PNEUMOLOGIA 2016

Milano, 16 – 18 giugno 2016

Le interfacce: sappiamo già tutto?

Lara Pisani
Terapia Intensiva Respiratoria e Pneumologia
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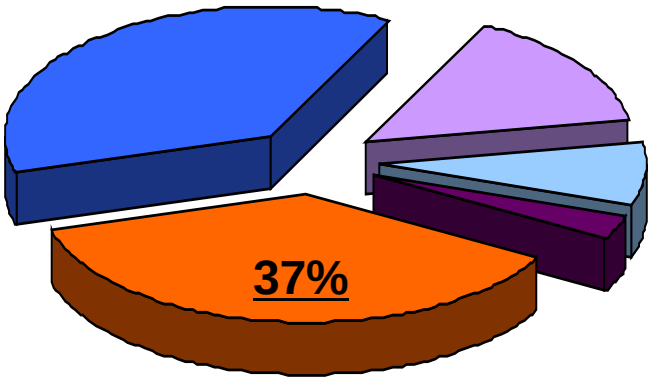
EDITORIAL

The interface: crucial for successful noninvasive ventilation

Eur Respir J 2004; 23: 7–8

M.W. Elliott

Reasons of NIV failure



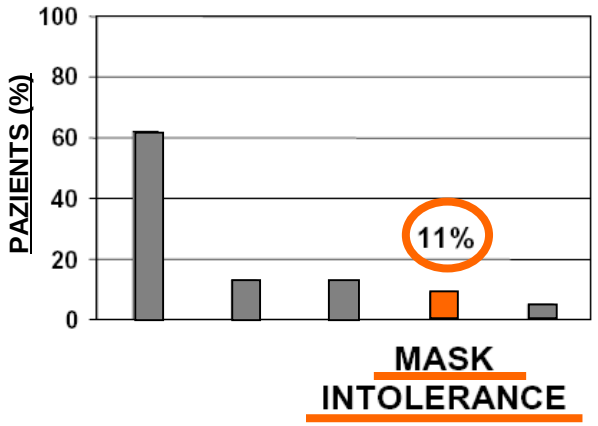
HEMODYNAMIC INSTABILITY
NEUROLOGICAL IMPAIRMENT
WOSENING OF ABG

LACK OF INTERFACES TOLERANCE

Enzo Squadrone
Pamela Frigerio
Claudio Fogliati
Cesare Gregoretti
Giorgio Conti
Massimo Antonelli
Roberta Costa
Paola Baiardi
Paolo Navalesi

Noninvasive vs invasive ventilation in COPD patients with severe acute respiratory failure deemed to require ventilatory assistance

