (n=11)	NIV (n=17)	*P*-value
Treatment intolerance	1(9.0)	8(47.1)	0.026
Aggravation of respiratory distress	4(36.4)	3(17.6)	0.381
Aggravation of hypoxemia	2(18.2)	1(5.9)	0.543
Aggravation of carbon dioxide retention	4(36.4)	5(29.4)	1.0

	0.142
	0.189
	0.375

Int J Chron Obstruct Pulmon Dis. 2019 Jun 5;14:1229-1237.

International Journal of *Environmental Research and Public Health*

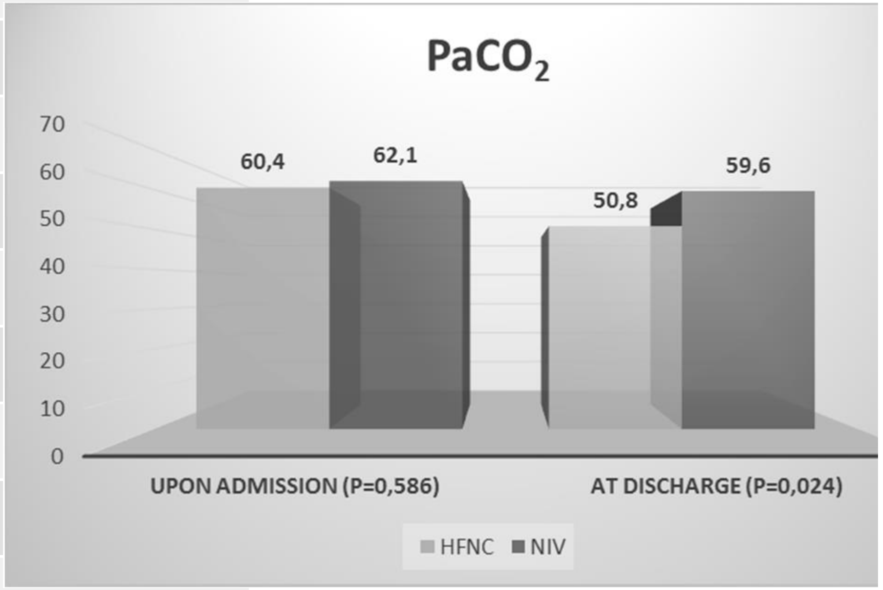
MDPI

Article

High-Flow Oxygen through Nasal Cannula vs. Non-Invasive Ventilation in Hypercapnic Respiratory Failure: A Randomized Clinical Trial

Single center, open-label, randomized 1:1
Total n= 40 patients in EM with hypercapnic respiratory failure ($PaCO_2 \geq 45$ mmHg)
HFNC (n=20) vs. NIV (n=20)

	HFNC (n=20)	NIV (n=20)	P-value
Age (SD),	76.0 (13.4)	78.1 (8.1)	0.544
APACHE II score (SD)	21.6 (8.9)	19.3 (6.1)	0.305
COPD	14 (70.0)	11 (55.0)	0.327
CHF (n, %)	8 (40.0)	9 (45.0)	0.749
DM	9 (45)	9 (45)	1
$PaCO_2$ IN (mmHg)	**60.4 (9.9)**	**62.1 (10.3)**	**0.586**
$PaCO_2$ 24h (mmHg)	**51.6 (9.6)**	**56.8 (9.7**	**0.096**
pH IN	**7.4 (0.1)**	**7.4 (0.1)**	**0.176**
pH 24h	**7.4 (0.1)**	**7.4 (0.1)**	**0.208**
PaO_2 IN (mmHg)	**65.2 (12.9)**	**71.6 (19.8)**	**0.192**
PaO_2 24h (mmHg)	**67.9 (8.8)**	**72.0 (10.4)**	**0.180**



Int J Environ Res Public Health. 2020 Aug; 17(16): 5994.

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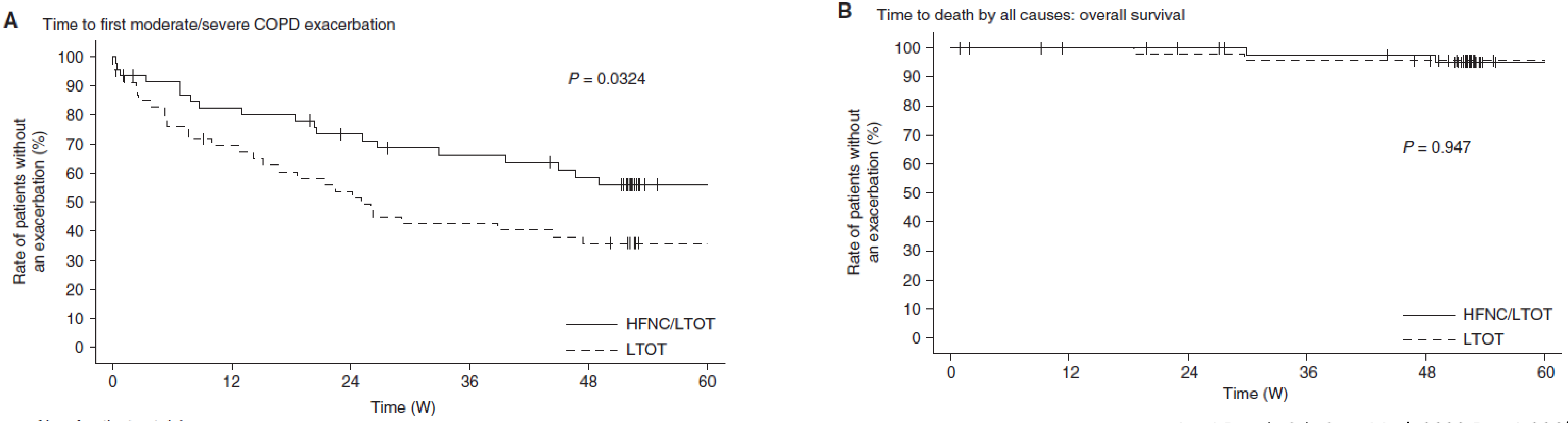
ORIGINAL ARTICLE

Home High-Flow Nasal Cannula Oxygen Therapy for Stable Hypercapnic COPD
A Randomized Clinical Trial

Multicenter, Randomized controlled trial
COPD patients with chronic hypercapnic respiratory failure
>40, daytime hypercapnia (PaCO2>45mmHg and pH>7.35)

LTOT (>16hr) vs. HFNC/LTOT (>4h during sleep, 30-40L/min)

Endpoints	Items	Statistics	HFNC/LTOT ($n = 47$)	n	LTOT ($n = 46$)	n	P Values
Primary	COPD exacerbation rate (moderate/severe)	Ratio of the mean count (95% CI)	Reference level		2.85 (1.48–5.47)		0.002
		Unadjusted mean count (SD)	1.0 (1.8)		2.5 (3.8)		



Am J Respir Crit Care Med. 2022 Dec 1;206(11):1326-1335.

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RESEARCH **Open Access**

High-flow nasal cannula versus non-invasive ventilation for acute hypercapnic respiratory failure in adults: a systematic review and meta-analysis of randomized trials

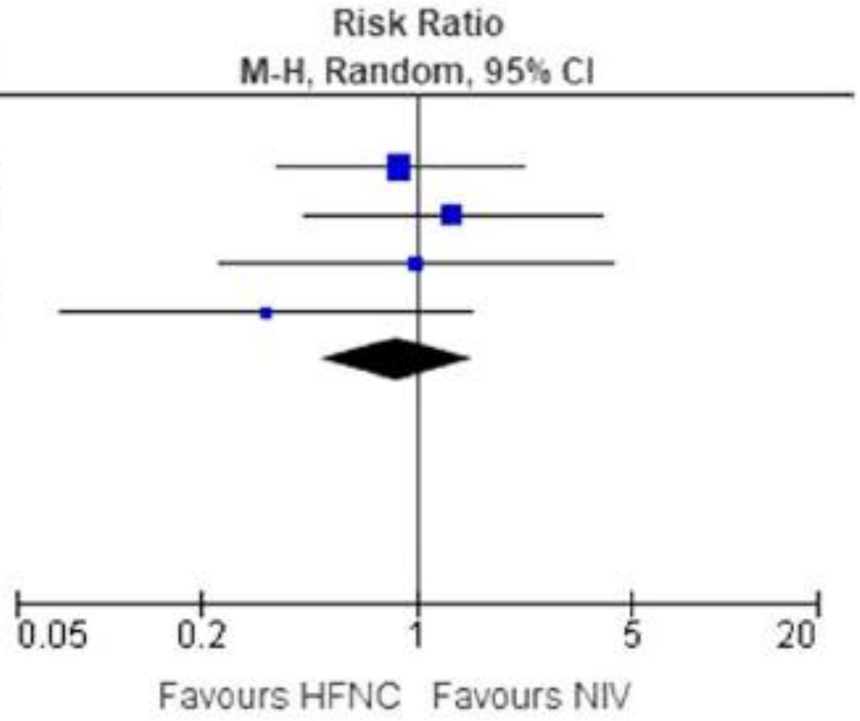
RCT of adults hypercapnic respiratory failure to receive HFNC or NIV
~October 2021.
Eight RCT included

Mortality

Study or Subgroup	HFNC Events	HFNC Total	NIV Events	NIV Total	Weight	Risk Ratio M-H, Random, 95% CI	Year
2.1.1 RCTs							
Lee 2016	7	44	8	44	41.0%	0.88 [0.35, 2.21]	2016
Wang 2019	6	23	4	20	28.2%	1.30 [0.43, 3.97]	2019
Papachatzakis 2020	3	20	3	20	16.1%	1.00 [0.23, 4.37]	2020
Cortegiani 2020	2	40	6	39	14.8%	0.33 [0.07, 1.51]	2020
Subtotal (95% CI)		127		123	100.0%	0.86 [0.48, 1.56]	
Total events	18		21				

