High Flow Nasal Cannula

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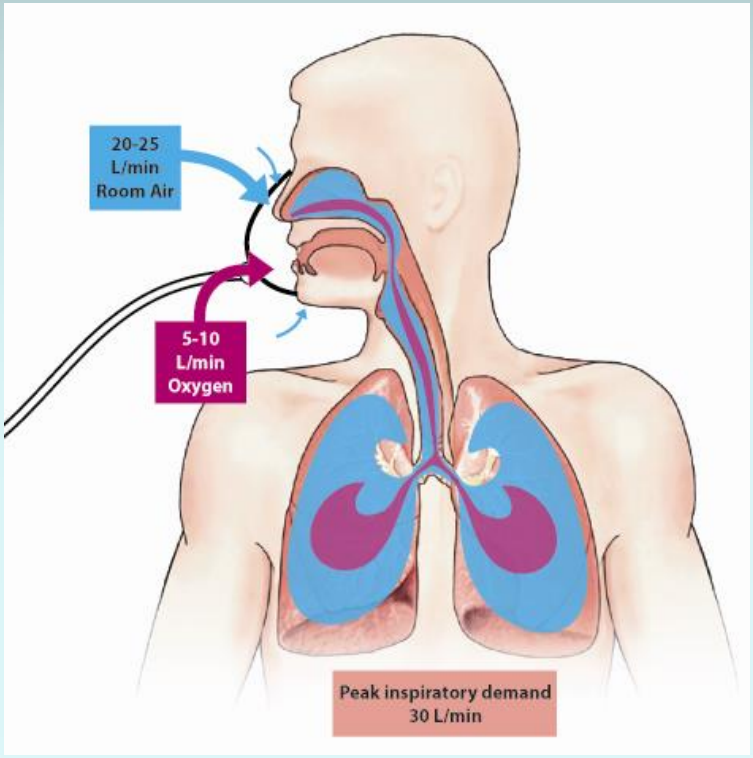
HFNC

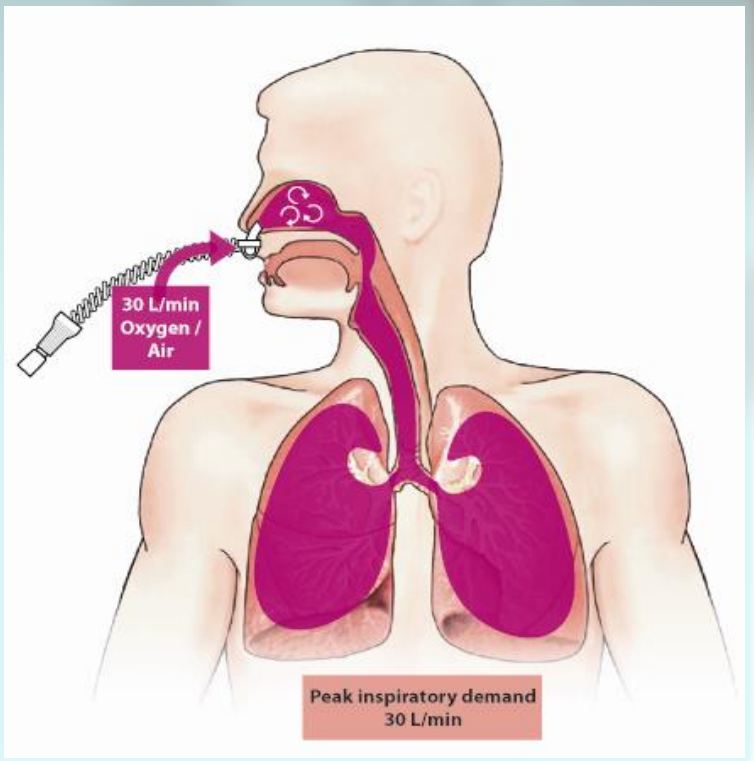
Comparison of oxygen delivery options:

	Nasal cannula	Optiflow™ Blender	Optiflow™ Blower
Flow	Up to 6 L/min	20-50 L/min	35 L/min
FiO_2	25-30 %	Up to 100 %	Up to 54 %
Humidification	No	37 °C, 44 mg/L	37 °C, 44 mg/L

Mechanism

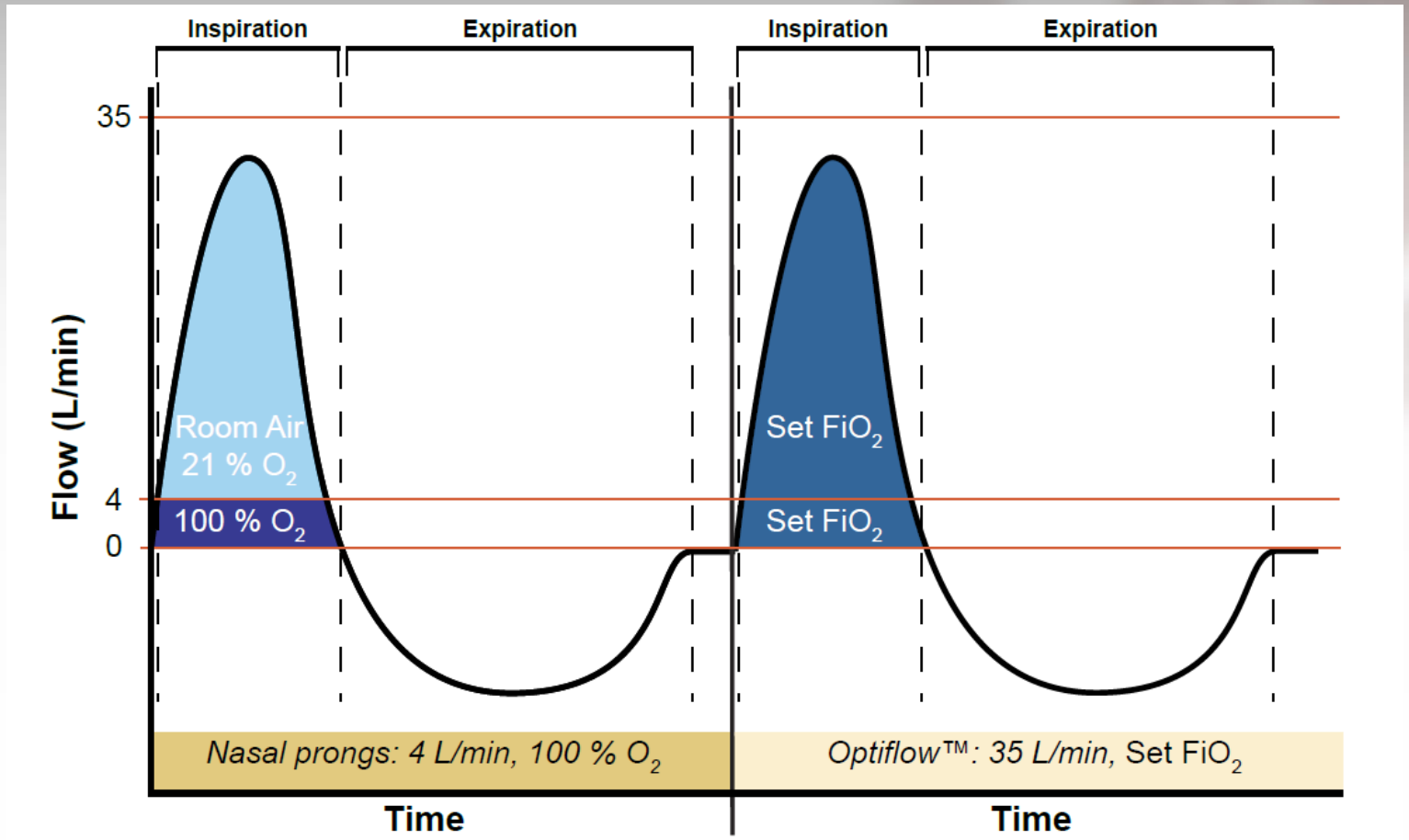


Simple Face Mask Example



Nasal High Flow

Mechanism



This graph illustrates two breaths, showing the flow of gas into the lung. (The peak inspiratory flow in this example is around 30 L/min).

Mechanism

BENEFITS OF HUMIDITY

Prevent reflex bronchoconstriction	Assist clearing secretions
Maintain secretion clearance	Improve comfort
Maximise mucociliary clearance	Improve compliance

Mechanism

Table 1 Demographics

	Group	Male	Female
Number	10	5	5
Age (years)	33.4 (4.1)	33.6 (4.4)	33.2 (3.8)
Height (cm)	174.1 (5.5)	178.4 (3.0)	169.9 (3.9)
Weight (kg)	78.3 (8.8)	80.1 (6.3)	76.4 (10.4)
BMI	25.8 (3.1)	25.1 (1.3)	26.6 (4.1)

Table 2 Expiratory pharyngeal pressure

	Nasal flow (L/min)				
	0	10	20	40	60
Mouth open (cmH_2O)					
Group	0.3 (0.3–0.5)	0.7 (0.6–0.9)	1.4 (1.3–1.8)[a]	2.2 (2.0–2.5)[a,b]	2.7 (2.4–3.1)[a]
Male	0.4 (0.2–0.6)	0.7 (0.6–0.9)	1.4 (1.0–1.8)[a]	2.0 (1.9–2.3)[a]	2.6 (2.3–2.7)[a]
Female	0.3 (0.3–0.4)	0.7 (0.6–1.0)	1.4 (1.3–1.8)[a]	2.3 (2.1–2.7)[a]	3.1 (2.6–3.9)[a]
Mouth closed (cmH_2O)					
Group	0.8 (0.5–1.3)	1.7 (1.2–2.3)	2.9 (2.2–3.7)[a,b]	5.5 (4.1–7.2)[a,b]	7.4 (5.4–8.8)[a]
Male	0.7 (0.2–1.0)	1.2 (1.0–1.6)	2.2 (2.0–2.9)[a]	4.1 (3.2–5.2)[a]	5.4 (5.0–6.0)[a]
Female	1.2 (0.5–1.7)	2.3 (1.9–2.6)	3.7 (2.9–4.0)[a]	7.2 (5.9–7.7)[a]	8.7 (7.7–9.7)[a]

[a] Significant adjusted *p*-value for comparison with zero flow.
[b] Significant adjusted *p*-value for comparison with previous flow rate.

Aust Crit Care 2007;20:126-31

Mechanism

Table 1. Main Characteristics of the Study Population

Patient	Sex	Age (*yr*)	SAPS II at ICU Admission	Number of Organs Dysfunction	Etiology of Acute Respiratory Failure	$Pa_{O_2}/setFI_{O_2}$ (*mm Hg*)	Bilateral Infiltrates on Chest Radiograph
1	M	60	40	2	Primary, infectious	119	No
2	M	55	36	2	Primary, infectious	134	Yes
3	M	53	34	3	Primary, infectious	193	No
4	F	43	26	1	Primary, infectious	97	No
5	F	66	56	2	Primary, infectious	121	Yes
6	M	68	43	1	Primary, infectious	107	Yes
7	M	47	33	2	Extrapulmonary, noninfectious	114	No
8	F	56	26	1	Primary, infectious	117	No
9	F	47	42	1	Primary, infectious	158	Yes
10	F	78	43	1	Primary, infectious	146	No
11	M	70	44	2	Extrapulmonary, noninfectious	171	No
12	M	49	51	1	Primary, infectious	68	Yes
13	M	95	26	1	Primary, infectious	83	Yes
14	M	47	35	1	Primary, infectious	144	Yes
15	F	74	48	1	Primary, infectious	180	No
Total or mean ± SD	6 F/9 M	60 ± 14	38 ± 9	1 ± 2	13 primary/2 extrapulmonary; 13 infectious/2 noninfectious	130 ± 35	7 yes/8 no

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Am J Respi Crit Care Med 2017;195:1207-15

Mechanism

Table 2. Effects of HFNC on Work of Breathing, Ventilation, Gas Exchange, and Hemodynamics