NEED FOR ETI

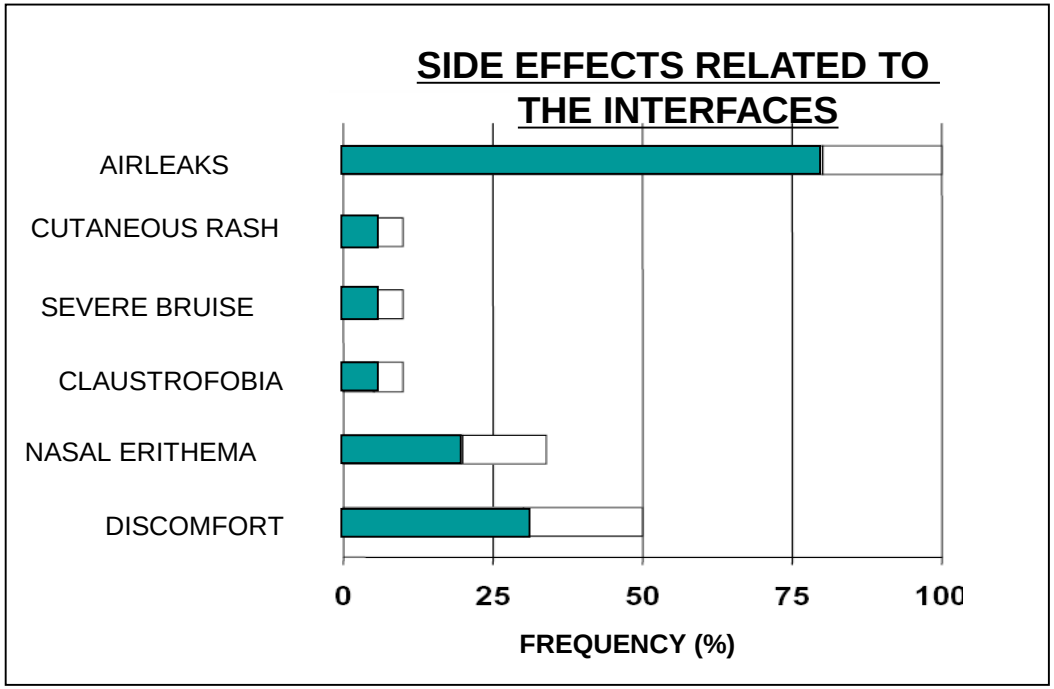


M.Antonelli: Intensive Care Med,2001; 27:1718-1728

State of the Art

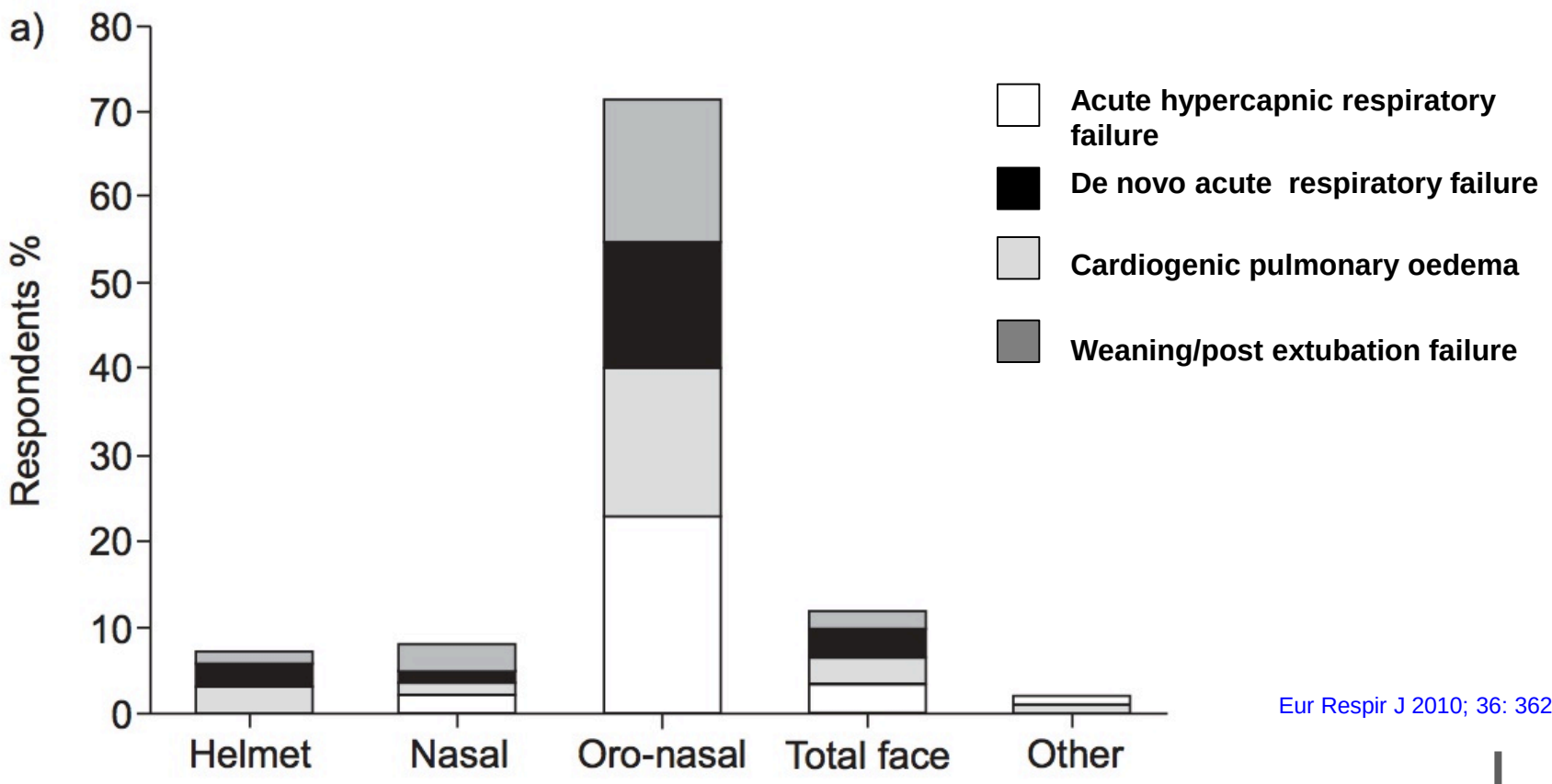
Noninvasive Ventilation

SANGEETA MEHTA and NICHOLAS S. HILL



A European survey of noninvasive ventilation practices