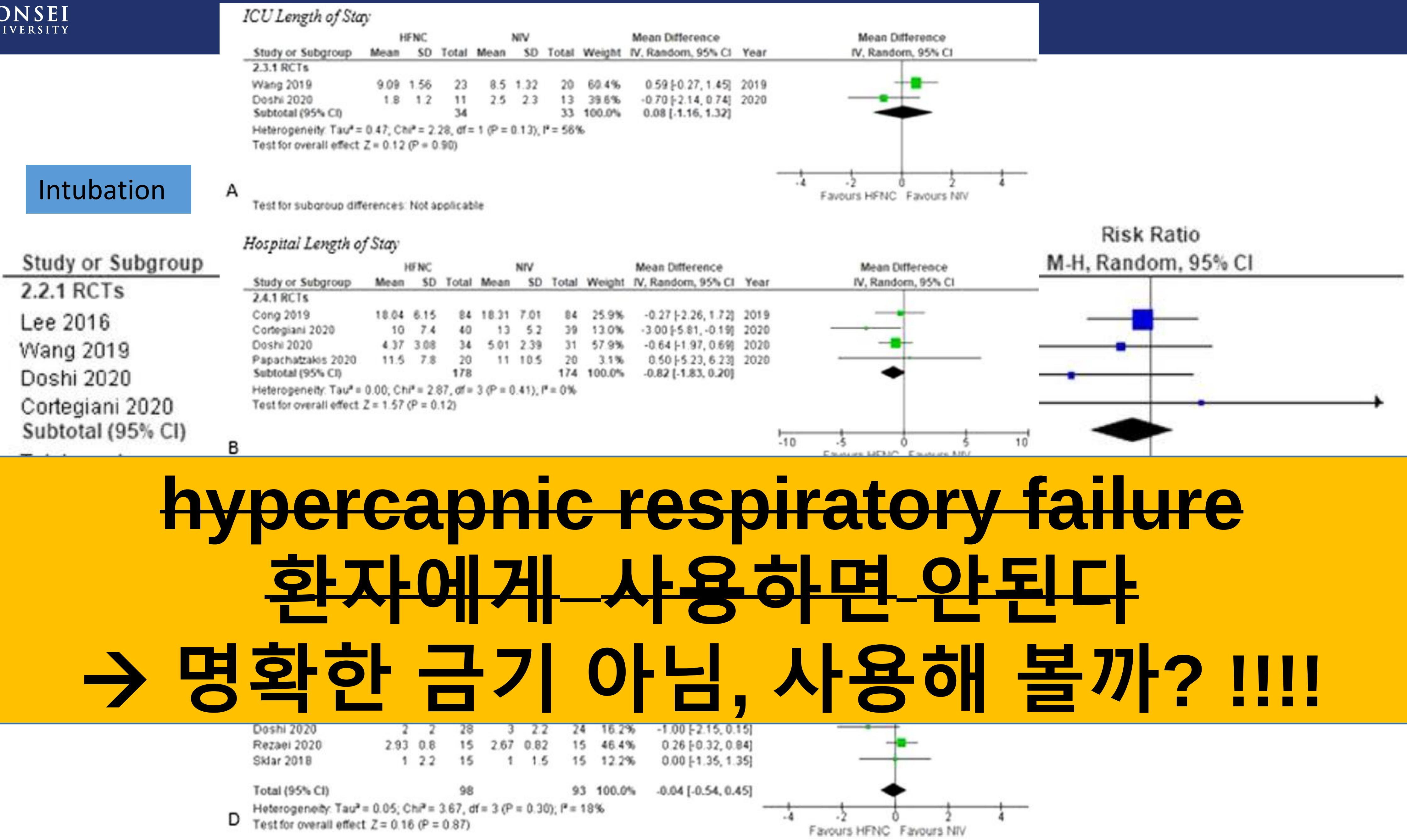
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.14$, df = 3 (P = 0.54); $I^2 = 0\%$
Test for overall effect: Z = 0.48 (P = 0.63)

Test for subgroup differences: Not applicable



Crit Care. 2022 Nov 9;26(1):348.

Intubation



~~hypercapnic respiratory failure~~
~~환자에게 사용하면 안된다~~
→ 명확한 금기 아님, 사용해 볼까? !!!!

Crit Care. 2022 Nov 9;26(1):348.

Post extubation
Post operation

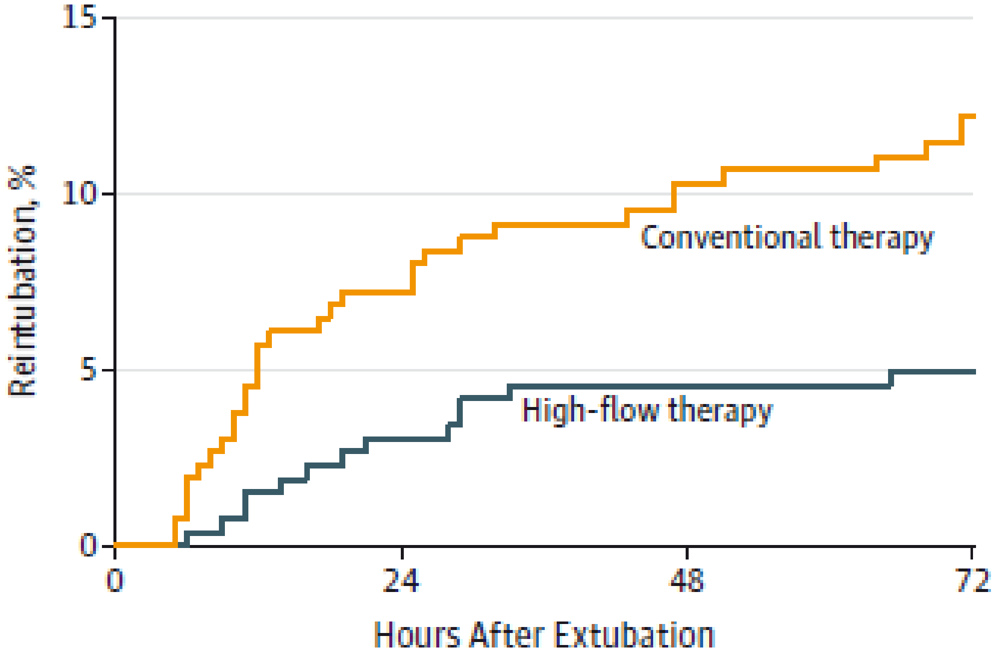
Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

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

A Randomized Clinical Trial

Multi center, randomized clinical trial
patients with low risk for reintubation ready for planned extubation
(<65, APACHEII <12, BMI <30, simple weaning, without HF or moderate to severe COPD)

	HFNC (n=264)	Convention (n=263)	P-value
All-cause reintubation	13 (4.9)	632(12.2)	0.004
Post extubation RF	22 (8.3)	38 (14.4)	0.03
Time to reintubation, median (IQR), h	19 (12-28)	15 (9-31)	
ICU length of stay, median (IQR), d	6 (2 to 8)	6 (2 to 9)	
ICU Mortality	3 (1.1)	3 (1.61)	
Hospital mortality	10 (3.8)	13 (5)	



JAMA. 2016;315(13):1354-1361

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

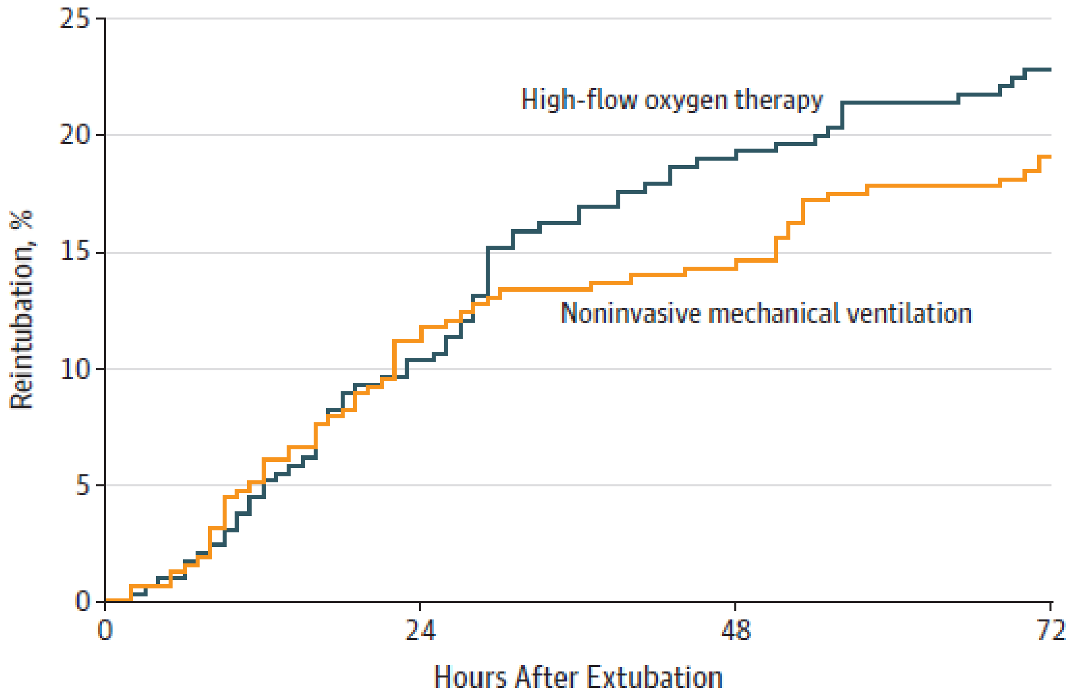
Effect of Postextubation High-Flow Nasal Cannula vs Noninvasive Ventilation on Reintubation and Postextubation Respiratory Failure in High-Risk Patients

A Randomized Clinical Trial

	NIV (n=314)	HFNC (n=290)
All-cause reintubation	60 (19.1)	66 (22.8)
Reintubation d/t respiratory problerm	50 (15.9)	49 (16.9)
Post extubation RF*	125 (39.8)	78 (26.9)
Time to reintubation, median (IQR), h	21.5 (10-47)	26.5 (14-39)
ICU length of stay, median (IQR), d	4 (2 to 9)	3 (2 to 7)
ICU Mortality	18 (5.7)	19 (6.6)
Hospital mortality	56 (17.8)	59 (20.3)
Adverse events*	135 (42.9)	0 (0)

Multi center, randomized clinical trial
patients ready for planned extubation with at least 1 of the following high-risk factors for reintubation

(>65, APACHEII >12, BMI >30, difficult or prolonged weaning, HF, moderate to severe COPD)



Time From Extubation to Reintubation

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

RESEARCH Open Access

High-flow nasal cannula oxygen therapy versus non-invasive ventilation for chronic obstructive pulmonary disease patients after extubation: a multicenter, randomized controlled trial

Check for updates

multicenter, randomized COPD with chronic hypercapnic who were receiving MV

	HFNC (*n* = 44)	NIV (*n* = 42)	Risk difference, % (95% CI)	*p* value
Primary outcome, *n* (%)				
Treatment failure	10 (22.7)	12 (28.6)	− 5.8 (− 23.8 to 12.4)	0.535
Invasive ventilation	6 (13.6)	6 (14.29)	− 0.65 (− 16.01 to 14.46)	0.931
Treatment switch	4 (9.1)	6 (14.3)	− 5.2 (− 19.82 to 9.05)	0.516
Analysis of treatment failure, *n* (%)				
Treatment intolerance	0/10 (0)	6/12 (50.0)	− 50.0 (− 74.62 to − 12.9)	0.015
Aggravation of respiratory distress	5/10 (50)	2/12 (16.67)	33.33 (− 5.21 to 62.27)	0.172
Aggravation of hypoxemia	2/10 (20)	1/12 (8.33)	11.67 (− 18.95 to 43.4)	0.571
Aggravation of carbon dioxide retention	3/10 (30)	3/12 (25)	5 (− 29.15 to 39.33)	1.0