Variable	Oxygen Facial Mask	HFNC	
ΔPes, cm H_2O	9.9 ± 4.2	8.0 ± 3.4	<0.01
PTP, cm H_2O × s	9.5 (5.7 to 12.1)	7.4 (4.1 to 9.4)	<0.01
PTP_{min}, cm H_2O × s/min	216.3 ± 100.5	154.8 ± 84.8	<0.001
$P_{L,ee}$, cm H_2O	−10.1 ± 5.0	−7.5 ± 5.2	<0.001
$P_{L,ei}$, cm H_2O	−3.6 ± 4.9	−2.6 ± 4.5	0.16
ΔP_L, cm H_2O	5.7 ± 3.4	4.3 ± 2.9	0.08
RR, bpm	24 (20 to 27)	22 (17 to 24)	<0.01
V_T (change from facial mask), %	—	−5 ± 32	0.44
$V_{T_{non-dep}}$ (change from facial mask), %	—	3 ± 49	0.59
$V_{T_{dep}}$ (change from facial mask), %	—	−5 ± 33	0.54
Minute ventilation (change from facial mask), %	—	−19 ± 16	<0.001
Corrected minute ventilation (change from facial mask), %	—	−18 ± 15	<0.001
Set FI_{O_2}	0.60 (0.50 to 0.75)	0.60 (0.50 to 0.75)	1.00
Pa_{O_2}, mm Hg	72 (68 to 75)	98 (78 to 131)	<0.001
$Pa_{O_2}/setFI_{O_2}$, mm Hg	130 ± 35	184 ± 53	<0.001
Pa_{CO_2}, mm Hg	40.7 ± 5.7	41.1 ± 5.9	0.27
pH	7.45 ± 0.02	7.44 ± 0.03	0.23
SBP, mm Hg	141 ± 25	137 ± 27	<0.05
MAP, mm Hg	90 ± 15	88 ± 16	0.11
CVP, mm Hg	4.6 ± 5.2	5.8 ± 4.7	<0.05
HR, bpm	85 ± 9	84 ± 9	0.44

Work of breathing

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Am J Respi Crit Care Med 2017;195:1207-15

Mechanism

Table 3. Effects of HFNC on Lung Aeration, Homogeneity, and Respiratory Pattern

Variable	Oxygen Facial Mask	High-F Nasal Can	
$\Delta EELI_{glob}$ (change from facial mask), % of baseline V_T	—	51 ± 57	<0.001
$\Delta EELI_{non\text{-}dep}$ (change from facial mask), % of baseline V_T	—	29 ± 36	⩽0.001
$\Delta EELI_{dep}$ (change from facial mask), % of baseline V_T	—		
GI index	0.50 (0.49 to 0.57)	0.47 (0.43 to 0.60)	<0.01
PIF_{glob} (change from facial mask), %	—	−15 ± 23	0.07
PEF_{glob} (change from facial mask), %	—	−27 ± 22	⩽0.001
$PIF_{non\text{-}dep}$ (change from facial mask), %	—	−11 ± 29	0.29
PIF_{dep} (change from facial mask), %	—	−20 ± 19	<0.01
$PEF_{non\text{-}dep}$ (change from facial mask), %	—	−19 ± 32	0.07
PEF_{dep} (change from facial mask), %	—	−34 ± 18	<0.001
Ti, s	1.2 ± 0.2	1.2 ± 0.3	0.84
Te, s	1.3 ± 0.2	1.5 ± 0.6	<0.05
Ti/Ttot	0.5 ± 0.0	0.4 ± 0.0	<0.05

End expiratory lung volume

Global inhomogeneity index

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Am J Respi Crit Care Med 2017;195:1207-15

Hypoxic Respiratory Failure

Study	Setting	Inclusion Criteria	Outcomes
Azoulay, 2018	ICU	PaO2 < 60mmHg or SpO2 <90% on R/A, **immune-suppression**	Mortality (Primary), Need for MV, Escalation, ICU and hospital LOS comfort and dyspnea
Bell, 2015	ED	RR ≥ 25 breaths/min, SpO2 ≤ 93%	Need for IMV, escalation, comfort
Frat, 2015	ICU	ARF with RR > 25 breaths/min, PF ≤ 300, on ≥ 10 L/min O2 for ≥ 15 min	Mortality (primary), need for IMV, e scalation, ICU LOS, comfort
Jones, 2016	ED	SpO2 ≤ 92% on R/A, RR ≥ 22 breaths/min	Mortality, need for IMV, escalation (primary), hospital LOS
Lemiale, 2015	ICU	**immune-compromised**, > 6 L/min O2 to maintain SpO2 > 95% or respiratory distress	Need for IMV, escalation (primary) , dyspnea, comfort
Makdee, 2017	ED	SpO2 < 95% on R/A, RR >24 breaths/min	Mortality, need for IMV, escalation, hospital LOS, dyspnea, comfort
Parke, 2011	ICU	≥ 4 L/min O2 via NP for > 4 h or ≥ 6 L/min O2 via a face mask for > 2 h and/or RR ≥ 25 breaths/min and/or ↑ WOB	Escalation
Rittayam, 2015	ED	RR > 24 breaths/min, SpO2 < 94% on R/A	Need for IMV, escalation, dyspnea (primary), comfort
Schwabbauer, 2014	ICU	PaO2 < 55mmHg on R/A	Dyspnea and comfort

Hypoxic Respiratory Failure

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)

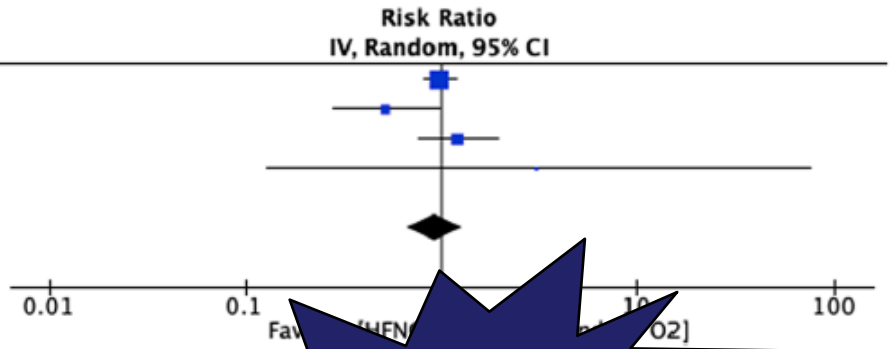

Fig. 2 Mortality forest plot

1.6%

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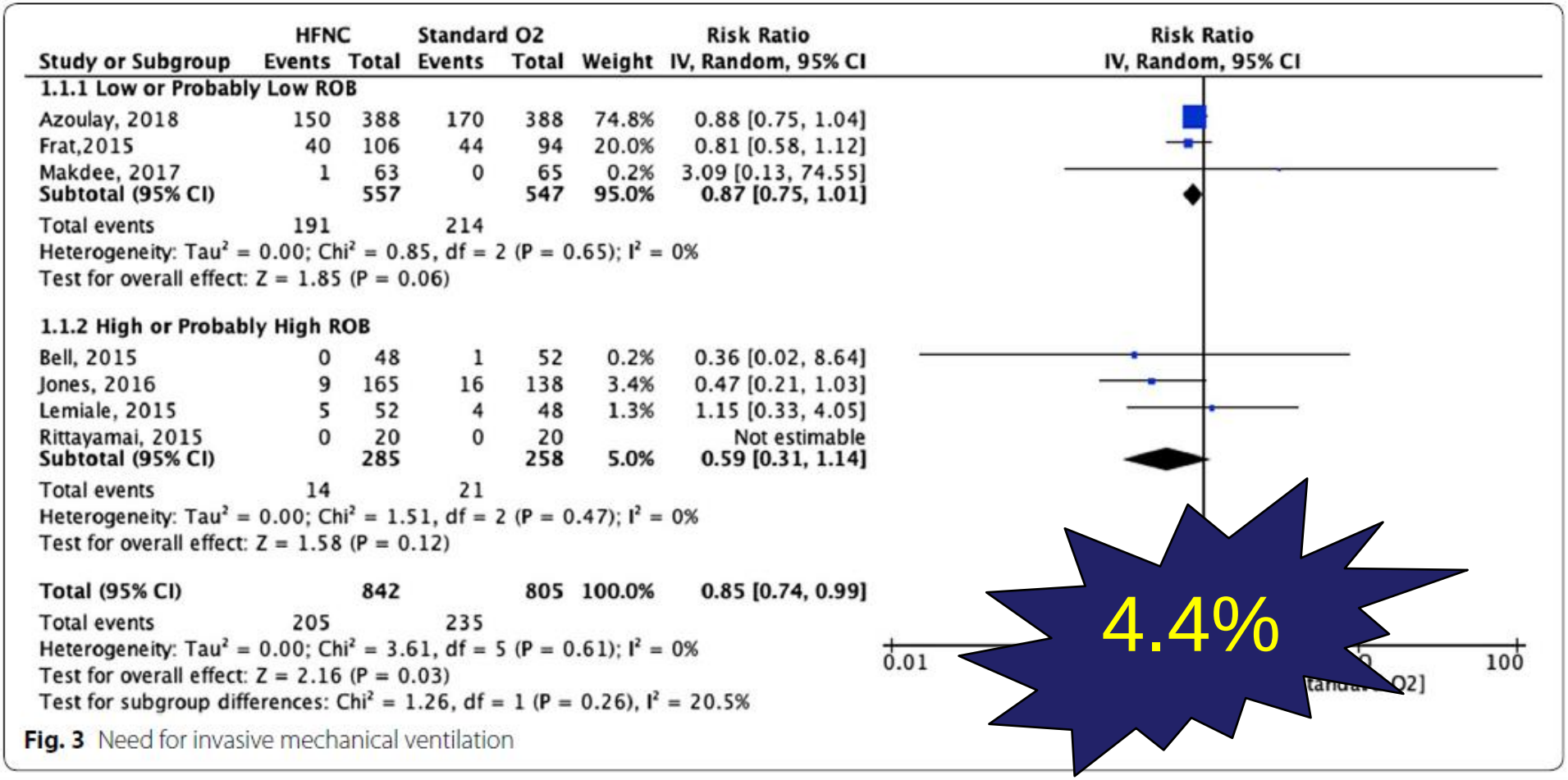
Intensive Care Med 2019;45:563-72

Hypoxic Respiratory Failure



Study or Subgroup	HFNC Events	HFNC Total	Standard O2 Events	Standard O2 Total	Weight	Risk Ratio IV, Random, 95% CI
1.1.1 Low or Probably Low ROB						
Azoulay, 2018	150	388	170	388	74.8%	0.88 [0.75, 1.04]
Frat,2015	40	106	44	94	20.0%	0.81 [0.58, 1.12]
Makdee, 2017	1	63	0	65	0.2%	3.09 [0.13, 74.55]
Subtotal (95% CI)		**557**		**547**	**95.0%**	**0.87 [0.75, 1.01]**
Total events	191		214			
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.85$, df = 2 (P = 0.65); $I^2 = 0\%$						
Test for overall effect: Z = 1.85 (P = 0.06)						
1.1.2 High or Probably High ROB						
Bell, 2015	0	48	1	52	0.2%	0.36 [0.02, 8.64]
Jones, 2016	9	165	16	138	3.4%	0.47 [0.21, 1.03]
Lemiale, 2015	5	52	4	48	1.3%	1.15 [0.33, 4.05]
Rittayamai, 2015	0	20	0	20		Not estimable
Subtotal (95% CI)		**285**		**258**	**5.0%**	**0.59 [0.31, 1.14]**
Total events	14		21			
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 1.51$, df = 2 (P = 0.47); $I^2 = 0\%$						
Test for overall effect: Z = 1.58 (P = 0.12)						
Total (95% CI)		**842**		**805**	**100.0%**	**0.85 [0.74, 0.99]**
Total events	205		235			
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 3.61$, df = 5 (P = 0.61); $I^2 = 0\%$						
Test for overall effect: Z = 2.16 (P = 0.03)						
Test for subgroup differences: $Chi^2 = 1.26$, df = 1 (P = 0.26), $I^2 = 20.5\%$						