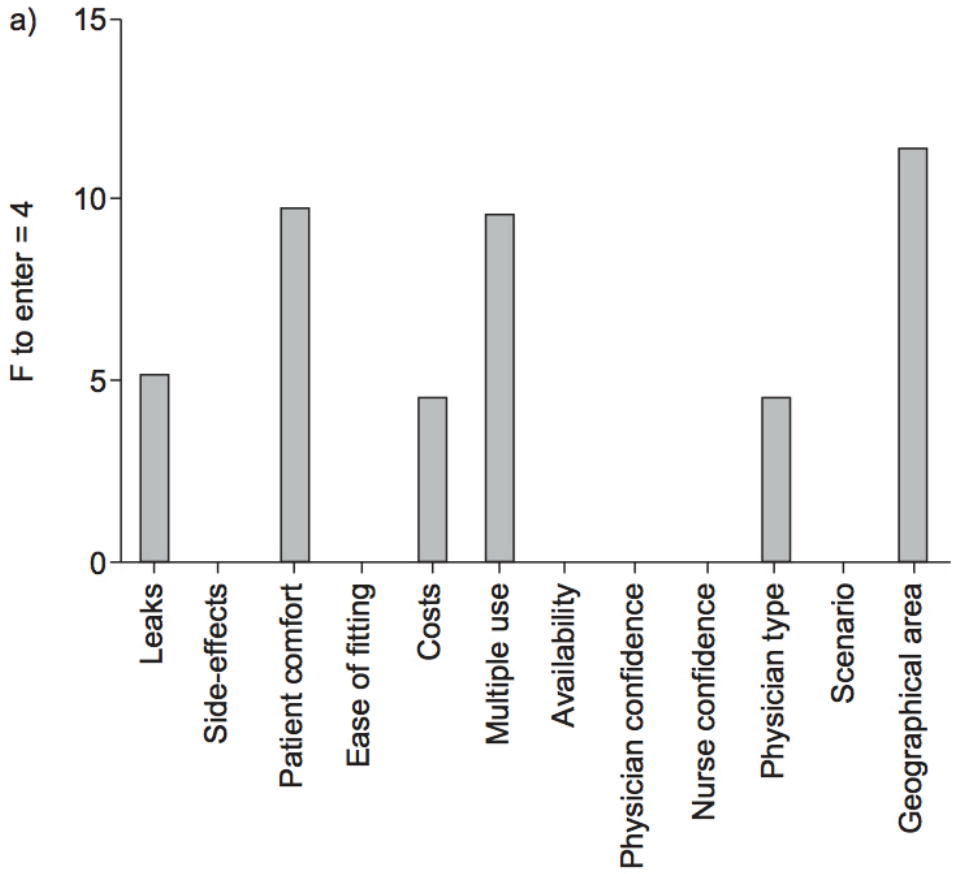
C. Crimi*, A. Noto#, P. Princi¶, A. Esquinas+ and S. Nava§



Eur Respir J 2010; 36: 362–369

A European survey of noninvasive ventilation practices

C. Crimi*, A. Noto#, P. Princi¶, A. Esquinas+ and S. Nava§



Eur Respir J 2010; 36: 362–369

Which interface?