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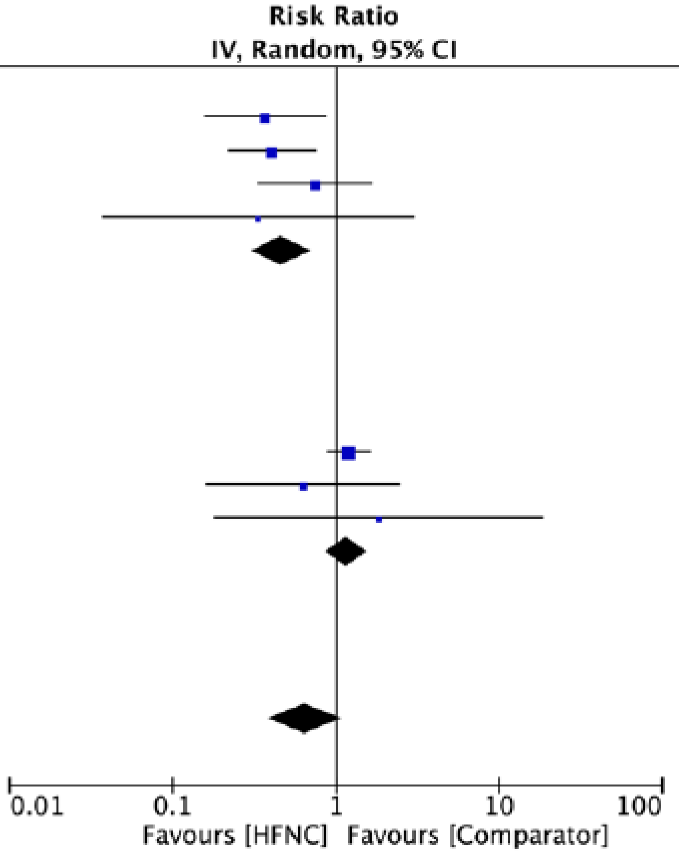
High-Flow Nasal Cannula Compared With Conventional Oxygen Therapy or Noninvasive Ventilation Immediately Postextubation: A Systematic Review and Meta-Analysis

Immediate postextubation period in critically ill patients
HFNC vs. COT or NIV
from January 2007 to October 8, 2019
Eight RCT included

Reintubation

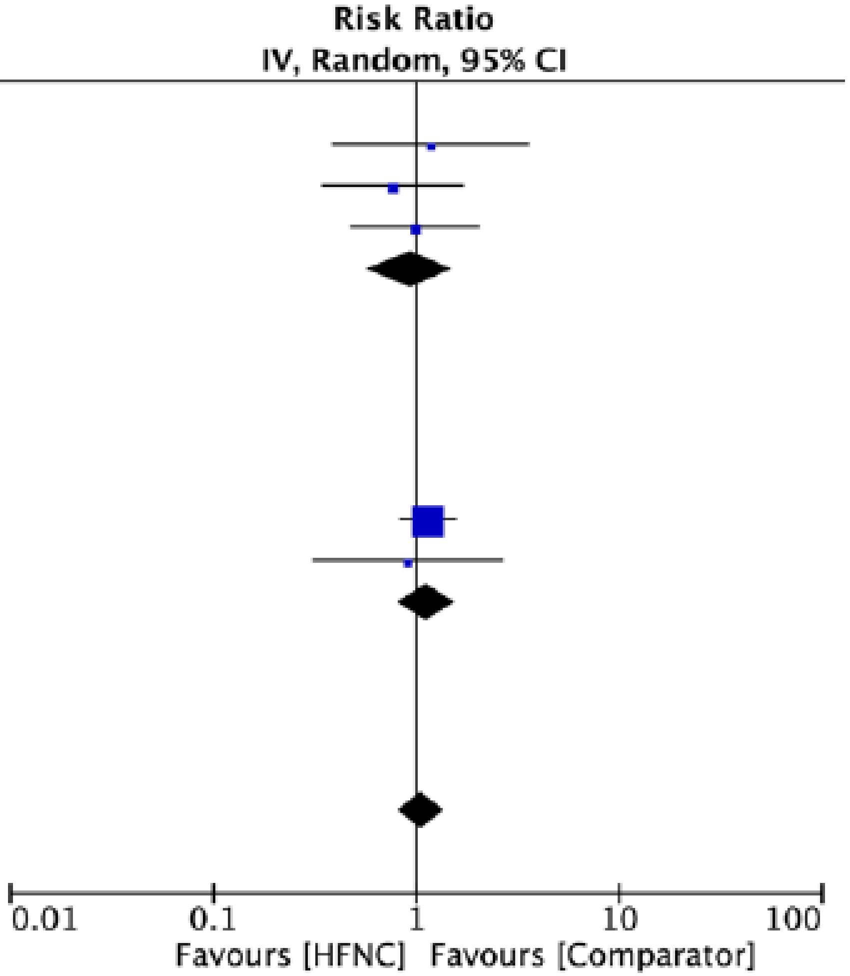
Study or Subgroup	HFNC Events	HFNC Total	Any comparator Events	Any comparator Total	Weight	Risk Ratio IV, Random, 95% CI	Year
3.1.1 Standard O2							
Maggiore 2014	6	53	16	52	16.4%	0.37 [0.16, 0.87]	2014
Hernandez 2016 (Low Risk)	13	264	32	263	20.8%	0.40 [0.22, 0.75]	2016
Fernandez 2017	9	78	12	77	17.3%	0.74 [0.33, 1.66]	2017
Song 2017	1	30	3	30	4.7%	0.33 [0.04, 3.03]	2017
Subtotal (95% CI)		**425**		**422**	**59.3%**	**0.46 [0.30, 0.70]**	
Total events	29		63				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.85$, df = 3 (P = 0.60); $I^2 = 0\%$							
Test for overall effect: Z = 3.61 (P = 0.0003)							
3.1.2 NIV							
Hernandez 2016 (High Risk)	66	288	60	312	26.6%	1.19 [0.87, 1.63]	2016
Theerawit 2017	3	43	5	45	9.8%	0.63 [0.16, 2.47]	2017
Jing 2019	2	22	1	20	4.3%	1.82 [0.18, 18.55]	2019
Subtotal (95% CI)		**353**		**377**	**40.7%**	**1.16 [0.86, 1.57]**	
Total events	71		66				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.94$, df = 2 (P = 0.62); $I^2 = 0\%$							
Test for overall effect: Z = 0.99 (P = 0.32)							
Total (95% CI)		**778**		**799**	**100.0%**	**0.65 [0.39, 1.10]**	
Total events	100		129				
Heterogeneity: $Tau^2 = 0.24$; $Chi^2 = 15.09$, df = 6 (P = 0.02); $I^2 = 60\%$							
Test for overall effect: Z = 1.61 (P = 0.11)							
Test for subgroup differences: $Chi^2 = 12.30$, df = 1 (P = 0.0005), $I^2 = 91.9\%$							



Crit Care Med . 2020 Nov;48(11):e1129-e1136.

Mortality

Study or Subgroup	HFNC Events	HFNC Total	Any comparator Events	Any comparator Total	Weight	Risk Ratio IV, Random, 95% CI	Year
3.2.1 Standard O2							
Maggiore 2014	6	53	5	52	5.5%	1.18 [0.38, 3.62]	2014
Hernandez 2016 (Low Risk)	10	264	13	263	10.8%	0.77 [0.34, 1.72]	2016
Fernandez 2017	12	78	12	77	12.9%	0.99 [0.47, 2.06]	2017
Subtotal (95% CI)		**395**		**392**	**29.2%**	**0.93 [0.57, 1.52]**	
Total events	28		30				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.42$, df = 2 (P = 0.81); $I^2 = 0\%$							
Test for overall effect: Z = 0.29 (P = 0.77)							
3.2.2 NIV							
Hernandez 2016 (High Risk)	59	288	56	312	64.8%	1.14 [0.82, 1.59]	2016
Jing 2019	5	22	5	20	6.0%	0.91 [0.31, 2.68]	2019
Subtotal (95% CI)		**310**		**332**	**70.8%**	**1.12 [0.82, 1.53]**	
Total events	64		61				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.16$, df = 1 (P = 0.69); $I^2 = 0\%$							
Test for overall effect: Z = 0.70 (P = 0.48)							
Total (95% CI)		**705**		**724**	**100.0%**	**1.06 [0.81, 1.38]**	
Total events	92		91				
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.96$, df = 4 (P = 0.92); $I^2 = 0\%$							
Test for overall effect: Z = 0.43 (P = 0.66)							
Test for subgroup differences: $Chi^2 = 0.39$, df = 1 (P = 0.53), $I^2 = 0\%$							



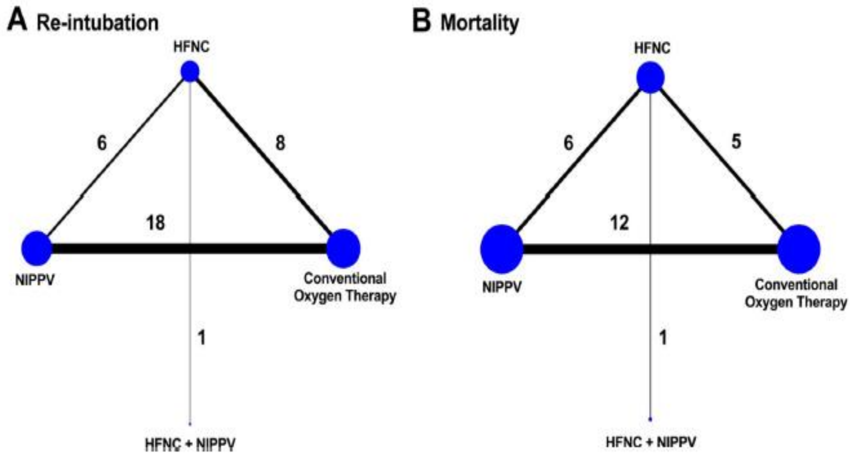
Crit Care Med . 2020 Nov;48(11):e1129-e1136.

YONSEI UNIVERSITY

SYSTEMATIC REVIEW

Noninvasive respiratory support following extubation in critically ill adults: a systematic review and network meta-analysis

extubation failure among critically ill adults
through October 2021
36 RCT included



Prevention of reintubation

Comparison	Network odds ratio (95% CI)	Absolute risk difference (95% CI)	Number needed to treat	GRADE
NIPPV vs conventional oxygen	0.65 (0.52–0.82)	− 5.18 (− 8.09 to − 2.26)	20 (13 to 45)	Moderate[a]
HFNC vs conventional oxygen	0.63 (0.45–0.87)	− 3.84 (− 6.7 to − 0.98)	26 (15 to 102)	Moderate[a]
NIPPV vs HFNC	1.04 (0.78–1.38)	− 1.34 (− 4.4 to 1.72)	N/A	Low[a,b]
HFNC + NIPPV vs conventional oxygen	0.38 (0.19–0.74)	− 10.25 (− 18.49 to − 2.01)	10 (6 to 50)	Moderate[a]
HFNC + NIPPV vs NIPPV	0.58 (0.3–1.11)	− 5.07 (− 13.38 to 3.24)	N/A	Low[a,b]
HFNC + NIPPV vs HFNC	0.6 (0.33–1.08)	− 6.41 (− 14.13 to 1.31)	N/A	Low[a,b]