Fig. 3 Need for invasive mechanical ventilation

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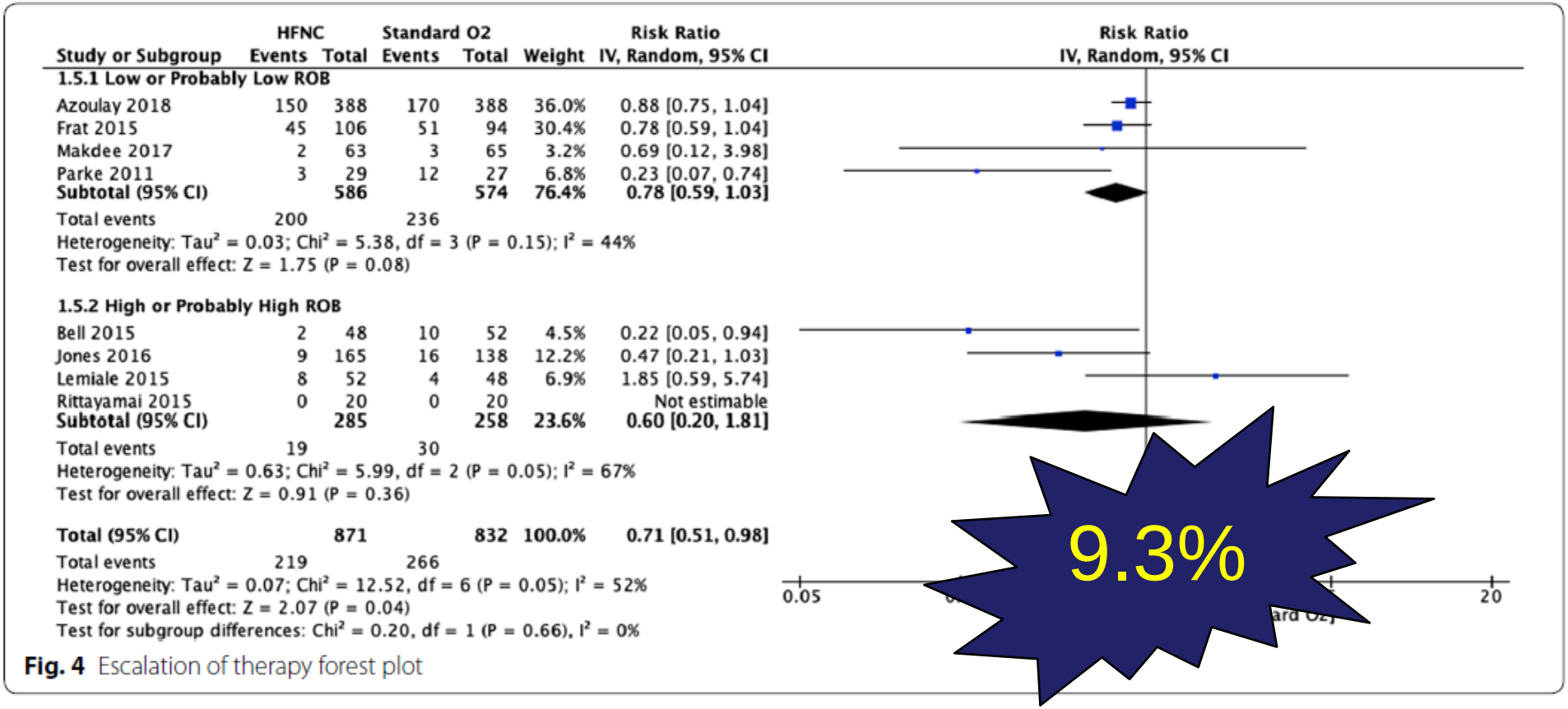
Hypoxic Respiratory Failure



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), $I^2 = 0\%$						

Risk Ratio IV, Random, 95% CI

0.05 20

9.3%

Fig. 4 Escalation of therapy forest plot

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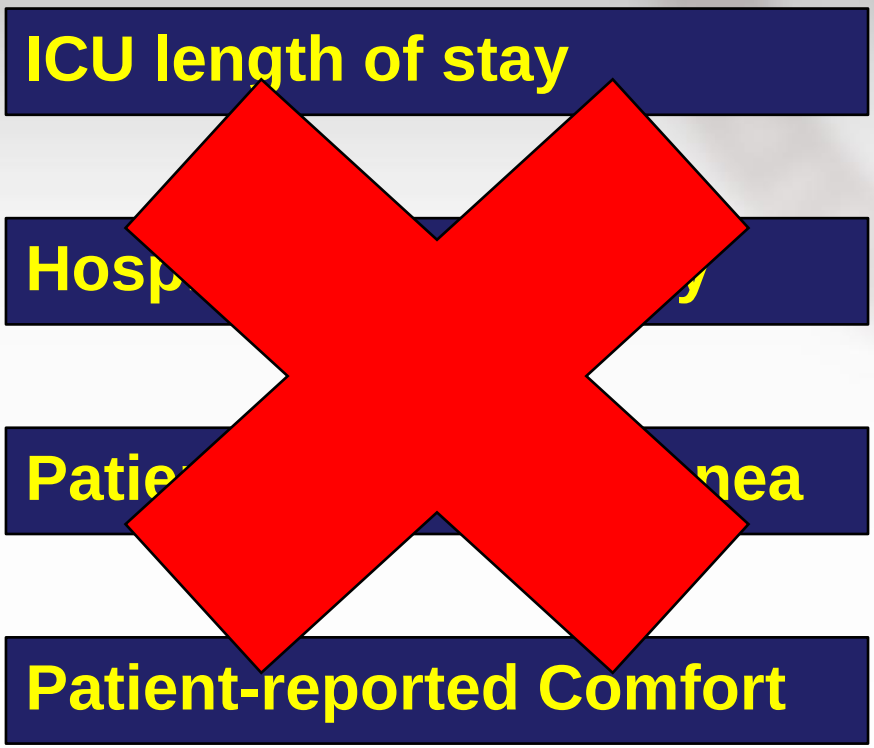
Hypoxic Respiratory Failure



Intensive Care Med 2019;45:563-72

Rox Index

ROX index= (Sp_{O2}/Fi_{O2})/RR

Table 1
Baseline characteristics of the study population at ICU admission

	HFNC success (113)	HFNC failure (44)	P^*
Sex (male)	74 (65.5%)	21 (50%)	.079
Age	52 (40-66)	53 (37-66)	.977
Comorbidities			
Immunosuppression	38 (33.6%)	16 (36.4%)	.852
Chronic heart failure	11 (9.7%)	5 (11.4%)	.773
Chronic liver disease	6 (5.4%)	3 (6.8%)	.714
Chronic respiratory disease	38 (33.6%)	7 (15.9%)	.031
Chronic renal failure	6 (5.4%)	2 (4.5%)	1.000
Type of pneumonia			.042
Bacterial			
Community acquired	93 (82.3%)	29 (65.9%)	
Health care related	13 (11.5%)	7 (15.9%)	
Viral pneumonitis	7 (6.2%)	8 (18.2%)	
PSI	107 (82-137)	118 (81-144)	.254
APACHE II of 24 h ICU admission	13 (10-17)	16 (10-20)	.252
SOFA ICU admission	4 (3-6)	6 (3-7)	.014
No. of affected quadrants on chest x-ray	2 (2-4)	3 (3-4)	.020

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J Crit Care 2016;35:200-5

ROX Index

Table 3
Diagnostic accuracy of different respiratory variables at different time points of need for MV in patients treated with HFNC

	Variable	AUROC	95% CI	*P*
12 h	Spo_2/Fio_2	0.71	0.61-0.82	<.001
	RR (beats per minute)	0.64	0.54-0.75	.018
	Flow (L/min)	0.58	0.46-0.69	.213
	ROX index	0.74	0.64-0.84	<.001
18 h	Spo_2/Fio_2	0.72	0.61-0.83	.001
	RR (beats per minute)	0.77	0.67-0.88	<.001
	Flow (L/min)	0.60	0.48-0.72	.120
	ROX index	0.83	0.74-0.92	<.001
24 h	Spo_2/Fio_2	0.82	0.73-0.92	<.001
	RR (beats per minute)	0.73	0.61-0.84	.003
	Flow (L/min)	0.59	0.47-0.72	.136
	ROX index	0.87	0.77-0.96	<.001

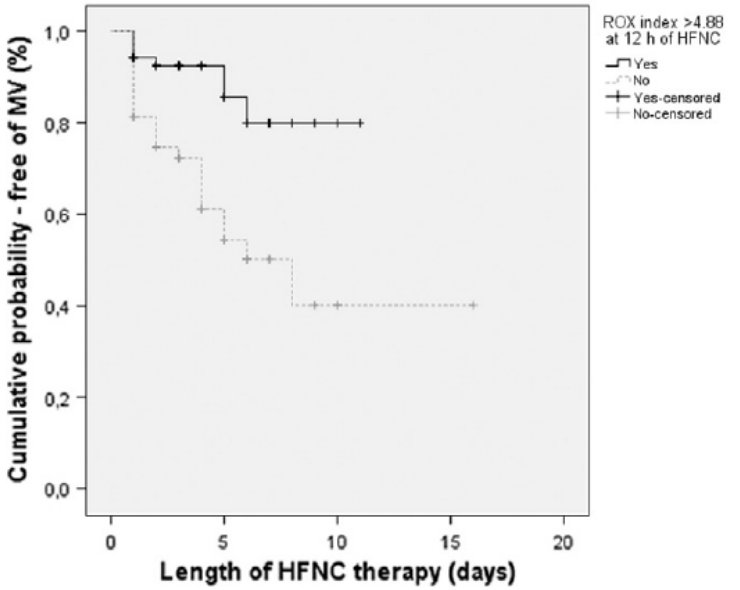

Fig. 1. Kaplan-Meier plot showing the cumulative probability of remaining free of intubation and MV in patients with pneumonia treated with HFNC therapy.

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J Crit Care 2016;35:200-5

ROX Index

Table 4
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

J Crit Care 2016;35:200-5

ROX Index

Table 1. Baseline Characteristics of the Validation Cohort (2016–2017) Comparing Success and Failure Patients

	Success (*n* = 123)	Failure (*n* = 68)	*P* Value
Sex, male, *n* (%)	76 (61.8)	42 (61.8)	0.997
Age, yr	64 (52–73)	60 (52–71)	0.412
Comorbidities, *n* (%)			
Immunosuppression	32 (26.0)	28 (41.2)	0.031
Chronic heart failure	26 (21.1)	14 (20.6)	0.929
Chronic liver disease	13 (10.6)	3 (4.4)	0.141
Chronic respiratory disease	45 (36.6)	24 (35.6)	0.859
Chronic renal failure	9 (7.3)	6 (8.8)	0.711
Type of pneumonia, *n* (%)			0.177
Bacterial			
Community acquired	78 (63.4)	34 (50.0)	
Health care related	31 (25.2)	25 (36.8)	
Viral pneumonitis	14 (11.4)	9 (13.2)	
Pneumonia severity index	112 (74–153)	121 (94–146)	0.445
APACHE II of 24-h ICU admission	16 (11–21)	18 (14–21)	0.140
SOFA score at ICU admission	5 (2–8)	4 (3–7)	0.198
NIV requirement, *n* (%)	6 (4.9)	4 (5.9)	0.746
Number of quadrants affected on chest X-ray	2.5 (2–4)	3 (2–4)	0.095

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Am J Respi Crit Care Med 2019;199:1368-76

ROX Index

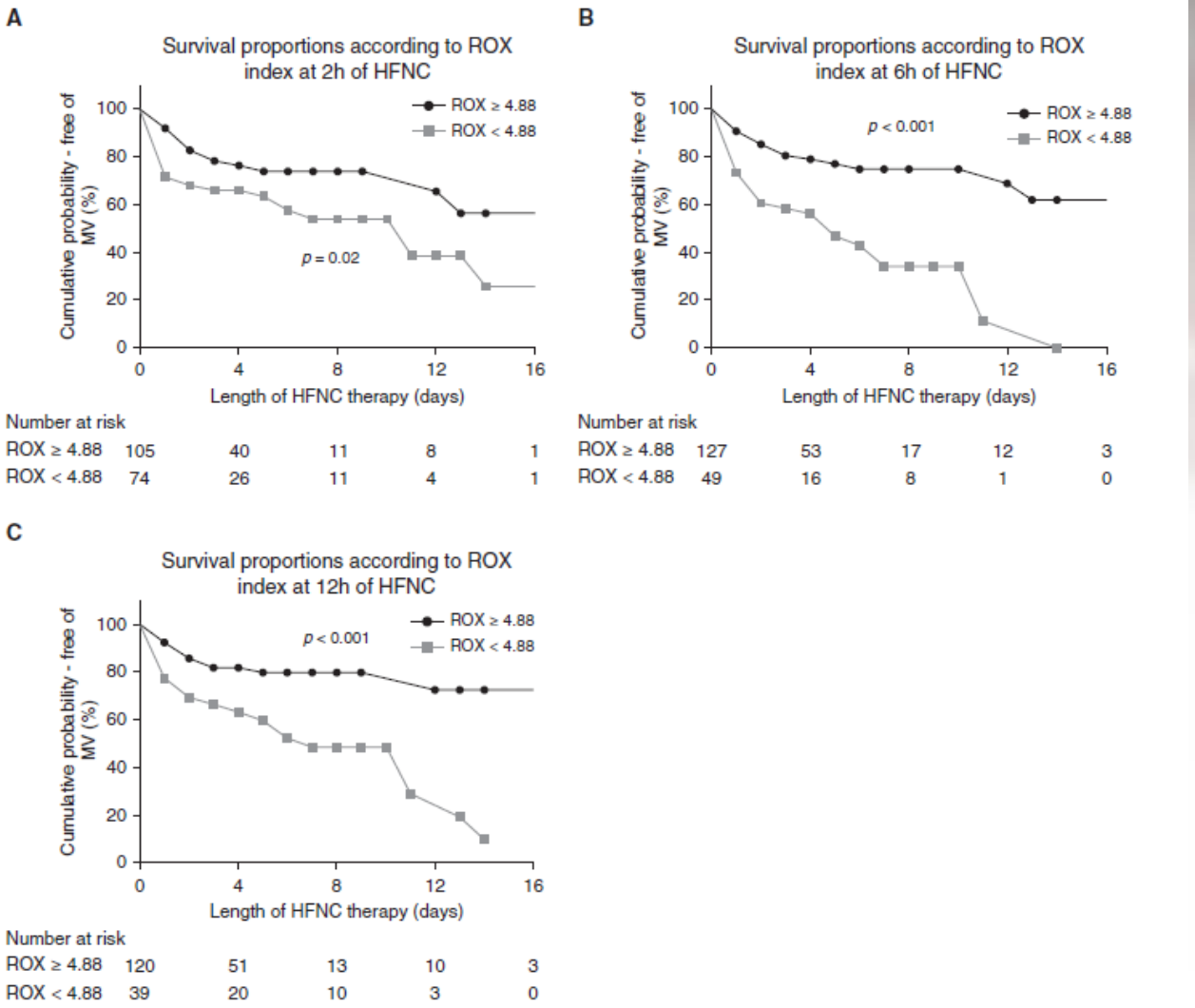

Figure 1. Kaplan-Meier plots showing the probability of mechanical ventilation according to the ROX group at (*A*) 2 hours, (*B*) 6 hours, and (*C*) 12 hours after high-flow nasal cannula onset. HFNC = high-flow nasal cannula; MV = mechanical ventilation.