Non-invasive ventilation in acute respiratory failure

Stefano Nava, Nicholas Hill

Mouthpieces—placed between lips and held in place by lip seal

Advantages

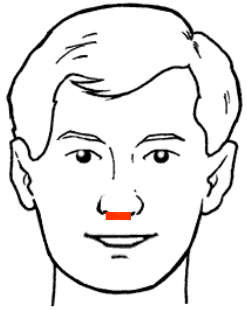
- Can be applied as rotating strategy with other interfaces

Disadvantages

- Vomiting and salivation
- Possible air leaks
- Gastric distension
- Speaking difficult

Lancet 2009; 374: 250–59

NASAL PILLOWS



NASAL PILLOWS

ADVANTAGES

As rotating strategy

No nasal bridge contact

DISADVANTAGES

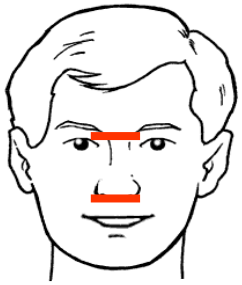
Monitoring Tidal Volume

Difficult to apply when high pressures needed

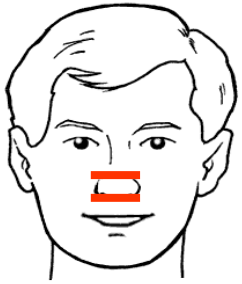
Nasal irritation

NASAL MASKS

STANDARD



EXTERNAL



ADVANTAGES

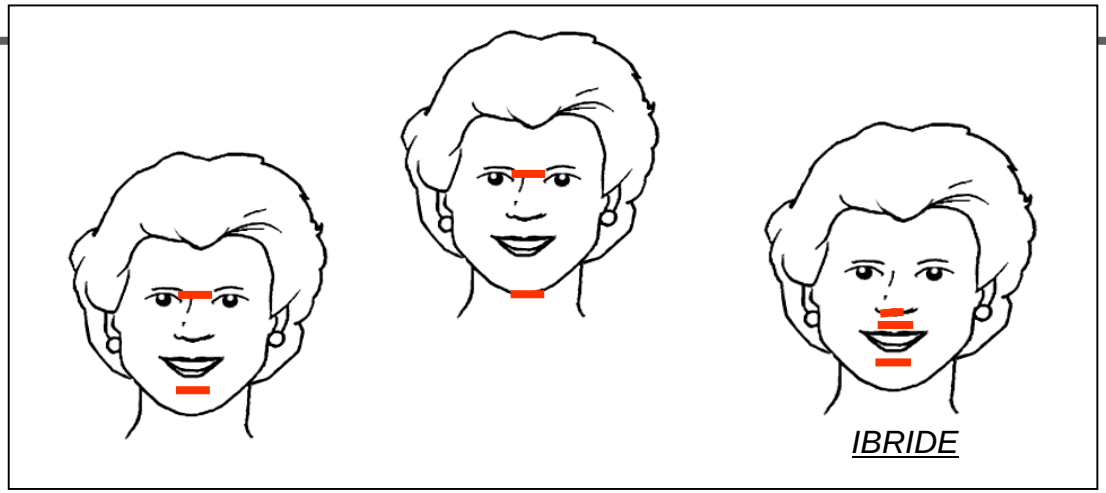
Allows expectoration

↓ risk of vomiting
↓ risk of suffocation

DISADVANTAGES

Nasal integrity
Mouth leaks
Nasal skin lesion

Oro-nasal masks



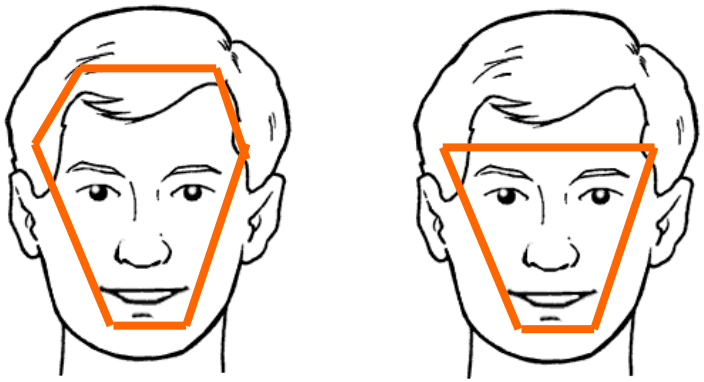
ADVANTAGES

Reduced airleaks
Less patient's collaboration needed

DISDVANTAGES

Vomiting/ claustrofobia
Cutaneous bruise
Difficult cough
Difficult speeching

“Total face”