Mortality

Comparison	Network odds ratio (95% CI)	Absolute risk difference (95% CI)	GRADE
NIPPV vs conventional oxygen	0.8 (0.61–1.04)	− 1.65 (− 3.81 to 0.5)	Moderate[b]
HFNC vs conventional oxygen	0.9 (0.66–1.24)	− 0.29 (− 1.58 to 1.01)	Low[a]
NIPPV vs HFNC	0.89 (0.69–1.13)	− 1.37 (− 3.47 to 0.72)	Moderate[b]
HFNC + NIPPV vs conventional oxygen	0.95 (0.56–1.62)	0.41 (− 5.36 to 6.18)	Low[a]
HFNC + NIPPV vs NIPPV	1.19 (0.73–1.95)	2.07 (− 3.93 to 8.07)	Low[a]
HFNC + NIPPV vs HFNC	1.05 (0.69–1.62)	0.7 (− 4.93 to 6.33)	Low[a]

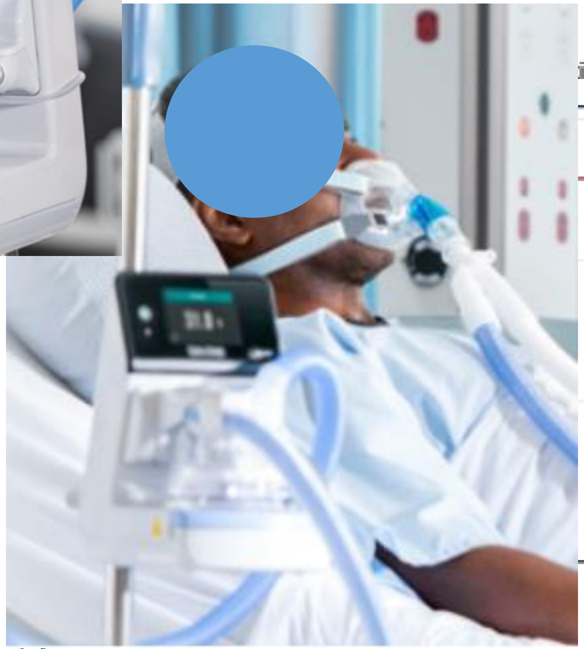
Intensive Care Med. 2022 Feb;48(2):137-147

ORIGINAL

	NIV (*n* = 92)	HFNC (*n* = 90)
Comorbidities[b], n (%)		
Heart disease	38 (41.3)	22 (24.4)
COPD	27 (29.3)	11 (12.2)
Other respiratory disease	46 (50)	30 (33.3)
High-risk factors for reintubation, no (%)		
Age > 65 y	42 (45.7)	41 (45.6)
Heart failure as primary indication for MV	25 (27.2)	6 (6.7)
COPD	28 (30.4)	14 (15.6)
APACHE II > 12 on extubation day[a]	53 (57.6)	56 (62.2)
Body mass index > 30[c]	49 (53.3)	46 (51.1)
Airway patency problems	33 (35.9)	31 (34.4)
Inability to deal with respiratory secretions	31 (33.7)	47 (52.2)
Difficult or prolonged weaning[d]	60 (66.7)	59 (64.1)
> 2 comorbidities	75 (81.5)	61 (67.8)
Prolonged MV	36 (39.1)	43 (47.8)
Hypercapnia at the end of the SBT	47 (51.1)	27 (30)
High-risk factors, median (IQR)	5 (4–6)	4 (4–6)

Two centers, randomized controlled,
planned extubation with ≥ 4 of the following risk factors for reintubation (>65, APACHEII >12, BMI> 30, inadequate secretions management, difficult or prolonged weaning, HF, modera c.)

(95%CI),
.2, −0.3),
4, 13.5), p=0.896
18.7), p=0.356
, p=0.582

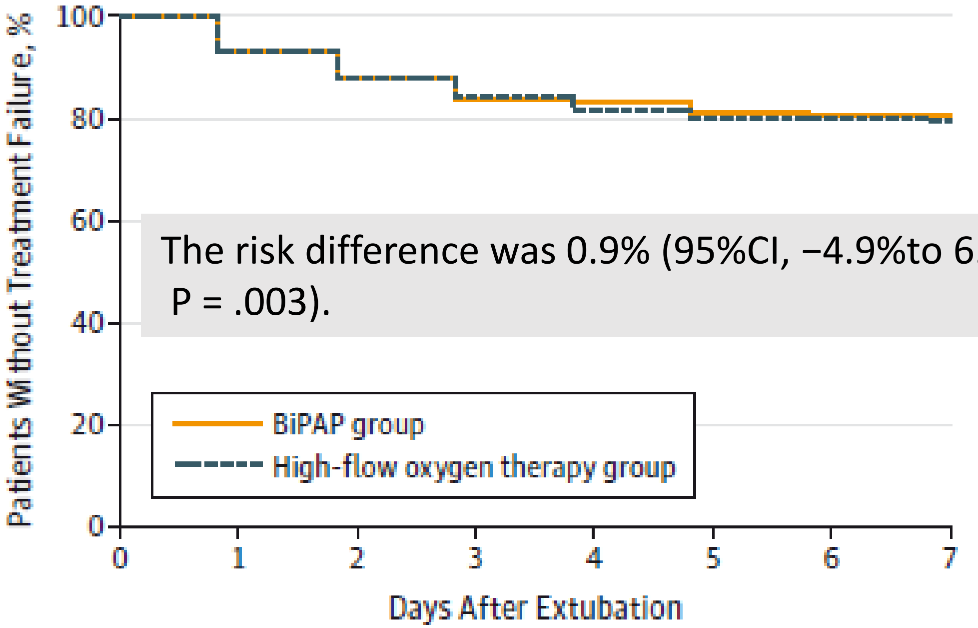


Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

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

Multi center, randomized clinical trial, non inferiority trial
total 850 cardiothoracic surgery
HFNC = flow 50/min, FiO2 50%
NIV= BiPAP /c full face PSV8, PEEP 4, FiO2 50%

	NIV (n=416)	HFNC (n=414)
SAPS II	28.8 (27.7-30.0)	29.0 (27.8-30.1)
CBP No. (%)	340 (81.7)	320 (77.2)
Duration of CBP, mean (95% CI), min	137 (129-146)	137 (128-146)
Duration of MV	13.0 (6.0-27.5)	11.5 (5.0-25.4)
Reintubation	57 (13.7)	58 (14%)
Treatment failure	91 (21.9)	87 (21%)



The risk difference was 0.9% (95%CI, −4.9%to 6.6%
P = .003).

JAMA. 2015;313(23):2331-2339

High-Flow Nasal Cannula in the Immediate Postoperative Period

A Systematic Review and Meta-analysis

Check for updates

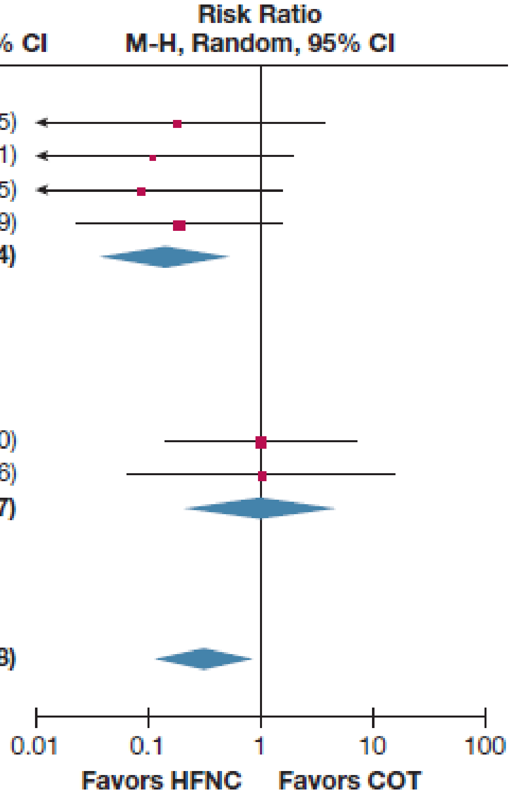
compared the effect of HFNC use with that of COT or NIV in the immediate postoperative period

HFNC vs COT 10 studies, HFNC vs NIV 1 study (11 RCT)

from January 1 2007 to April 15, 2019

Reintubation

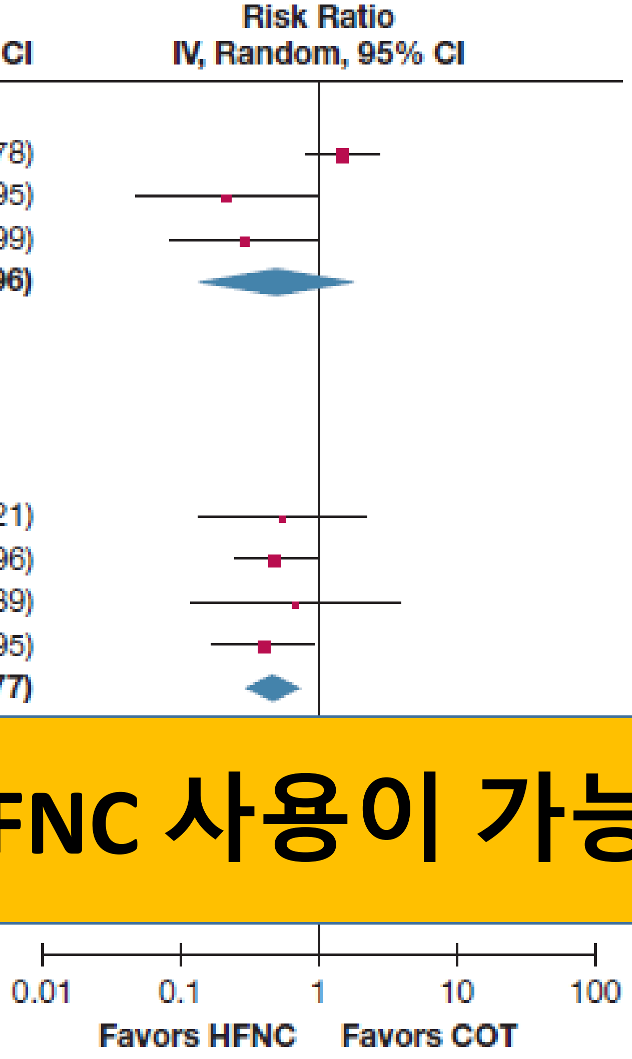
Study or Subgroup	HFNC Events	HFNC Total	COT Events	COT Total	Weight	Risk Ratio M-H, Random, 95% CI
1.15.1 High risk						
Corley 2015	0	81	2	74	11.3	0.18 (0.01-3.75)
Sahin 2018	0	50	4	50	12.3	0.11 (0.01-2.01)
Yu 2017	0	56	5	54	12.5	0.09 (0.00-1.55)
Zochios 2018	1	51	5	49	23.1	0.19 (0.02-1.59)
Subtotal (95% CI)		**238**		**227**	**59.2**	**0.14 (0.04-0.54)**
Total events	1		16			
Heterogeneity: $\tau^2 = 0.00$; $\chi^2_3 = 0.25$, $P = .97$; $I^2 = 0\%$						
Test for overall effect: $z = 2.88$ ($P = .004$)						
1.15.2 Average risk						
Parke 2013	2	169	2	171	27.1	1.01 (0.14-7.10)
Pennisi 2019	1	47	1	48	13.7	1.02 (0.07-15.86)
Subtotal (95% CI)		**216**		**219**	**40.8**	**1.01 (0.21-4.97)**
Total events	3		3			
Heterogeneity: $\tau^2 = 0.00$; $\chi^2_1 = 0.00$, $P = 1.00$; $I^2 = 0\%$						
Test for overall effect: $z = 0.02$ ($P = .99$)						
Total (95% CI)		**454**		**446**	**100.0**	**0.32 (0.12-0.88)**
Total events	4		19			
Heterogeneity: $\tau^2 = 0.00$; $\chi^2_5 = 3.82$, $P = .58$; $I^2 = 0\%$						
Test for overall effect: $z = 2.20$ ($P = .03$)						
Test for subgroup differences: $\chi^2_1 = 3.44$, $P = .06$, $I^2 = 70.9\%$						