Am J Respi Crit Care Med 2019;199:1368-76

ROX Index

Table 4. Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, Likelihood Positive Ratio, and Likelihood Negative Ratio of ROX Index ⩾4.88 at Different Time Points in the Validation and Training Cohorts

		Se (%)	Sp (%)	PPV (%)	NPV (%)	LR+	LR−
2 h	Validation	69.6	60.0	75.5	52.7	1.74	0.51
	Training	37.1	73.8	76.6	33.7	1.41	0.85
6 h	Validation	83.8	50.0	76.6	61.2	1.68	0.32
	Training	50.5	60.0	76.6	31.8	1.26	0.82
12 h	Validation	86.8	52.2	81.8	61.5	1.82	0.25
	Training	70.1	72.4	89.4	42.0	2.54	0.41
18 h	Validation	87.7	47.4	83.3	56.2	2.00	0.22
	Training	81.0	66.7	88.9	51.6	2.43	0.28
24 h	Validation	89.1	42.9	83.1	55.6	1.56	0.25
	Training	80.7	72.2	93.1	44.8	2.90	0.27

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Am J Respi Crit Care Med 2019;199:1368-76

ROX Index

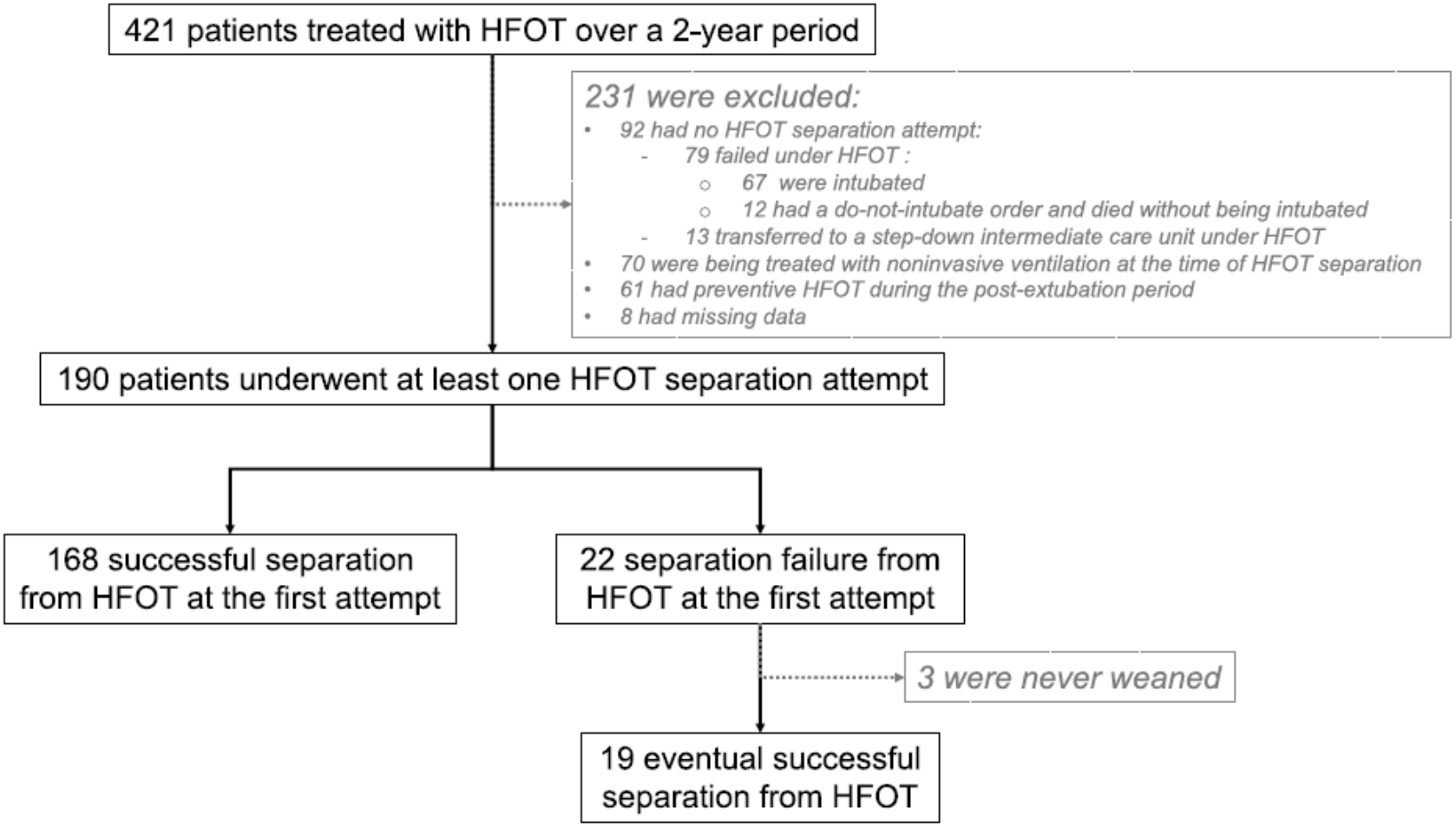

Fig. 1 Flow chart of patients included over the study period

Ann Intensive Care 2019;9:101

ROX Index

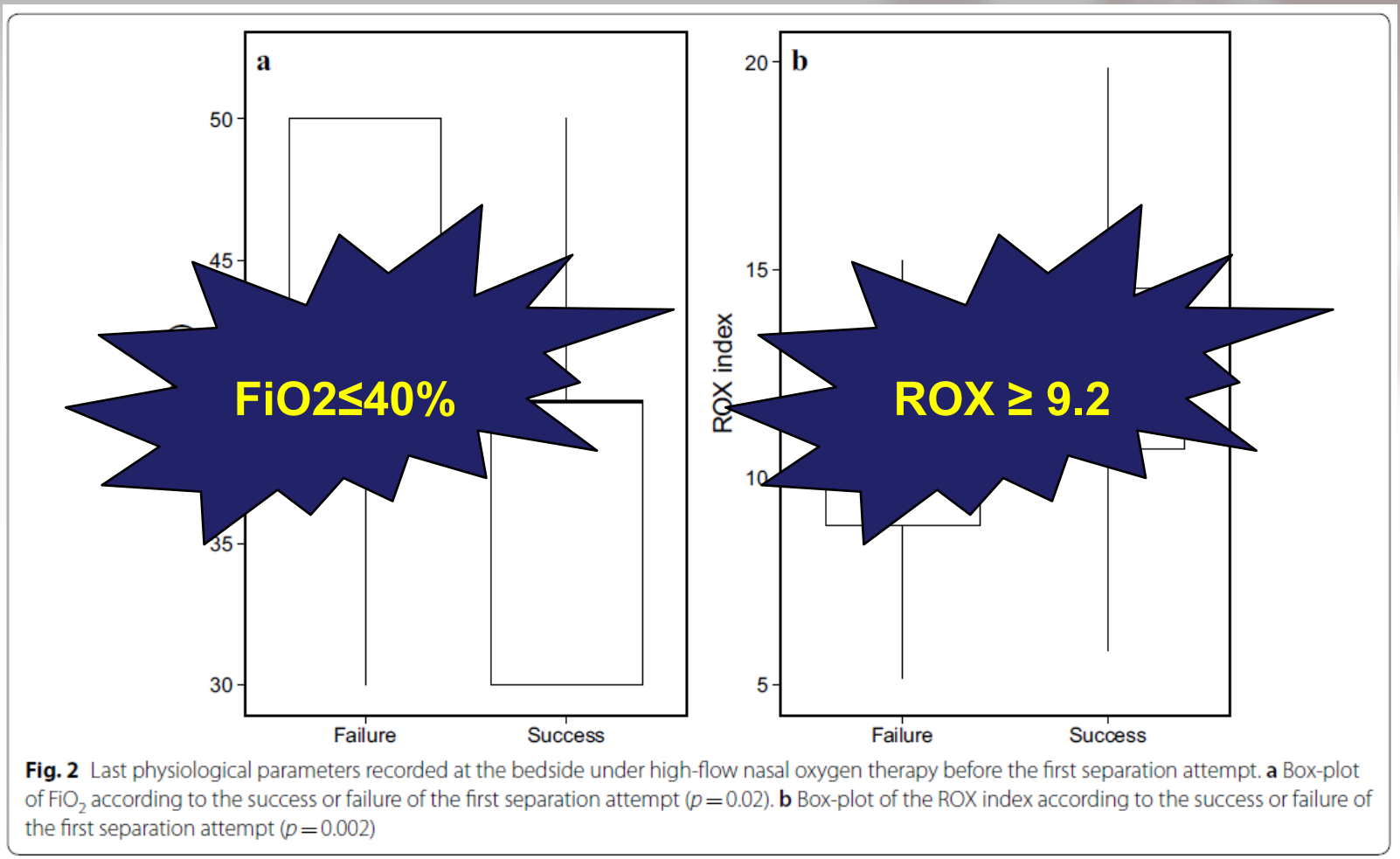

Fig. 2 Last physiological parameters recorded at the bedside under high-flow nasal oxygen therapy before the first separation attempt. **a** Box-plot of FiO_2 according to the success or failure of the first separation attempt ($p = 0.02$). **b** Box-plot of the ROX index according to the success or failure of the first separation attempt ($p = 0.002$)

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Ann Intensive Care 2019;9:101

Hypercapnic Respiratory Failure

TABLE 2 Clinical, laboratory and functional parameters between HFNC and NIV groups

Variables	Total (n = 88)	HFNC (n = 44)	NIV (n = 44)	P value
Clinical, median (IQR)				
Mean BP (mm Hg)	92.3 (79.5–108.7)	90.5 (79.2–101.0)	99.5 (81.7–113.7)	.242
PR (beats/minute)	106.5 (93.25–120)	106 (89.5–119.5)	106.5 (94.5–120)	.277
RR (1/minute)	24 (20.5–28)	24 (20–28)	24 (22–29)	.235
Laboratory, mean ± SD[a]				
Oxygen saturation (%)	89.1 ± 3.1	88.9 ± 3.0	88.2 ± 3.2	.660
pH	7.32 ± 0.03	7.32 ± 0.28	7.31 ± 0.29	.595
PaO_2/FiO_2 (mm Hg)	134.6 ± 7.4	134.8 ± 7.3	134.5 ± 7.5	.877
$paCO_2$ (mm Hg)	54.5 ± 9.6	56.4 ± 10.1	52.6 ± 8.8	.067
Hb (g/dL)	12.7 ± 2.2	12.5 ± 2.5	12.9 ± 1.7	.342
Albumin (g/dL)	3.4 ± 0.5	3.4 ± 0.5	3.4 ± 0.5	.983
hs-CRP (mg/dL)	8.6 ± 8.5	8.9 ± 8.0	8.2 ± 9.0	.678
Functional (before an admission)				
FEV_1 (%)	51.0 ± 18.9	52.8 ± 21.2	49.1 ± 16.3	.364
FVC (%)	72.0 ± 20.4	73.8 ± 21.1	70.3 ± 19.7	.418
FEV_1/FVC (%)	49.9 ± 13.2	49.1 ± 13.4	50.6 ± 13.1	.591
$FEF_{25\%-75\%}$	28.4 ± 21.6	26.8 ± 22.3	29.9 ± 21.0	.508