Total face mask—covers mouth, nose, and eyes

Advantages

- Minimum airleaks
- Little cooperation required
- Easy fitting and application

Disadvantages

- Vomiting (risk of aspiration)
- Claustrophobia
- Speaking difficult

Lancet 2009; 374: 250–59

Helmet

Helmet—covers the whole head and all or part of the neck (no contact with face)

Advantages

- Minimum airleaks
- Little cooperation required
- Absence of nasal or facial skin damage

Disadvantages

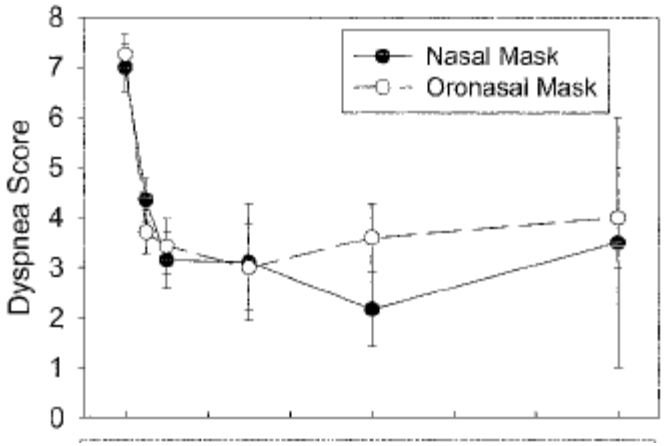
- Rebreathing
- Vomiting
- Noisy
- Asynchrony with pressure support ventilation
- Discomfort of axillae (from straps)

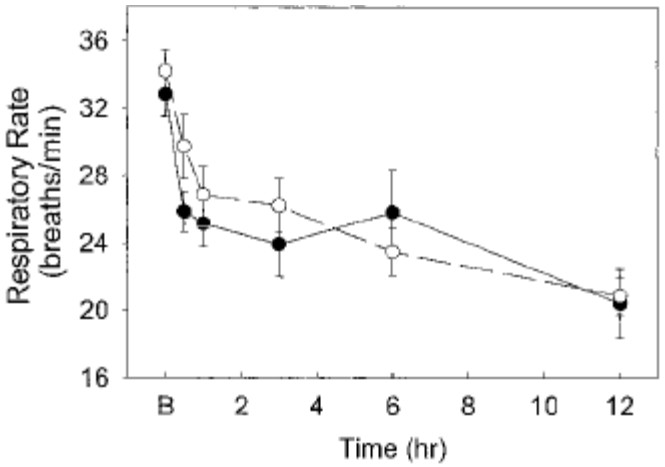
Lancet 2009; 374: 250–59

Do they work similarly ?

Controlled trial of oronasal versus nasal mask ventilation in the treatment of acute respiratory failure

Henry Kwok, MD; James McCormack, MD; Richard Cece, RRT; Jeanne Houtchens, RN, BSN; Nicholas S. Hill, MD