Chest . 2020 Nov;158(5):1934-1946

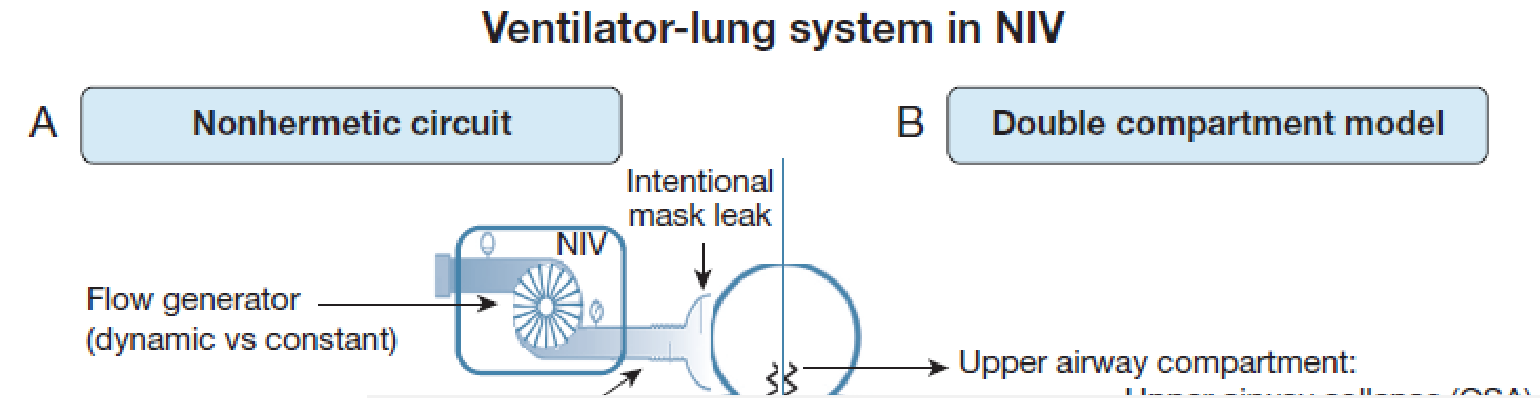
Escalation

Study or Subgroup	HFNC Events	HFNC Total	COT Events	COT Total	Weight	Risk Ratio IV, Random, 95% CI
1.11.1 High risk						
Futier 2016	20	108	14	112	21.8	1.48 (0.79-2.78)
Yu 2017	2	56	9	54	9.6	0.21 (0.05-0.95)
Zochios 2018	3	51	10	49	12.2	0.29 (0.08-0.99)
Subtotal (95% CI)		**215**		**215**	**43.7**	**0.51 (0.13-1.96)**
Total events	25		33			
Heterogeneity: $\tau^2 = 1.11$; $\chi^2_2 = 9.26$, $P = .010$; $I^2 = 78\%$						
Test for overall effect: $z = 0.98$ ($P = .33$)						
1.11.2 Average risk						
Corley 2015	3	81	5	74	10.4	0.55 (0.14-2.21)
Parke 2013	11	169	23	171	20.8	0.48 (0.24-0.96)
Pennisi 2019	2	47	3	48	7.6	0.68 (0.12-3.89)
Sahin 2018	6	50	15	50	17.6	0.40 (0.17-0.95)
Subtotal (95% CI)		**347**		**343**	**56.3**	**0.48 (0.29-0.77)**

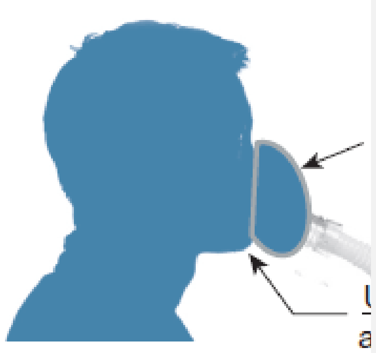


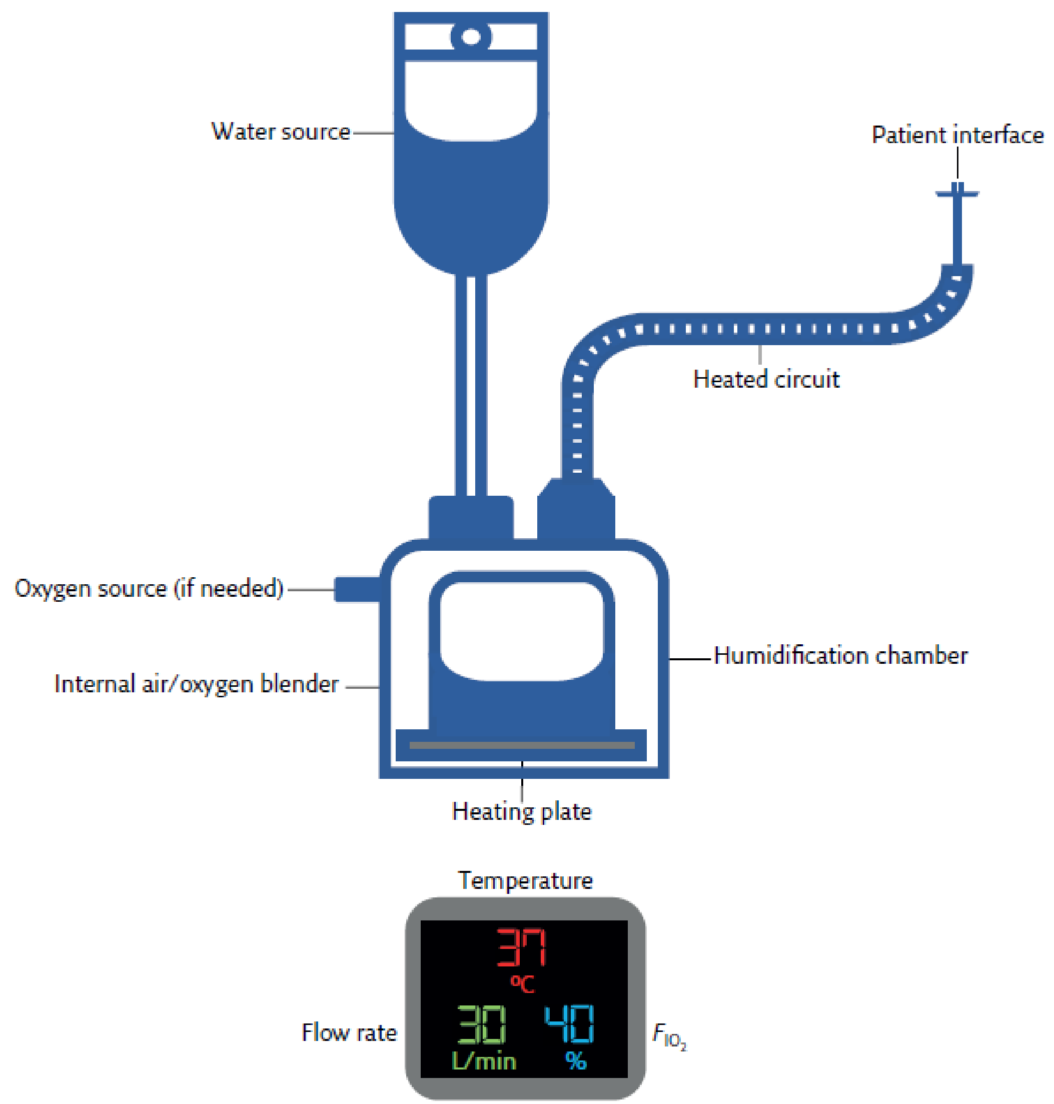
Post extubation 환자에서 HFNC 사용이 가능하다.

Heterogeneity: $\tau^2 = 0.27$; $\chi^2_6 = 12.34$, $P = .05$; $I^2 = 51\%$
Test for overall effect: $z = 2.18$ ($P = .03$)
Test for subgroup differences: $\chi^2_1 = 0.01$, $P = .93$, $I^2 = 0\%$



- Augmentation of alveolar ventilation to reverse respiratory acidosis and hypercarbia
- Alveolar recruitment and increased FiO2 to reverse hypoxia
- Reduction in work of breathing to reduce or prevent respiratory muscle insufficiency
- Stabilisation of the chest wall in the presence of chest trauma or surgery
- Reduction in left ventricular afterload that may lead to improved cardiac function
- Reduction of right ventricular afterload and improved RV function





- **Mucociliary clearance**
  - Optimised respiratory epithelial function
  - Improved mucociliary transport in bench studies
- **Dead space washout**
  - Reduced anatomical dead space
  - Carbon dioxide washout and oxygen reservoir
- **Improved pulmonary mechanics**
  - Reduced work of breathing
  - Increased lung compliance
  - Improved gas exchange
  - Improved ventilation homogeneity

Breathe 2020 16: 200224

J Appl Physiol 132: 1580–1590, 2022.
First published May 5, 2022; doi:10.1152/japplphysiol.00416.2021