Clin Respir J 2018;12:2046-56

Hypercapnic Respiratory Failure

TABLE 3 Primary and secondary outcomes between HFNC and NIV groups

Outcomes, *n* (%)	HFNC (*n* = 44)	NIV (*n* = 44)	*P* value	HR (or OR) (95% CI)
Intubation rate at day 30[a]	11 (25.0)	12 (27.3)	.857	0.927 (0.409–2.102)
30-Day mortality[a]	7 (15.9)	8 (18.2)	.845	0.904 (0.328–2.493)
Duration of device application, days, median (IQR)	7.0 (5–10)	8.0 (6–10)	.978	0.822 (–1.657–1.611)
Cause of mortality				
Pneumonia	4/7 (57.1)	3/8 (37.5)	.694	
Severe AECOPD	2/7 (28.6)	5/8 (62.5)	.434	
Sepsis	1/7 (14.3)	0/8 (0.0)	1.000	

Clin Respir J 2018;12:2046-56

Hypercapnic Respiratory Failure

Table 1 Baseline characteristics of enrolled patients

Characteristics	Total(n=82)	HFNC(n=39)	NIV(n=43)	*P*-value
Male, n(%)	54(65.9)	24(61.5)	30(69.8)	0.645
Age, years	71.8±8.2	73.2±9.0	70.4±7.4	0.130
History of COPD, years	8 (6–11)	9(6–12)	8(6–10)	0.216
Comorbidities, n(%)				
Diabetes Mellitus	22(26.8)	9(23.1)	13(30.2)	0.824
Hypertension	46(56.1)	21(53.8)	25(58.1)	0.696
Coronary artery disease	36(43.9)	17(43.6)	19(44.2)	1.0
Chronic liver disease	7(8.5)	4(10.3)	3(7.0)	0.703
Chronic kidney disease	22(26.8)	9(23.1)	13(30.2)	0.618
Cerebrovascular disease	13(15.9)	7(17.9)	6(14.0)	0.764
Malignancy	9(11.0)	4(10.3)	5(11.6)	1.0
Medication before an exacerbation, n(%)				
Inhaled corticosteroids	27(32.9)	12(30.8)	15(34.9)	0.815
Beta adrenoceptor agonist	33(40.2)	16(41.0)	17(39.5)	1.0
Anticholinergics	16(19.5)	8(20.5)	8(18.6)	1.0
Lung function test before an exacerbation (n=49)*				
FEV_1,%	46.8±15.2	47.7±15.9	45.9±14.9	0.682
FEV_1/FVC,%	45.5±11.3	46.0±11.1	45.2±11.6	0.806
Mean length from the acute attack to the admission to the ICU, days	5(3–7)	4(2–6)	5(3–7)	0.224
On admission to ICU				
APACHE II score	17.8±3.1	18.4±2.7	17.3±3.4	0.126
SAPS II score	33.4±6.1	34.8±5.9	32.2±6.0	0.053
Arterial pH	7.31(7.29–7.33)	7.31(7.29–7.33)	7.30(7.28–7.32)	0.106
Oxygen saturation, %	89(86–91)	89(84–91)	89(87–90)	0.514
$PaCO_2$, mm Hg	58(54–62)	56(53–62)	59(55–62)	0.088
Mean arterial pressure, mm Hg	89.2±6.7	88.3±5.9	90.0±7.4	0.251
Heart rate, beats/min	103.1±10.9	102.2±10.7	103.9±11.2	0.491
Respiratory frequency,/min	27.5±3.5	28.1±3.3	27.0±3.5	0.142
PaO_2/FiO_2, mm Hg	139.2±6.7	138.2±6.6	140.1±6.6	0.189
With pneumonia, n(%)	34(41.4)	14(35.9)	20(46.5)	0.375

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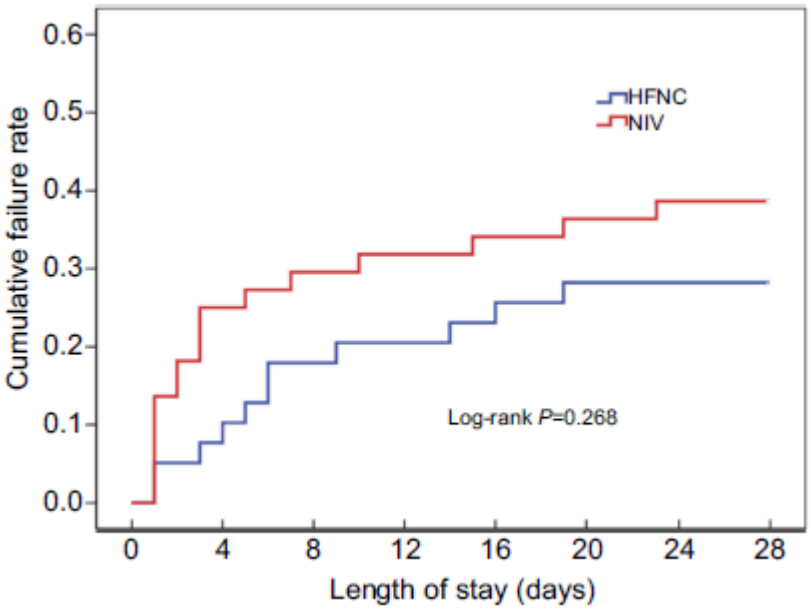
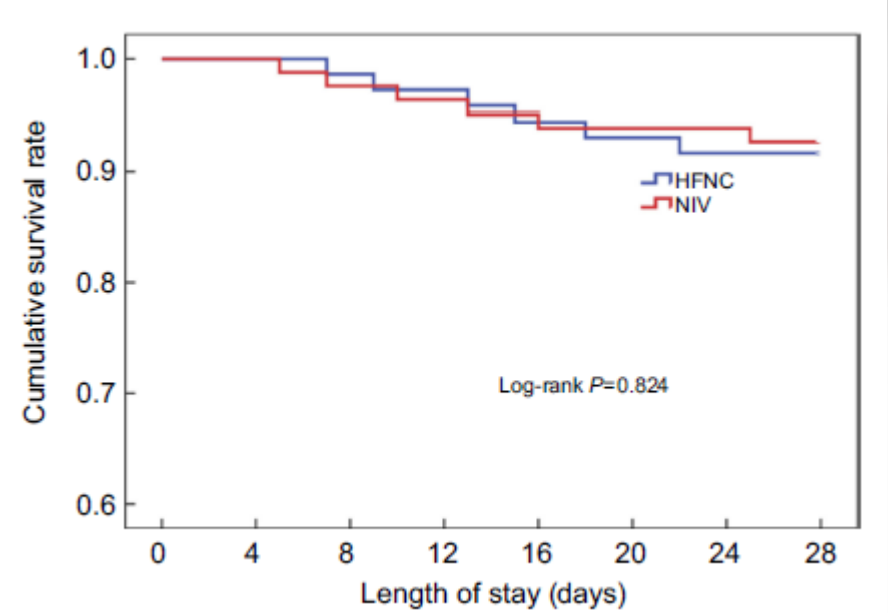
Int J Chron Obstruct Pulmo Dis 2019;14:1229-37

Hypercapnic Respiratory Failure





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Int J Chron Obstruct Pulmo Dis 2019;14:1229-37

Hypercapnic Respiratory Failure

Table 2 Outcomes between the HFNC and NIV groups

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

Table 3 Analysis of treatment failure in the HFNC and NIV groups

	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

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Int J Chron Obstruct Pulmo Dis 2019;14:1229-37

Hypercapnic Respiratory Failure

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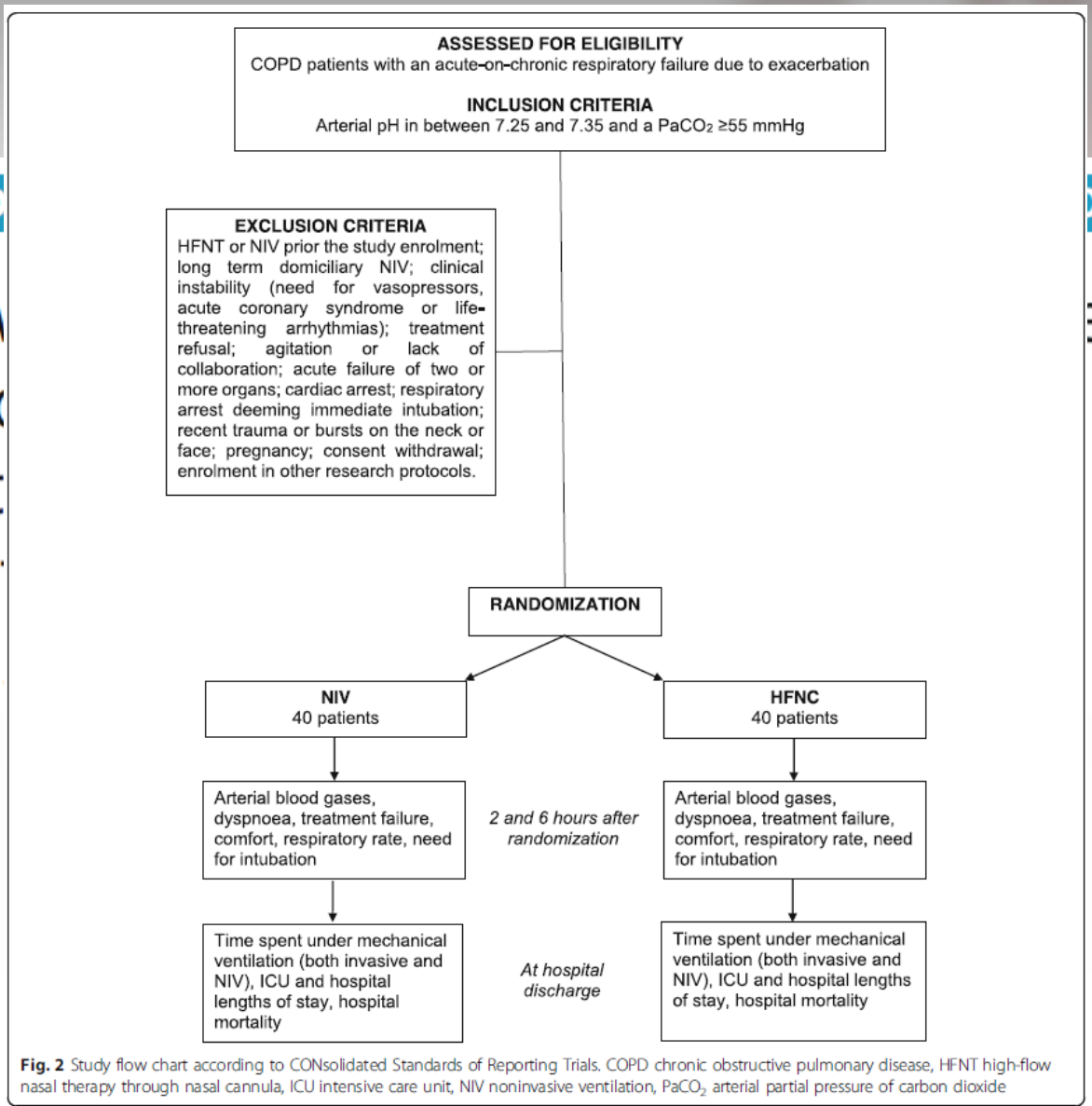

Fig. 2 Study flow chart according to CONsolidated Standards of Reporting Trials. COPD chronic obstructive pulmonary disease, HFNT high-flow nasal therapy through nasal cannula, ICU intensive care unit, NIV noninvasive ventilation, $PaCO_2$ arterial partial pressure of carbon dioxide

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Trials 2019;20:450

Post-extubation

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

A Randomized Clinical Trial

- ✓ Age <65
- ✓ Absence of heart failure
- ✓ Absence of moderate-to-severe COPD
- ✓ APACHE II score <12
- ✓ BMI<30
- ✓ Absence of airway patency problems
- ✓ Ability to manage respiratory secretions
- ✓ Simple weaning
- ✓ Comorbidities<2
- ✓ No prolonged mechanical ventilation