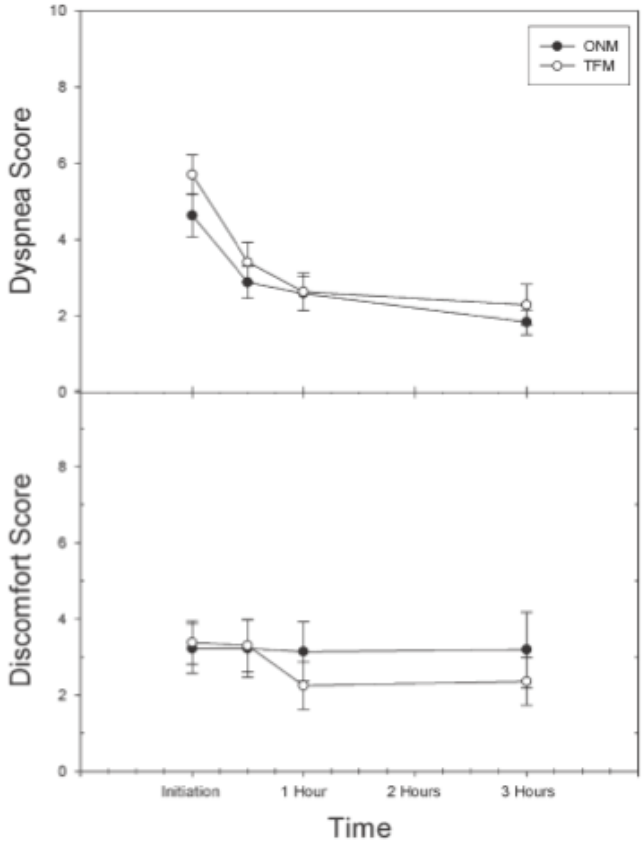


Nasal and oro-nasal equivalent in improving dyspnea and respiratory rate

CHEST Original Research
CRITICAL CARE

Evaluation of the Total Face Mask for Noninvasive Ventilation to Treat Acute Respiratory Failure

Aylin Ozsancak, MD; Samy S. Sidhom, MD, MPH; Timothy N. Liesching, MD, FCCP; William Howard, RRT; and Nicholas S. Hill, MD, FCCP

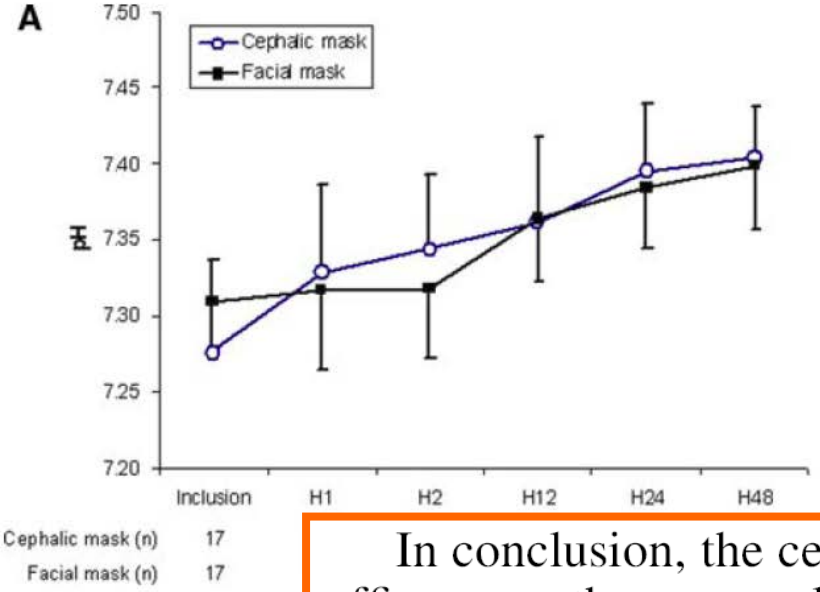


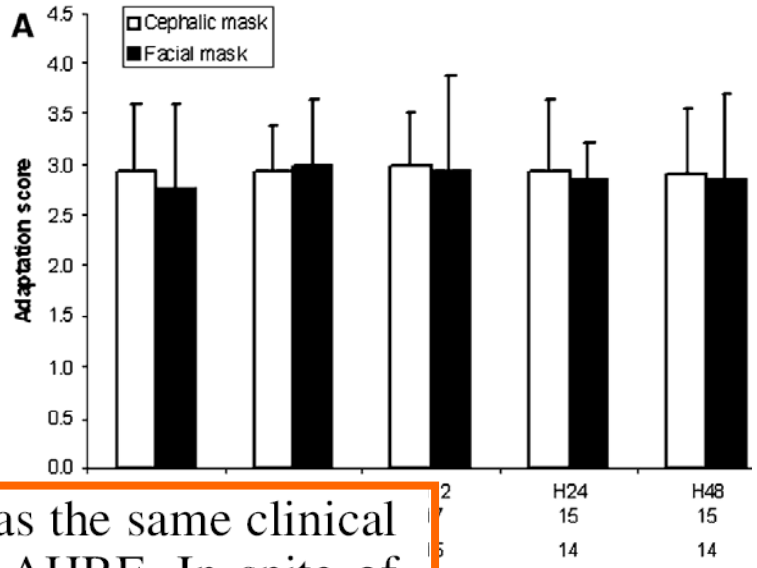
Total face and oro-nasal equivalent in improving dyspnea and respiratory rate