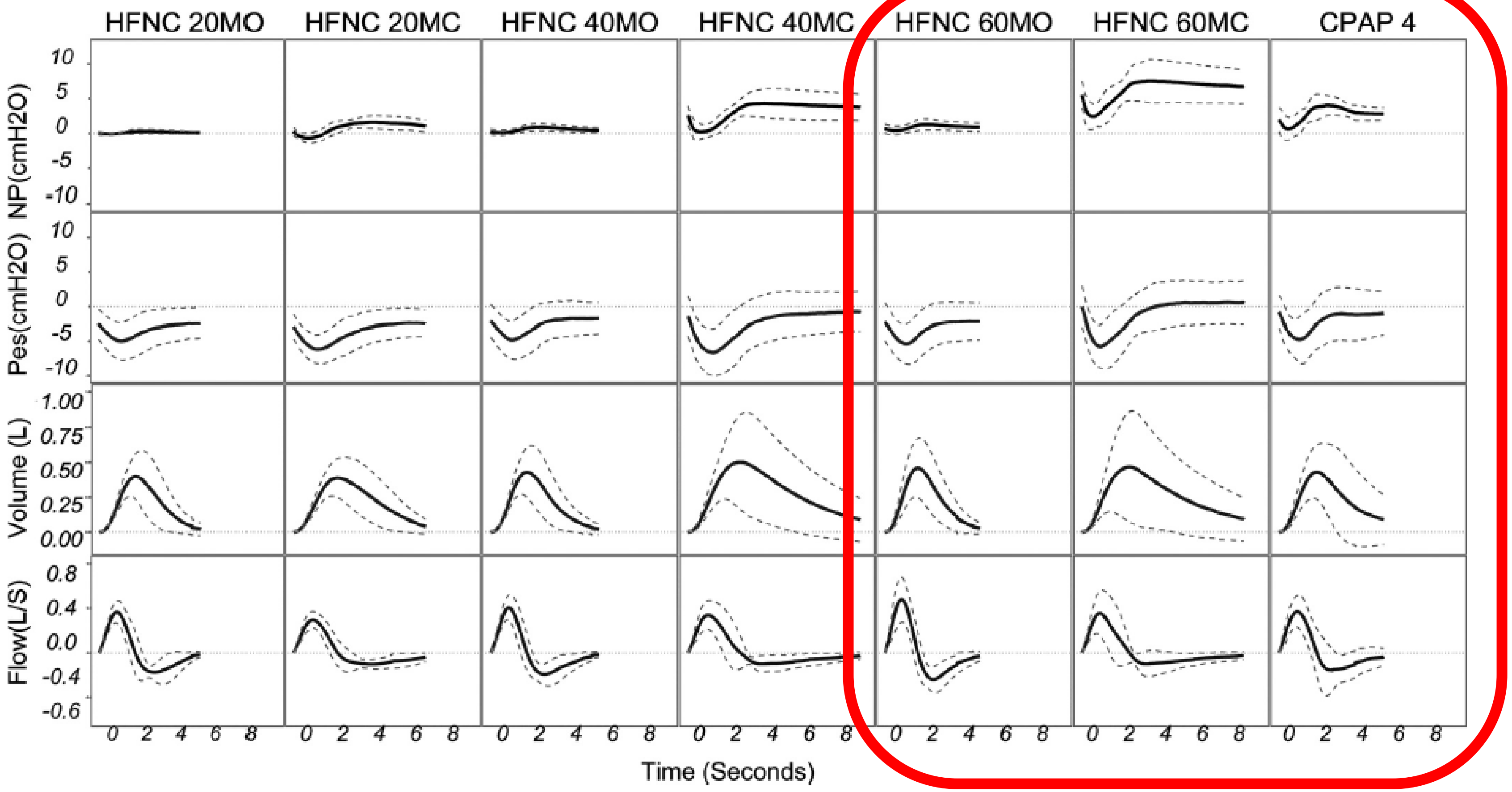
american physiological society

JOURNAL OF APPLIED PHYSIOLOGY

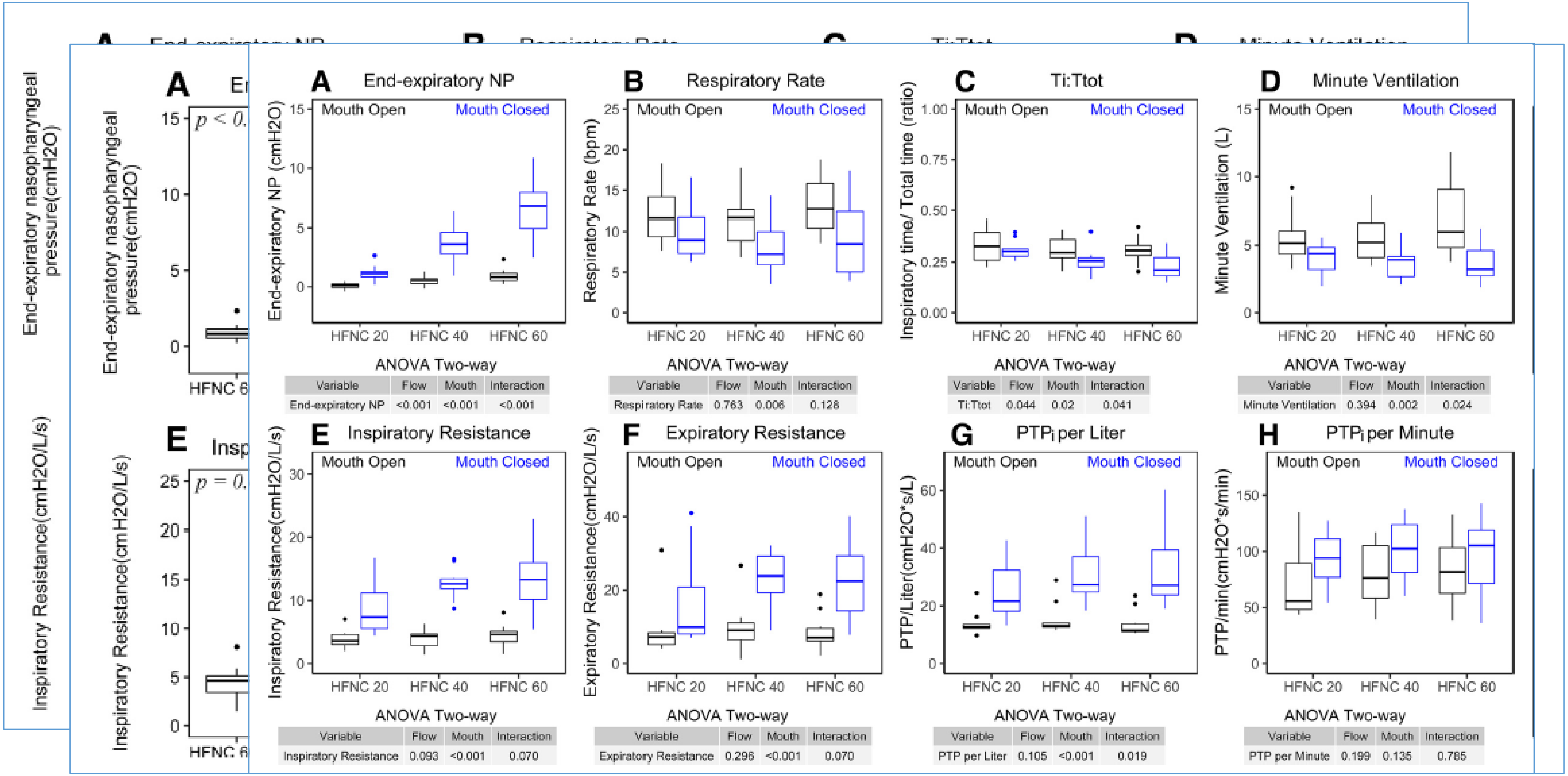
RESEARCH ARTICLE

High-flow nasal cannula compared with continuous positive airway pressure: a bench and physiological study

1) whether HFNC produced similar effects to CPAP
2) possible explanations of respiratory rate changes
3) the effects of mouth opening.



J Appl Physiol (1985). 2022 May 5



ANOVA Two-way

Variable	Flow	Mouth	Interaction
End-expiratory NP	<0.001	<0.001	<0.001

ANOVA Two-way

Variable	Flow	Mouth	Interaction
Respiratory Rate	0.763	0.006	0.128

ANOVA Two-way

Variable	Flow	Mouth	Interaction
Ti:Ttot	0.044	0.02	0.041

ANOVA Two-way

Variable	Flow	Mouth	Interaction
Minute Ventilation	0.394	0.002	0.024

ANOVA Two-way

Variable	Flow	Mouth	Interaction
Inspiratory Resistance	0.093	<0.001	0.070

ANOVA Two-way

Variable	Flow	Mouth	Interaction
Expiratory Resistance	0.296	<0.001	0.070

ANOVA Two-way

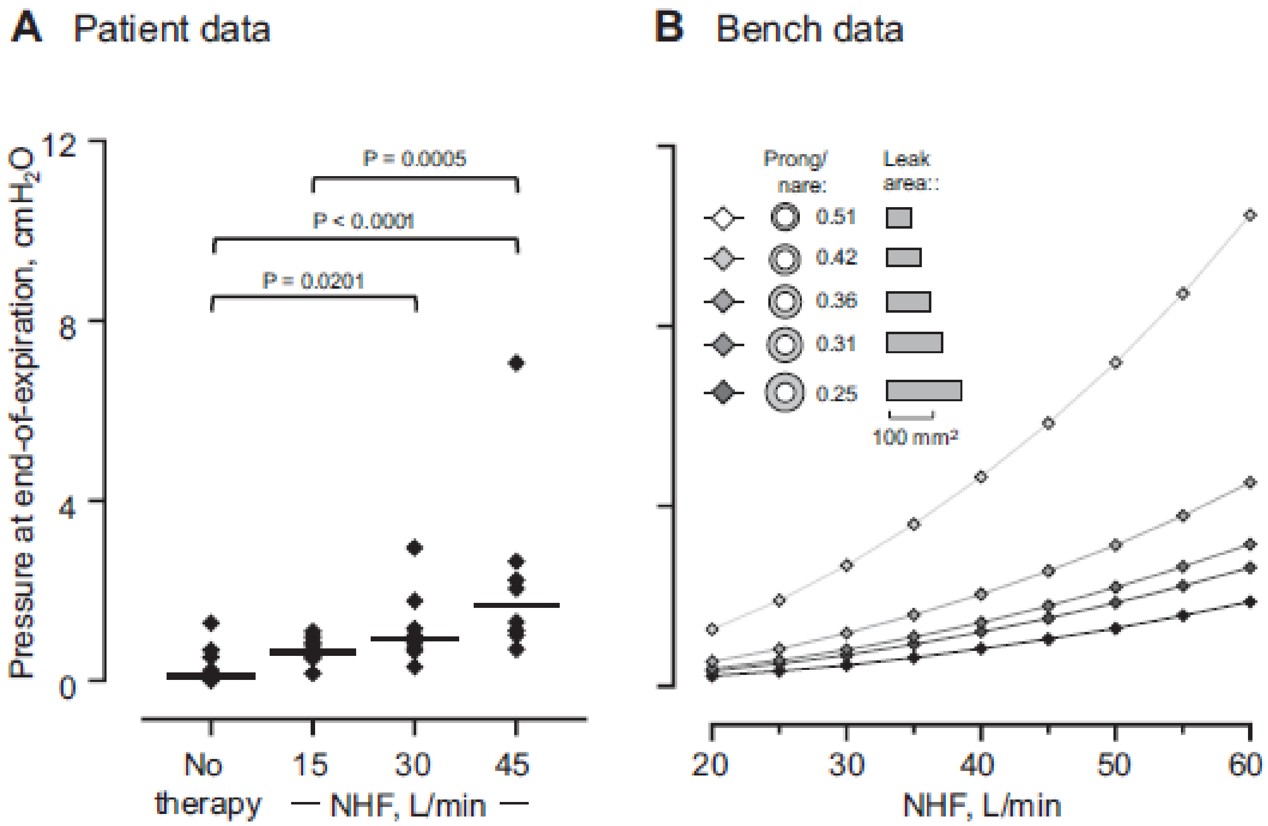
Variable	Flow	Mouth	Interaction
PTP per Liter	0.105	<0.001	0.019