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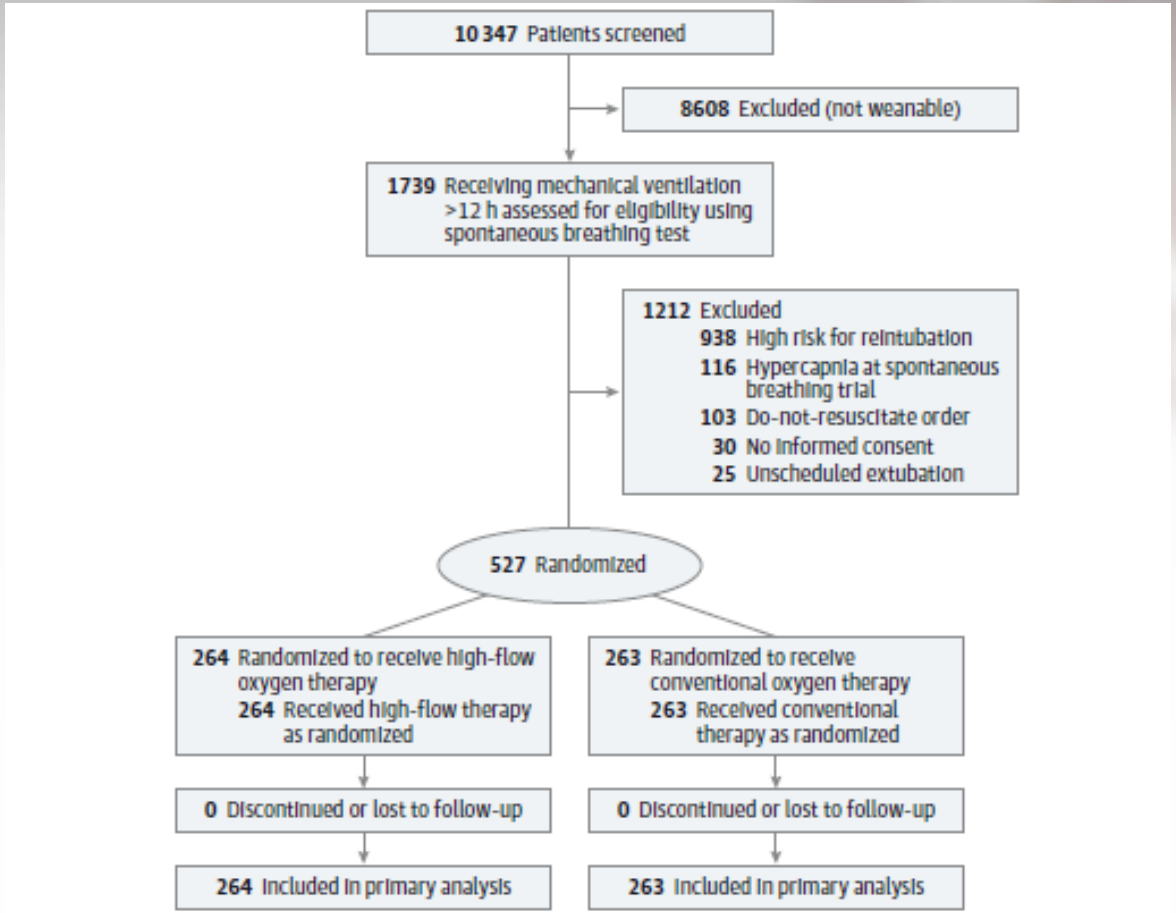
JAMA 2016;315:1354-61

Post-extubation



JAMA 2016;315:1354-61

Post-extubation

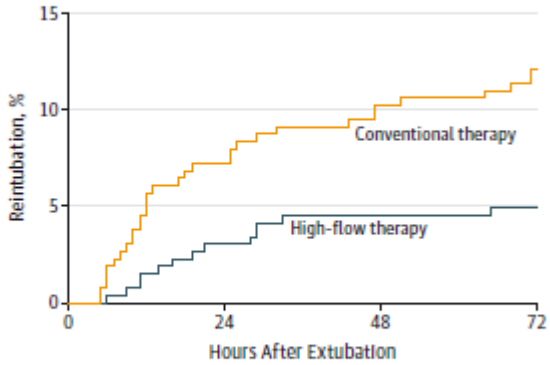
Table 2. Primary and Secondary Outcomes

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]

Table 3. Exploratory Outcomes and Between-Group Differences in Physiologic Variables

	Oxygen Therapy: High-Flow (n = 264)	Oxygen Therapy: Conventional (n = 263)	Difference Between Groups (95% CI)	*P* Value
Exploratory Outcomes, No. (%)				
Respiratory-causes reintubation[a]	4 (1.5)	23 (8.7)	7.2 (3.6 to 11.4)	.001[b]
Immediate postextubation stridor	2 (0.9)	9 (4.1)	2.7 (0.1 to 5.7)	.04[c]
Laryngeal edema requiring reintubation[a]	0	7 (3.1)	2.7 (0.7 to 5.4)	.001[c]
Physiologic Variables, Mean (SD)				
Fio_2 12 h after extubation	0.32 (0.08)	0.4 (0.09)	−0.08 (−0.09 to −0.07)	<.001[d]
High-flow oxygen therapy 12 h after extubation, L/min	30.9 (7.6)	NA	NA	NA
Pao_2:Fio_2, mm Hg[e]	105 (32)	108 (34)	−3 (−9 to 3)	.57
$Paco_2$, mm Hg[e]	37 (8)	36 (6)	1 (−0.2 to 2.2)	.84
Arterial pH[e]	7.37 (0.3)	7.4 (0.4)	−0.3 (−0.09 to 0.03)	.49

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



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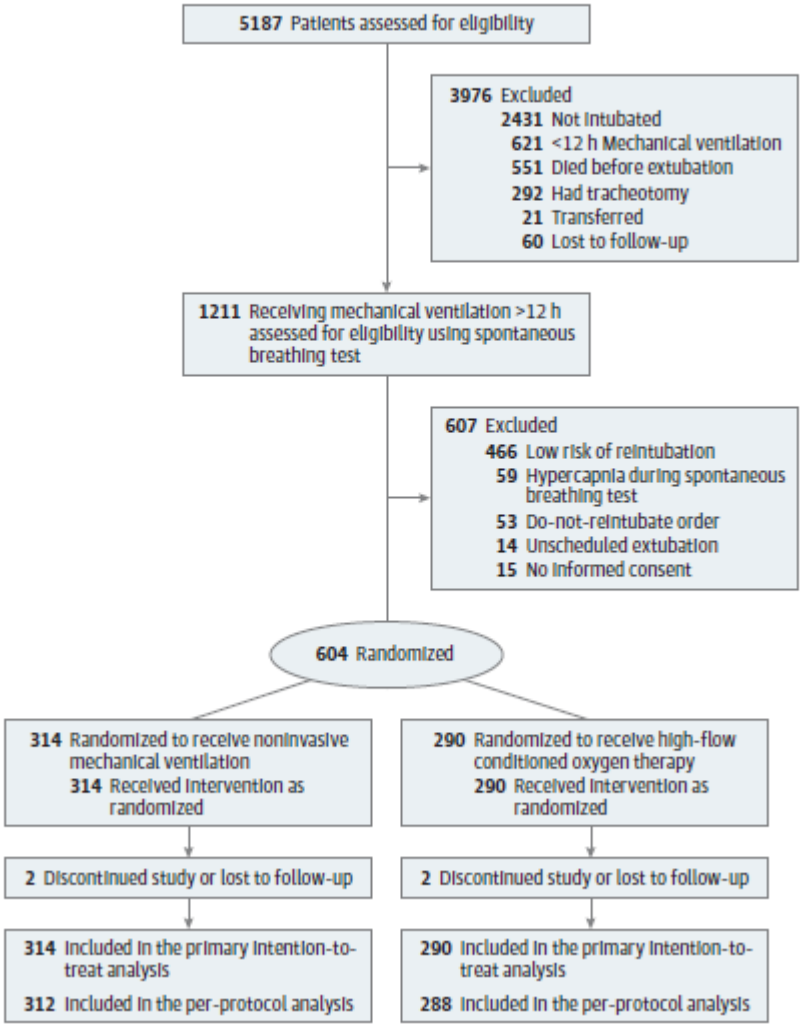
JAMA 2016;315:1354-61

Post-extubation

Figure 1. Flowchart of Participants in a Study of Postextubation High-Flow Conditioned Oxygen vs Noninvasive Mechanical Ventilation for Preventing Reintubation in High-Risk Patients



JAMA 2016;316:1565-74

Post-extubation

Table 2. Primary and Secondary Outcomes

	No. (%)		
	Noninvasive Mechanical Ventilation (n = 314)	High-Flow Conditioned Oxygen Therapy (n = 290)	Difference Between Groups (95% CI)[a]
Primary outcome			
All-cause reintubation[b]	60 (19.1)	66 (22.8)	−3.7 (−9.1 to ∞)[c]
Postextubation respiratory failure[b]	125 (39.8)	78 (26.9)	12.9 (6.6 to ∞)[c]
Secondary Outcomes			
Causes of postextubation respiratory failure			*P* = .89[d]
Respiratory acidosis[e]	21 (6.7)	11 (3.8)	
Hypoxia[f]	19 (6.1)	12 (4.1)	
Unbearable dyspnea	26 (8.3)	21 (7.2)	
Decreased level of consciousness	7 (2.2)	4 (1.4)	
Inability to clear secretions	52 (16.6)	30 (10.3)	
Causes for reintubation			*P* = .28[d]
Cardiorespiratory arrest	3 (1)	3 (1)	
Agitation	1 (0.3)	3 (1)	
Inability to clear secretions	20 (6.4)	13 (4.5)	
Hemodynamic impairment[g]	10 (3.2)	14 (4.8)	
Persistent postextubation respiratory failure[f]	16 (5.1)	16 (5.5)	
Nonrespiratory causes for reintubation			
Surgery	4 (1.3)	2 (0.7)	
Low level of consciousness[h]	6 (1.9)	15 (5.2)	
Adverse events[i]	135 (42.9)	0 (0)	*P* < .001
Sepsis	4 (1.3)	6 (2.1)	−0.8 (−3.3 to 1.5)[d,j]
Multiorgan failure	5 (1.6)	5 (1.7)	−0.1 (−2.6 to 2.2)[d,j]
Respiratory infection	34 (10.8)	23 (7.9)	2.9 (−1.8 to 7.6)[j]
Ventilator-associated tracheobronchitis	18 (5.7)	11 (3.8)	1.9 (−1.6 to 5.5)[j]
Ventilator-associated pneumonia	17 (5.4)	12 (4.1)	1.3 (−2.3 to 4.8)[j]
Time to reintubation, median (IQR), h	21.5 (10 to 47)	26.5 (14 to 39)	−5 (−34 to 24)[j,k]
ICU length of stay, median (IQR), d	4 (2 to 9)	3 (2 to 7)	1 (−0.1 to 2.1)[k,l]
Hospital length of stay, median (IQR), d	26 (16 to 37)	23 (14 to 46)	3 (−6.8 to −0.8)[k,l]
Mortality			
ICU	18 (5.7)	19 (6.6)	−0.8 (−4.9 to 3.1)[j]
Hospital	56 (17.8)	59 (20.3)	−2.5 (−8.8 to 3.8)[d,j]

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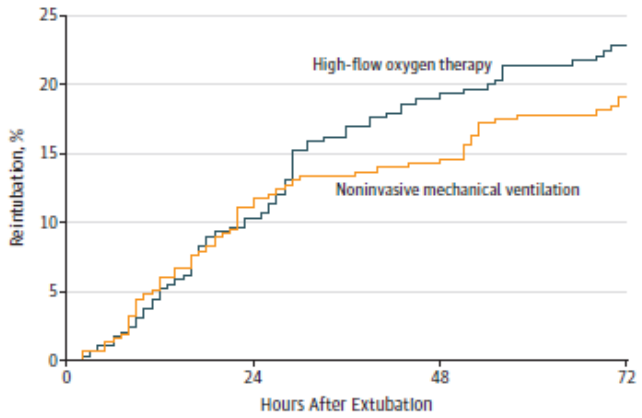
JAMA 2016;316:1565-74

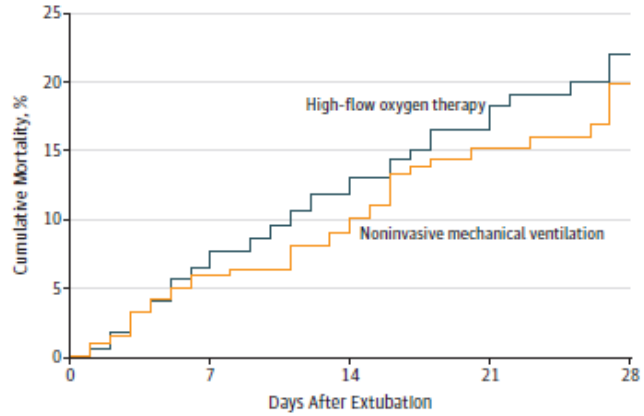
Post-extubation

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



No. at risk				
High-flow oxygen therapy	290	260	234	223
Noninvasive mechanical ventilation	314	279	269	253