CHEST 2011; 139(5):1034-1041

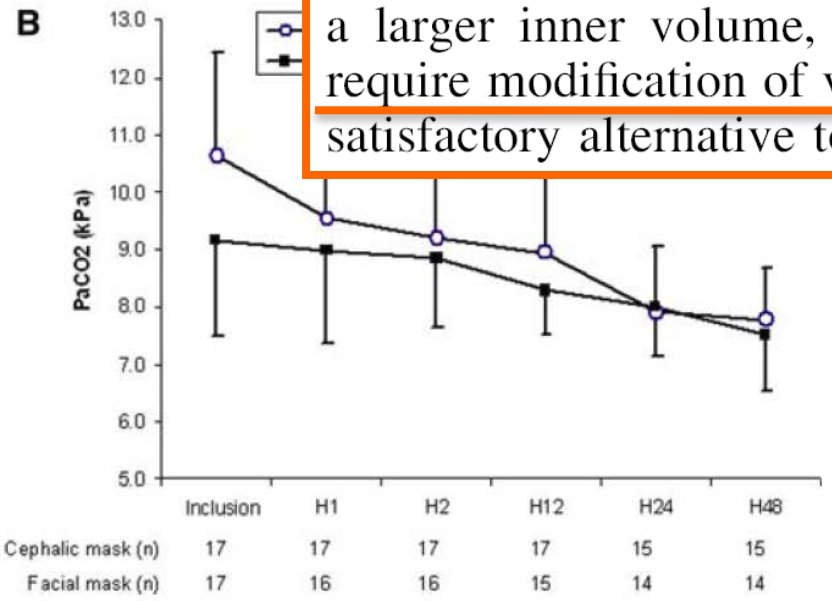
Cephalic versus oronasal mask for noninvasive ventilation in acute hypercapnic respiratory failure