ANOVA Two-way

Variable	Flow	Mouth	Interaction
PTP per Minute	0.199	0.135	0.785

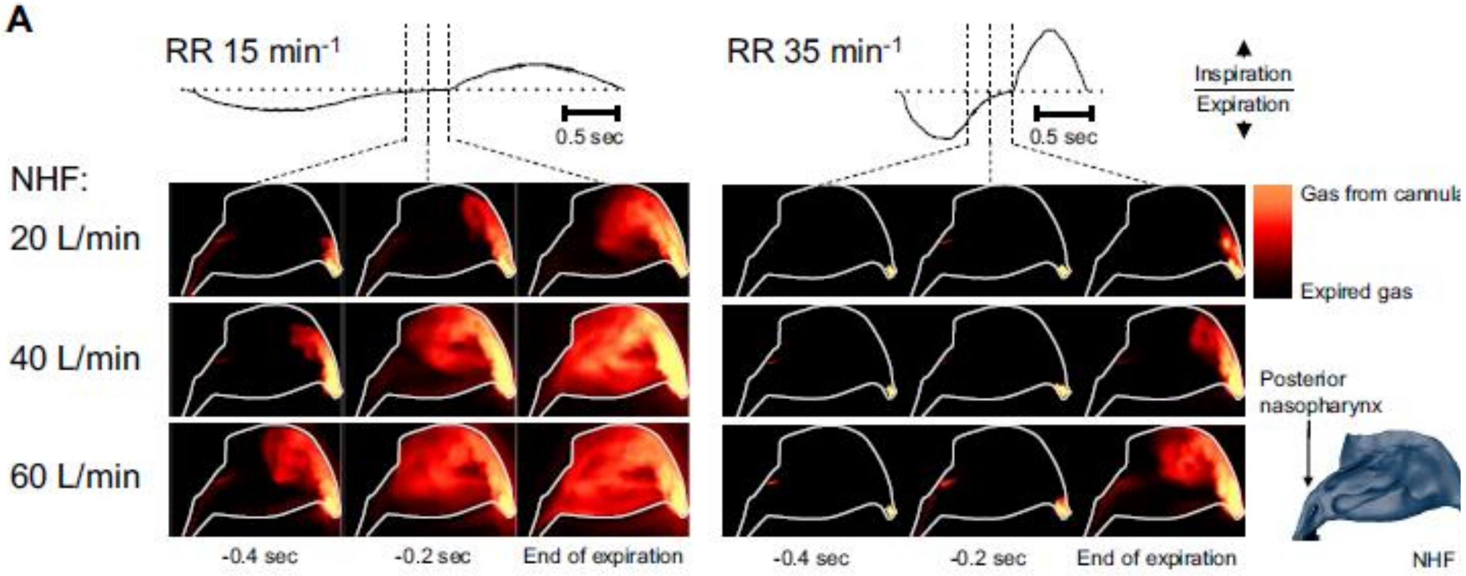
RESEARCH ARTICLE

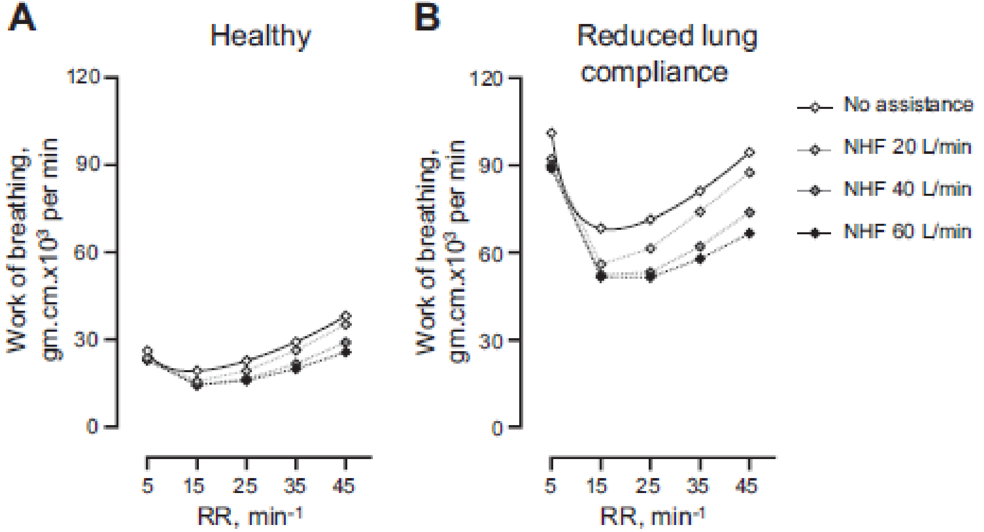
Effect of respiratory rate and size of cannula on pressure and dead-space clearance during nasal high flow in patients with COPD and acute respiratory failure



measured via a tracheostomy retainer
n = 8.

J Appl Physiol (1985). 2022 Feb 1;132(2):553-563.





nasal cavity model during NHF at RR of 15 /min and 35/ min at the end of expiration

J Appl Physiol (1985). 2022 Feb 1;132(2):553-563.

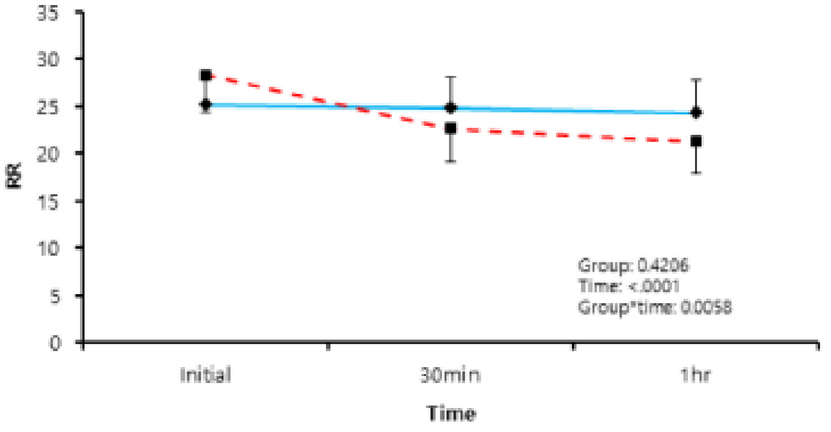
Journal of Clinical Medicine

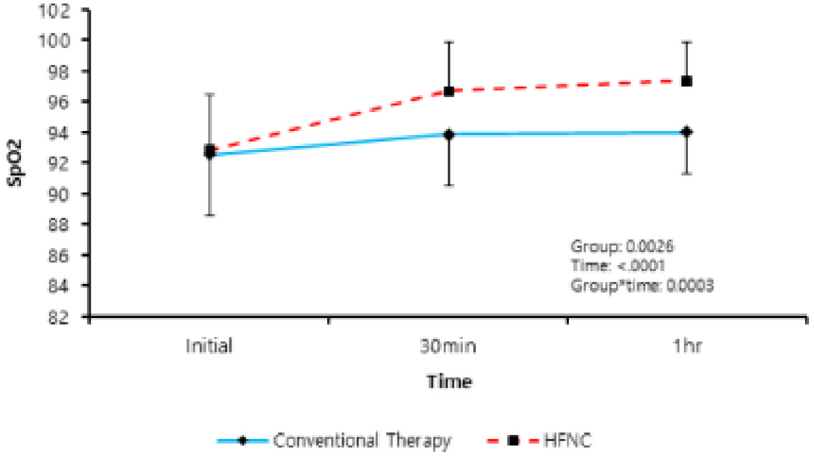
MDPI

Article

Benefits of High-Flow Nasal Cannula Therapy for Acute Pulmonary Edema in Patients with Heart Failure in the Emergency Department: A Prospective Multi-Center Randomized Controlled Trial

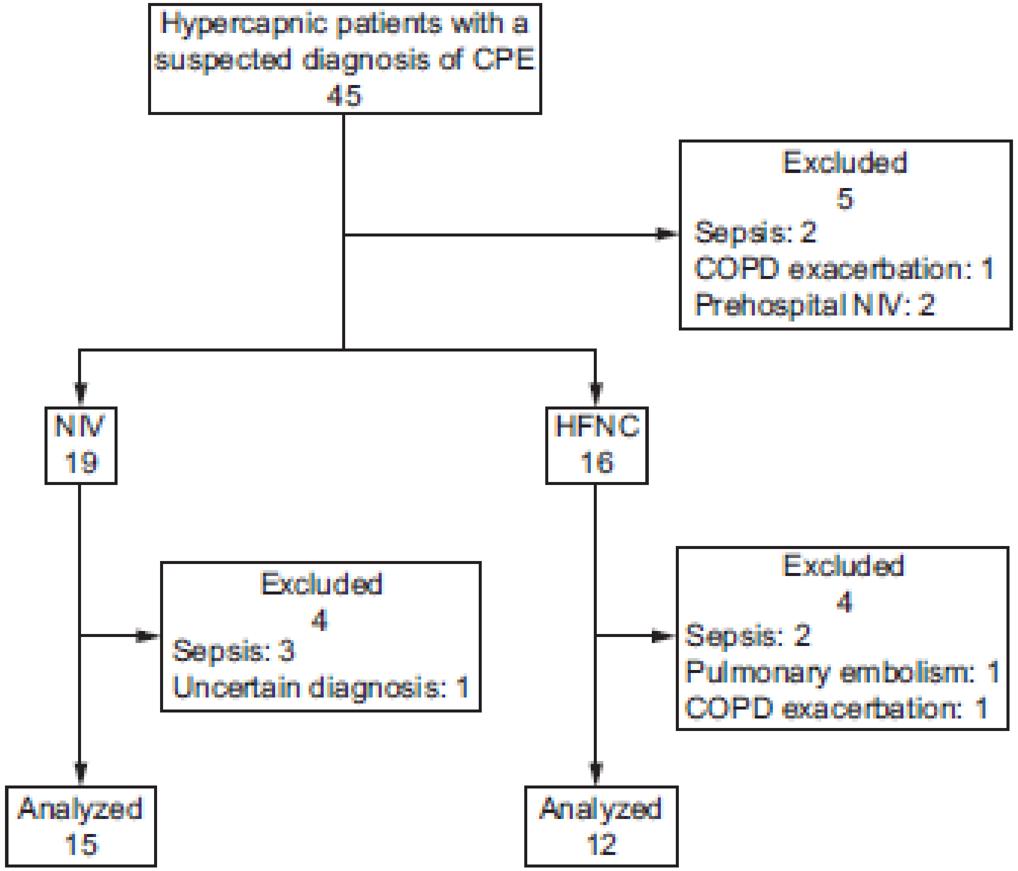
Variable	Total (n = 72)	Conventional O_2 Therapy Group	High-Flow Nasal Cannula Group	p-Value
	Mean ± SD or n (%)	(n = 33, 49.3%)	(n = 34, 50.7%)	
Respiratory rate (bpm)				
Initial	26.78 ± 3.99	25.18 ± 3.51	28.32 ± 3.86	0.001 *
30 min	23.75 ± 3.50	24.85 ± 3.19	22.68 ± 3.49	0.010 *
60 min	22.79 ± 3.72	24.30 ± 3.55	21.32 ± 3.32	0.001 *
SpO_2 (%)				
Initial	91.41 ± 5.89	92.55 ± 3.78	90.31 ± 7.29	0.120
30 min	95.69 ± 3.31	94.15 ± 3.26	97.18 ± 2.65	<0.001 *
60 min	95.94 ± 3.27	94.12 ± 3.25	97.71 ± 2.14	<0.001 *
Lactate (mmol/L)				
Initial	2.39 ± 2.02	2.01 ± 1.78	2.77 ± 2.20	0.126
60 min	1.82 ± 1.31	1.89 ± 1.55	1.75 ± 1.04	0.666
Echocardiography After ED visit				
Ejection fraction (%)	40.15 ± 13.12	40.36 ± 15.23	39.94 ± 10.92	0.896
Valve disease	18(26.87)	8(24.24)	10(29.41)	0.633
Intubation	2(2.99)	1(3.03)	1(2.94)	0.999
ICU admission	18(26.87)	8(24.24)	10(29.41)	0.633