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

JAMA 2016;316:1565-74

Post-extubation

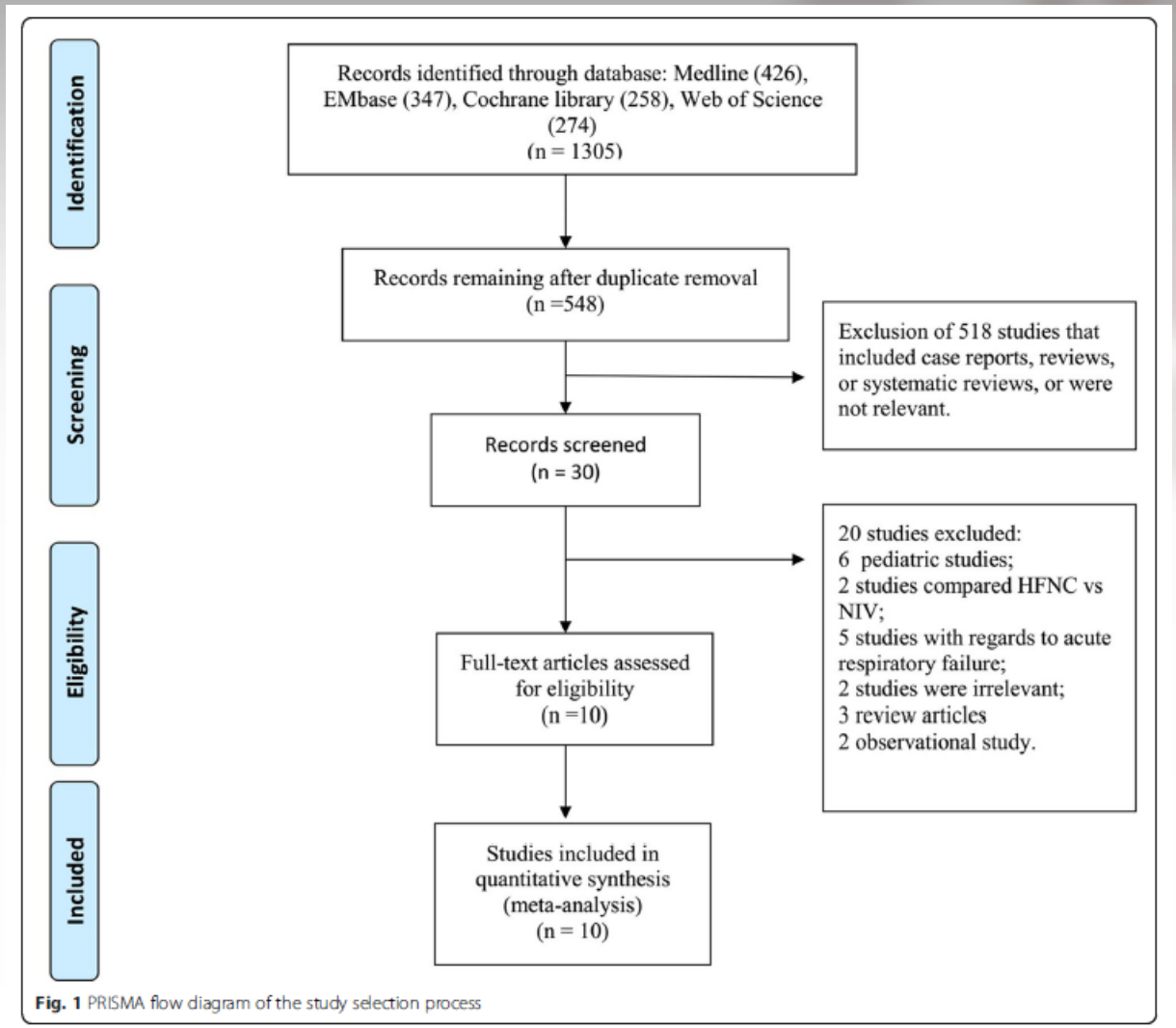


Fig. 1 PRISMA flow diagram of the study selection process

Crit Care 2019;23:180

Post-extubation

Table 3 Subgroup analysis for outcomes (displayed with RR or SMD)

Outcomes	Postextubation respiratory failure (RR)	Reintubation (RR)	Respiratory rate (SMD)	PaO_2 (SMD)
Subgroup analyses				
Study type				
RCT study	0.61 (0.41, 0.92)	0.58 (0.30, 1.11)	− 1.12 (− 1.45, − 0.79)	0.39 (− 0.02,0.79)
Crossover study	Na	Na	− 0.35 (− 0.75, 0.04)	0.14 (− 0.23, 0.51)
Interaction	Na	Na	$P = 0.004$	$P = 0.38$
Severity of patients				
Severe populations	0.42 (0.12, 1.52)	0.39 (0.13, 1.19)	− 0.56 (− 1.29, 0.18)	0.31 (0.05, 0.58)
Non severe population	0.72 (0.53, 0.99)	0.81 (0.27, 2.45)	− 0.93 (− 1.36, − 0.50)	0.35 (− 0.29, 1.00)
Interaction	0.42	0.36	0.39	0.92
HFNC flow				
≥ 40 L/min	0.59 (0.34, 1.05)	0.72 (0.29, 1.83)	− 1.14 (− 1.47, − 0.81)	0.39 (− 0.02, 0.79)
< 40 L/min	0.58 (0.35, 0.95)	0.39 (0.21, 0.72)	− 0.44 (− 1.09, 0.21)	0.10 (− 0.33, 0.52)
Interaction	0.94	0.28	0.06	0.33
Non-hypercapnic or not				
Non-hypercapnic	0.65 (0.44, 0.94)	0.52 (0.29, 0.93)	− 0.16 (− 0.59, 0.26)	0.10 (− 0.33, 0.52)
Mixed[a]	0.48 (0.18, 1.29)	0.45 (0.12, 1.77)	− 1.07 (− 1.37, − 0.77)	0.39 (− 0.02, 0.79)
Interaction	0.59	0.86	0.0007	0.33
HFNC duration				
≥ 24 h	0.52 (0.33, 0.84)	0.48 (0.26, 0.89)	− 1.12 (− 1.45, − 0.79)	0.58 (0.27, 0.90)
< 24 h	0.88 (0.58, 1.34)	0.88 (0.11, 7.33)	− 0.35 (− 0.75, 0.04)	0.09 (− 0.13, 0.30)
Interaction	$P = 0.10$	$P = 0.59$	$P = 0.004$	$P = 0.01$
Post cardiac surgery or not				
Post cardiac surgery	Na	0.96 (0.04, 24.84)	Na	Na
Other patients	0.62 (0.42, 0.92)	0.55 (0.28, 1.08)	− 0.70 (− 1.16, − 0.25)	0.30 (0.04, 0.56)
Interaction	Na	$P = 0.74$	Na	Na

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Crit Care 2019;23:180

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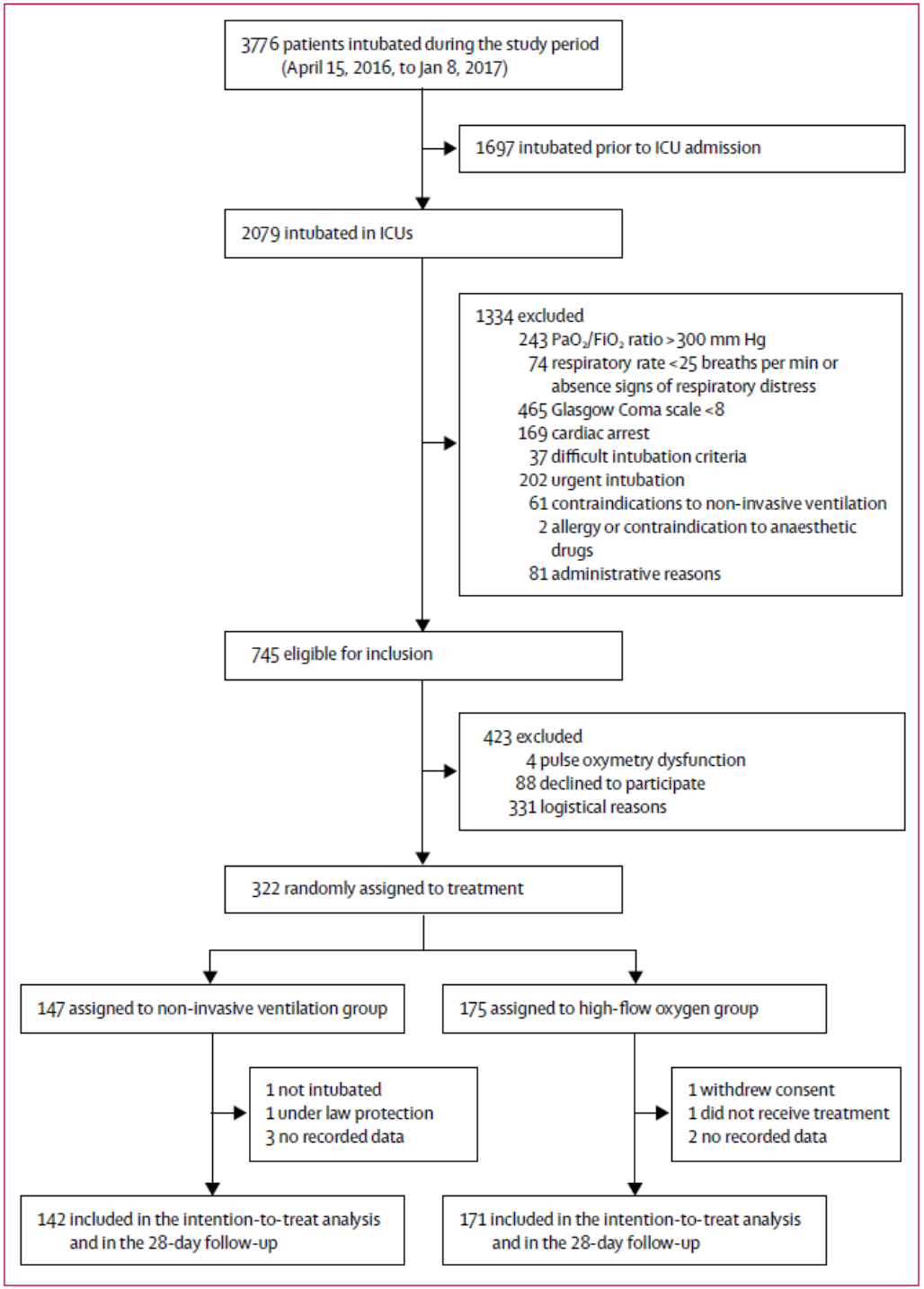

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Lancet Respir Med 2019;7:303-12

Preoxygenation

	Non-invasive ventilation (n=142)	High-flow nasal cannula oxygen therapy (n=171)	Absolute difference estimate (95% CI)	p value
Primary outcome				
SpO_2 <80% during intubation procedure				
Number of patients	33 (23%)	47 (27%)	−4·2 (−13·7 to 5·5)	0·39
95% CI	(17–31)	(21–35)	..	..
Secondary outcomes				
Lowest SpO_2 during intubation procedure, %	87 (13)	84 (16)	3·0 (−0·3 to 6·3)	0·13
SpO_2 at the beginning of preoxygenation, %	95 (5)	95 (4)	0·0 (−1·0 to 1·0)	0·65
SpO_2 at the end of preoxygenation, %	97 (4)	96 (5)	1·0 (0·0 to 2·0)	0·08
Duration of laryngoscopy, min	..	..	..	0·86
<1	88 (63%)	105 (61%)	1·4 (−9·3 to 12·1)	..
1–3	40 (29%)	53 (31%)	−2·4 (−12·4 to 7·8)	..
>3	12 (9%)	13 (8%)	1·0 (−5·2 to 7·6)	..
Procedure of tracheal intubation				
Number of laryngoscopy attempts	..	..	..	0·75
One	113 (80%)	135 (79%)	0·6 (−8·5 to 9·5)	..
Two	22 (15%)	30 (18%)	−2·0 (−10·2 to 6·4)	..
Three or more, or >10 min	7 (5%)	6 (4%)	1·4 (−3·2 to 6·7)	..
First operator junior	26 (18%)	37 (22%)	−3·3 (−12·0 to 5·7)	0·46
Intervention of another skilled operator	38 (27%)	47 (27%)	−0·7 (−10·4 to 9·2)	0·89
Use of alternative management devices	16 (11%)	25 (15%)	−3·3 (−10·7 to 4·4)	0·38
Introducer	15 (11%)	22 (13%)	−2·3 (−9·4 to 5·1)	..
Other	2 (1%)	6 (4%)	−2·1 (−6·2 to 1·9)	..
Successful intubation	142 (100%)	171 (100%)	0·0 (0·0 to 0·0)	1·00
At least one episode of systolic arterial pressure <90 mm Hg	70 (50%)	86 (50%)	−1·0 (−12·0 to 10·0)	0·86

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Preoxygenation

	Severe-to-moderate hypoxaemia (PaO_2/FiO_2 ≤200 mm Hg)				Mild hypoxaemia (PaO_2/FiO_2 >200 mm Hg)			
	Non-invasive ventilation (n=117)	High-flow nasal cannula oxygen therapy (n=125)	Absolute difference estimate (95% CI)	p value	Non-invasive ventilation (n=25)	High-flow nasal cannula therapy (n=46)	Absolute difference estimate (95% CI)	p value
Primary outcome								
SpO_2 <80% during intubation procedure	28 (24%)	44 (35%)	−11·3 (−22·3 to 0·3)	0·0553	5 (20%)	3 (7%)	13·4 (−2·2 to 33·1)	0·1197
95% CI	16–32	27–44	..	..	4–36	0–14	..	..
Adjusted on PaO_2	..	..	..	0·0459	..	..	..	0·1003
Secondary outcomes								
SpO_2 at the beginning of preoxygenation	94% (5)	94% (4)	0·0 (−1·1 to 1·1)	0·75	97% (3)	97% (4)	0·0 (−1·8 to 1·8)	0·36
SpO_2 at the end of preoxygenation	97% (4)	96% (6)	1·0 (−0·0 to 2·0)	0·02	99% (3)	98% (4)	1·0 (−0·8 to 2·8)	0·31
Lowest SpO_2 during intubation procedure	86% (12)	81% (17)	5·0 (1·2 to 8·7)	0·02	90% (15)	93% (8)	−3·0 (−8·4 to 2·4)	0·31

Data are n (%) or mean % (SD), unless otherwise indicated. SpO_2=pulse oximetry.

Table 3: Outcomes in the intention-to-treat population, by subgroup of stratification and treatment group

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Preoxygenation

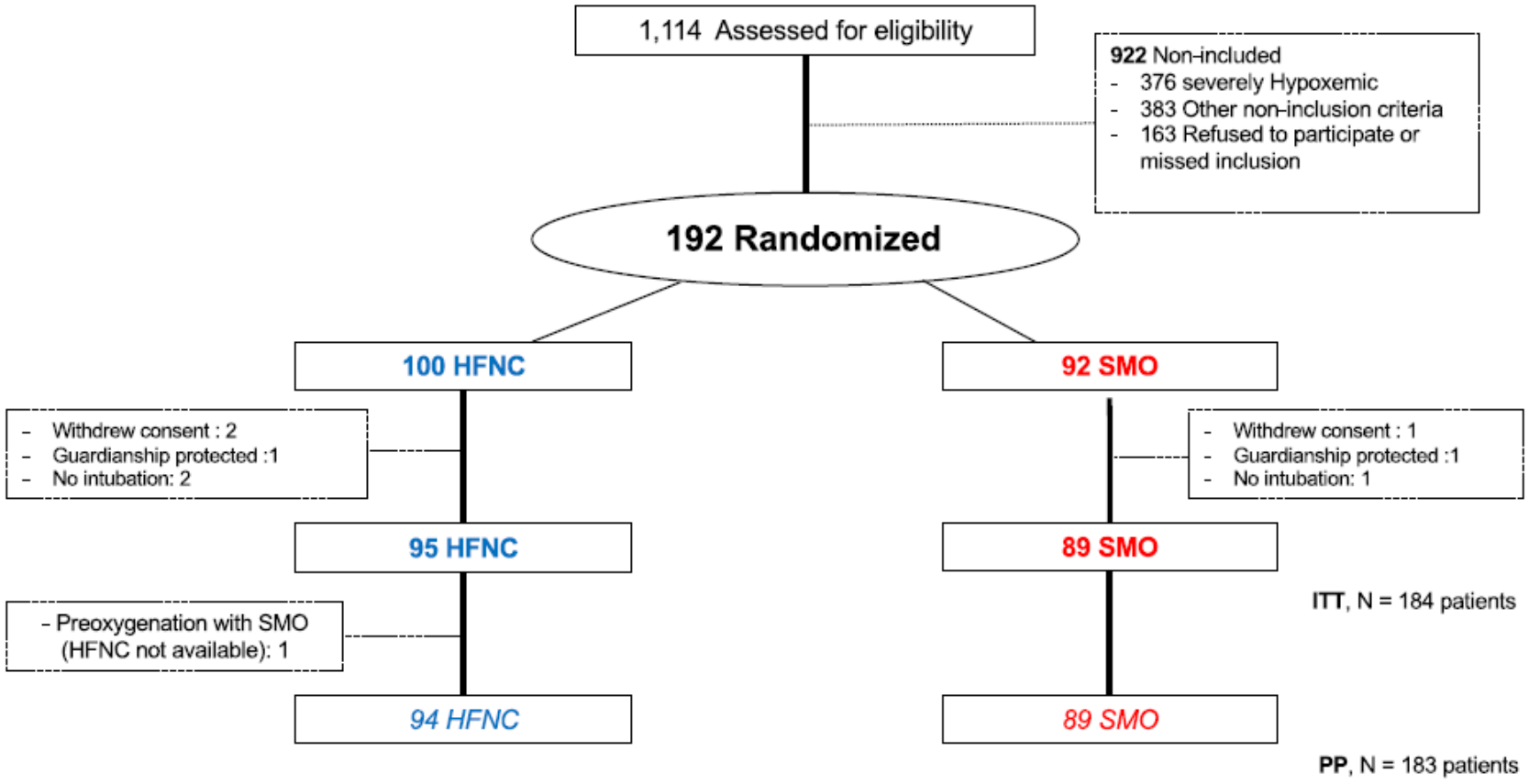

Fig. 1 Study flowchart. HFNC high-flow nasal cannulae, SMO standard bag-valve mask oxygenation

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Preoxygenation

	High-flow nasal cannulae $n=95$	Standard bag-valve mask oxygenation $n=89$	*P*	Relative risk or difference (95% CI)
Primary outcome				
Lowest SpO_2, median [IQR], %, ITT analysis	100 [97; 100]	99 [95; 100]	0.30	
Lowest SpO_2, min–max, %	69–100	43–100		
Secondary outcomes				
Preoxygenation				
SpO_2 at the beginning, median [IQR], %	98 [96; 100]	98 [97; 100]	0.75	
SpO_2 at the end, median [IQR], %	100 [100; 100]	100 [100; 100]	0.66	
Jaw-thrust maneuver, *n* (%)[a]	**12/94 (13)**	29 (33)	**0.0009**	**0.38 (0.21–0.71)**
Failure to reach SpO_2 90%, *n* (%)	2 (2)	0	0.19	
Intubation				
Two or more operators, *n* (%)	27 (28)	14 (16)	0.06	1.74 (0.97–3.12)
Length, median [IQR], mins[b]	1 [0.5; 1.9]	0.8 [0.5; 1.4]	**0.04**	
Successful intubation, *n* (%)	95 (100)	89 (100)	0.9	
Difficult intubation, *n* (%)[c]	9 (10)	1 (1)	**0.01**	**8.58 (1.04–70.82)**
IDS score, median [IQR][d]	3 [2; 5]	3 [2; 4]	0.10	
Mask ventilation for $SpO_2<90\%$, *n* (%)	1 (1)	5 (6)	0.08	0.16 (0.02–1.62)
$SpO_2<95\%$, *n* (%)	11 (12)	20 (23)	**0.045**	**0.51 (0.26–0.99)**
$SpO_2<90\%$, *n* (%)	6 (6)	12 (14)	0.1	1.09 (0.98–1.20)
Intubation-related adverse events				
At least one complication, *n* (%)	6 (6)	17 (19)	**0.007**	**0.31 (0.13–0.76)**
At least one severe complication, *n* (%)[f]	6 (6)	14 (16)	**0.03**	**0.38 (0.15–0.95)**
$SpO_2<80\%$	2 (2)	7 (8)	0.06	0.26 (0.05–1.20)
Severe hypotension[e]	4 (4)	8 (9)	0.18	0.45 (0.13–1.48)
Cardiac arrest	1 (1)	0	0.36	–
At least one moderate complication, *n* (%)[f]	0	6 (7)	**0.01**	–
Esophageal intubation	0	5 (6)	**0.02**	–
Aspiration	0	2 (2)	0.15	–
Morbidity in the ICU after intubation				
Time on ventilator, median [IQR], days	3 [2; 6]	3 [2; 7]	0.80	
Ventilator-associated pneumonia, *n* (%)	8 (8)	10 (11)	0.55	0.77 (0.32–1.84)
SOFA score from day 1–5, median [IQR]	5 [3; 9]	6 [4; 10]	0.26	
Length of stay in ICU, median [IQR], days	5 [3; 12]	6 [3; 11]	0.89	
Death, *n* (%)	25 (26)	23 (26)	0.90	1.03 (0.65–1.65)
Mortality at day 28, *n* (%)	26 (27)	24 (27)	0.93	0.99 (0.90–1.24)

Preoxygenation

Table 4 Multivariable analysis for desaturation < 90% or complications during intubation

N = 175[a]	Desaturation < 90%			Severe and moderate complications		
	OR	CI	*P*	OR	CI	*P*
First operator, senior	0.49	0.09–2.56	0.39	2.07	0.69–6.22	0.20
Age	1.02	0.99–1.06	0.22	1.01	0.98–1.04	0.48
HFNC (vs. SMO)	**0.21**	**0.06–0.72**	**0.01**	**0.26**	**0.08–0.77**	**0.02**
Difficult intubation, no	**0.08**	**0.01–0.48**	**0.005**	2.14	0.73–6.21	0.16
MACOCHA score ≥ 3, yes	0.87	0.24–3.21	0.84	1.00	1.00–1.01	0.37
NYHA III or IV, yes	0.32	0.02–4.78	0.40	0.22	0.04–1.32	0.10
PaO_2/FiO_2 at inclusion	0.99	0.99–1.00	0.06	0.93	0.07–12.45	0.10

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During Endoscopy

Table 4. RCTs Comparing HFNC and O_2 Therapy or NIV During Endoscopy

Study Characteristics	Simon et al[41]	Douglas et al[15]	Saksitthichok et al[10]	Lin et al[7]	Teng et al[14]	Riccio et al[13]
Subjects, *N*	40	60	51	1,994	101	59
Country	Germany	Australia	Thailand	China	Taiwan	United States
Procedure	Bronchoscopy	Bronchoscopy	Bronchoscopy	Gastroscopy	Esophagogastroduodenoscopy	Colonoscopy
Indication	Hypoxemic respiratory failure	Adults planned for conscious sedation for endobronchial ultrasound	Hypoxemic patients	Outpatients undergoing routine gastroscopy with propofol sedation	Patients need sedative	Obese
Comparison	HFNC at 50 L/min vs NIV; $F_{IO_2} = 1.0$ for both devices	HFNC at 50 L/min; F_{IO_2} 1.0 vs nasal cannula at 10 L/min	HFNC at 40 L/min; F_{IO_2} 0.6 vs NIV	HFNC at 60 L/min; F_{IO_2} 1.0 vs nasal cannula at 2 L/min	HFNC at 30 L/min; F_{IO_2} 1.0 vs nasal cannula at 5 L/min	HFNC at 60 L/min; F_{IO_2} 0.36–0.4 vs nasal cannula at 4 L/min
Incidence of hypoxia ($S_{pO_2} \leq 90\%$)	Oxygenation was lower with HFNC than NIV	13.3 vs 33.3% ($P = .07$)	34.6 vs 12.0% ($P = .057$)	0 vs 8.4% ($P < .001$)	2 vs 20% ($P = .004$)	39.3% vs 45.2% ($P = .79$)

RCT = randomized, controlled trial
HFNC = high-flow nasal cannula
NIV = noninvasive ventilation

Respir Care 2020;65:545-57

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Take Home Messages

- ✓ Hypoxic respiratory failure
  - Reduces the risk of intubation
- ✓ ROX index ≥ 4.88
- ✓ Hypercapnic respiratory failure
  - May be considered as an alternative to NIV in mild to moderate COPD
- ✓ Postextubation
  - Low risk: Reduces the risk of reintubation within 72 hours
  - High risk: Not inferior to NIV
- ✓ Preoxygenation
  - Reduces intubation-related complications
- ✓ During Endoscopy
  - Effectiveness of preventing hypoxia during endoscopy

THANK YOU FOR YOUR ATTENTION