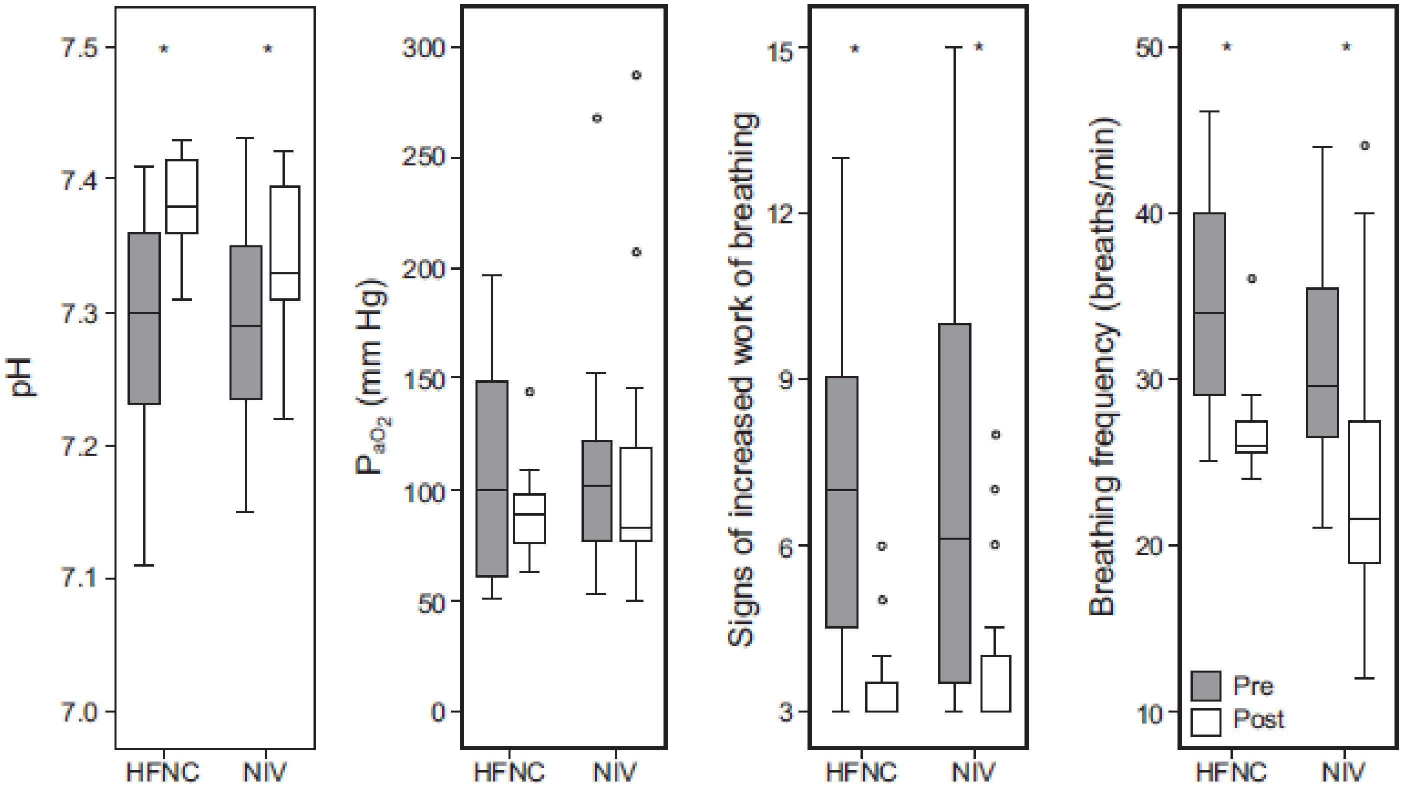




J Clin Med. 2020 Jun; 9(6): 1937.

High-Flow Nasal Cannula in Early Emergency Department Management of Acute Hypercapnic Respiratory Failure Due to Cardiogenic Pulmonary Edema





Respir Care . 2020 Sep;65(9):1241-1249

Open access Protocol

BMJ Open

Parallel-group, randomised, controlled, non-inferiority trial of high-flow nasal cannula versus non-invasive ventilation for emergency patients with acute cardiogenic pulmonary oedema: study protocol

ClinicalTrials.gov

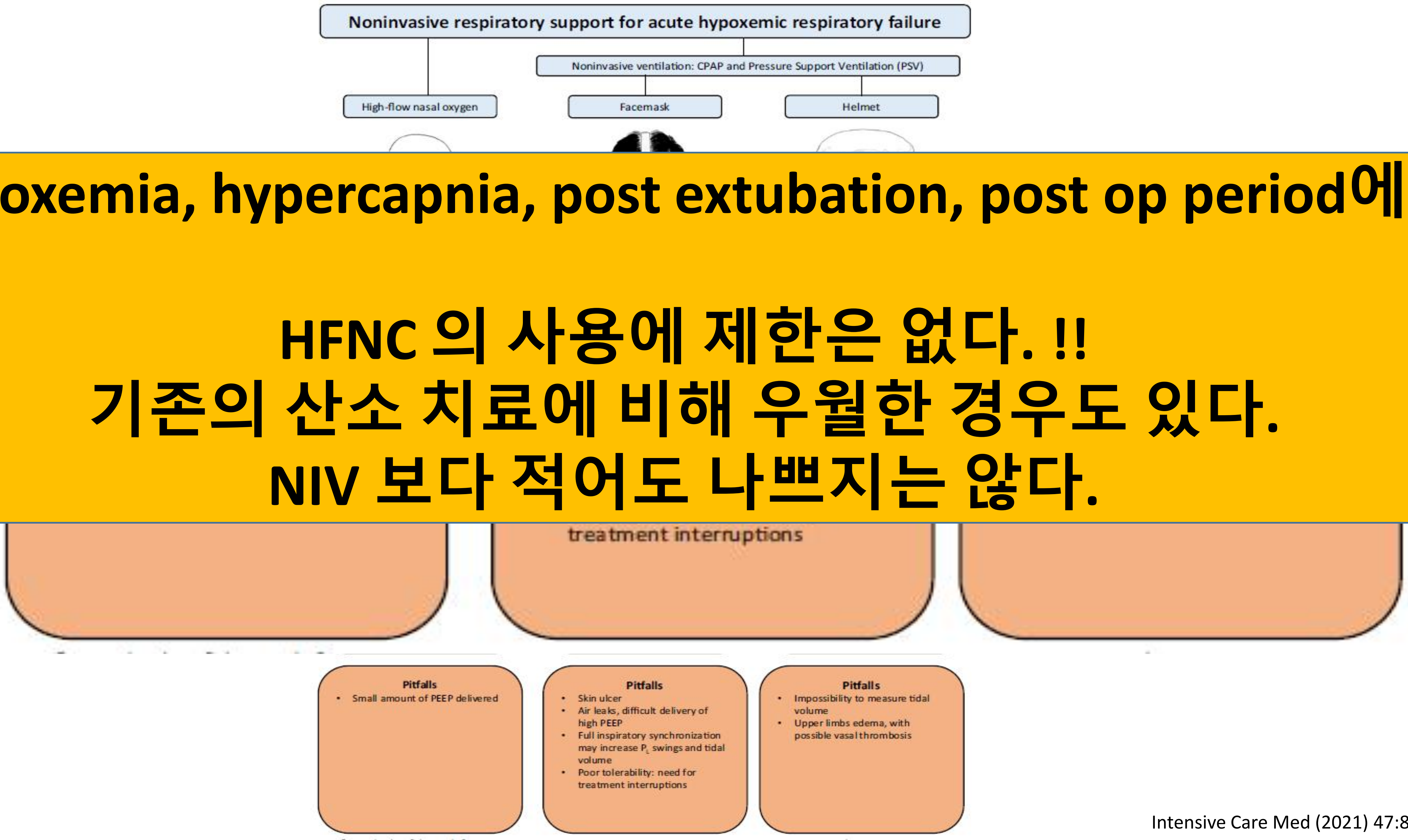
Home > Search Results > Study Record Detail

HIgh Flow Versus NIV for Acute Cardiogenic PuLmonary Oedema With Acute Respiratory Failure in an ED

The safety and scientific validity of this study is the responsibility of the study sponsor and investigators. Listing a study does not mean it has been evaluated by the U.S. Federal Government. Read our disclaimer for details.

ClinicalTrials.gov Identifier: NCT0497121З

Recruitment Status : Completed
First Posted : July 21, 2021
Last Update Posted : January 6, 2023



Hypoxemia, hypercapnia, post extubation, post op period에서

HFNC 의 사용에 제한은 없다. !!
기존의 산소 치료에 비해 우월한 경우도 있다.
NIV 보다 적어도 나쁘지는 않다.

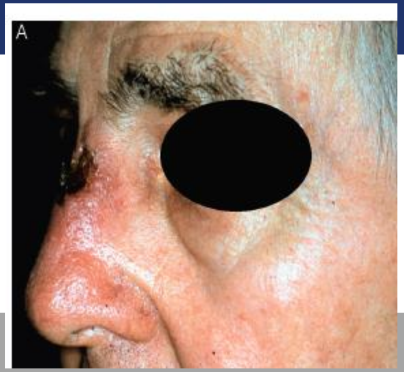
Intensive Care Med (2021) 47:851–866

- **Cost & insurance**
- **Compliance**
- **Difficulty**
- **Size**
- **Noise**

YONSEI UNIVERSITY

Complications of Noninvasive Ventilation in Acute Care

Peter C Gay MD



Nasal mask	
Mask discomfort	30–50%
Skin rash	10–20%
Nasal-bridge sores	5–10%
Nasal obstruction	Occasional
Oronasal mask	
Mask discomfort	30–50%
Claustrophobia	10–20%
Skin rash, nasal bridge sores	10–20%
More dead space	Depends on mask
Aspiration of vomit	Rare

Mouthpiece	
Discomfort	Common
Hypersalivation, salivary retention	Common
Aerophagia	Common
Pressure sores on lips, gums	Infrequent
Orthodontic problems	After prolonged use
Head straps	
Discomfort	10–30%
Unstable mask	Common with 2-strap system

Respir Care. 2009 Feb;54(2):246-57

	HFNC	NIV
보험 적용?	O	X
순응도	쉬움	어려움
적용 난이도?	쉬움	어려움
크기	작다	기계환기 + circuit + 가습기
소리	Flow 높을 수록 높음	그냥 큼, leak 에 따라 소리가
Complication	코피, 코막힘, 코내점막 상해, 불편감, 두통	불편감, 복부팽만, 흡인, 피부손상,barotrauma

값은 값이면 ? 다홍치마
호흡부전?→ 편하고, 쉽고, 넓은 적응증 → HFNC

Thank you for attention !!!