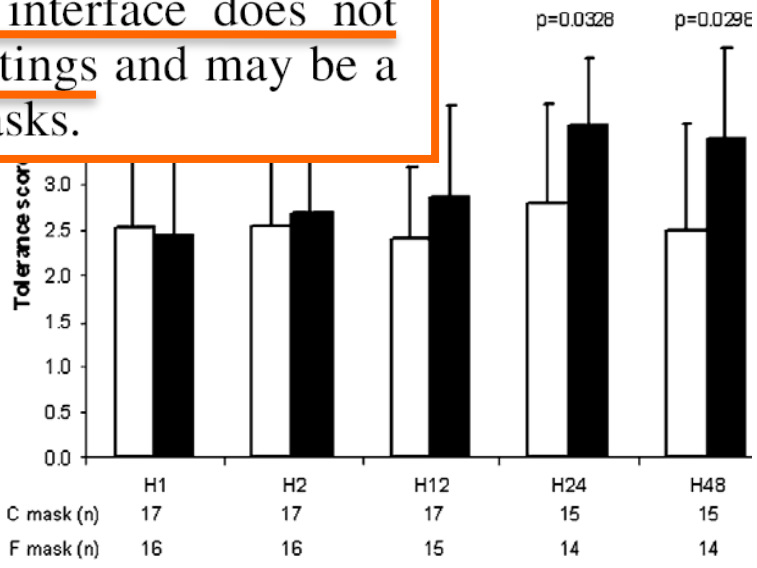
Intensive Care Med (2009) 35:519–526





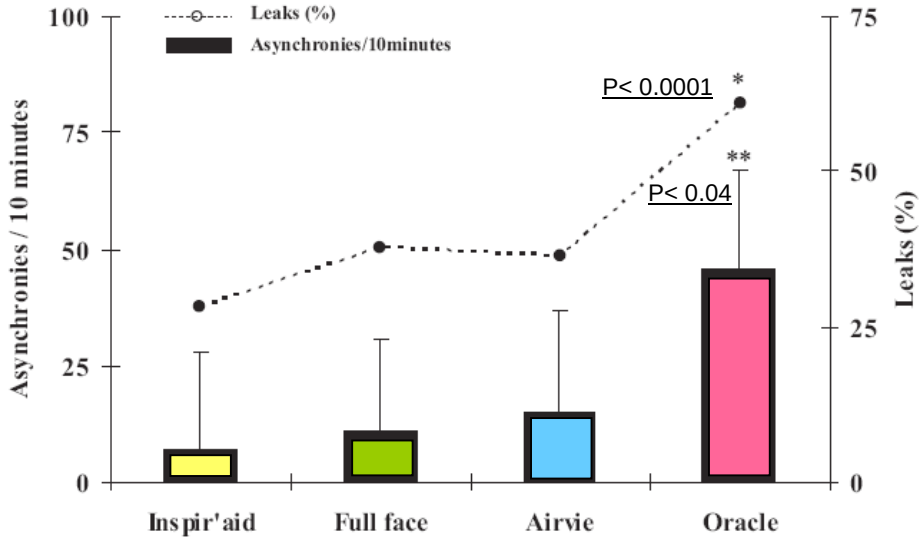
In conclusion, the cephalic mask has the same clinical efficacy as the oronasal mask during AHRF. In spite of a larger inner volume, the cephalic interface does not require modification of ventilatory settings and may be a satisfactory alternative to oronasal masks.

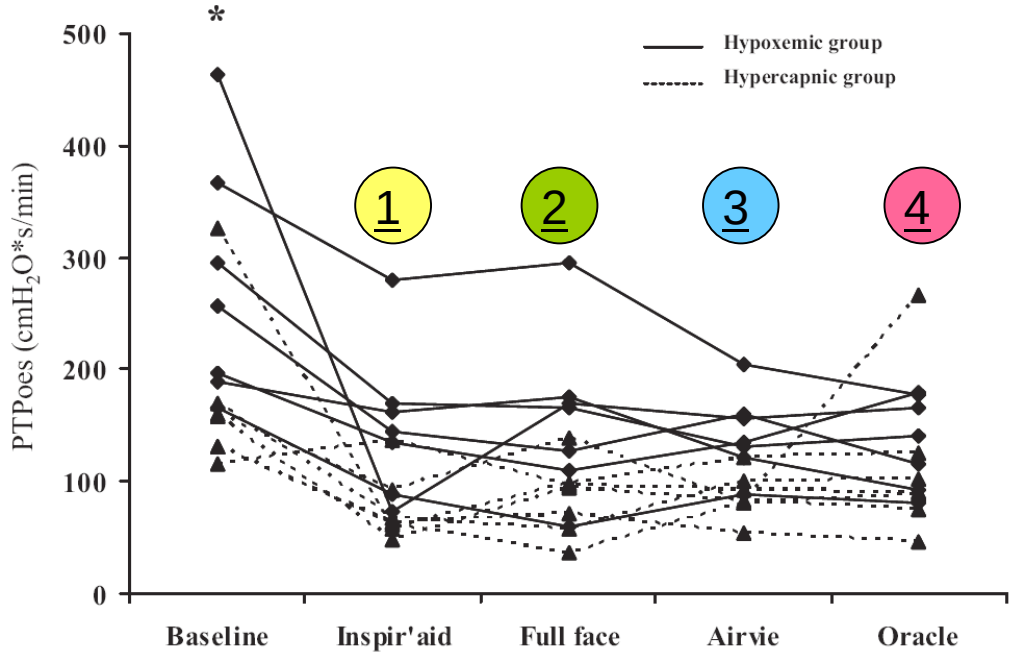


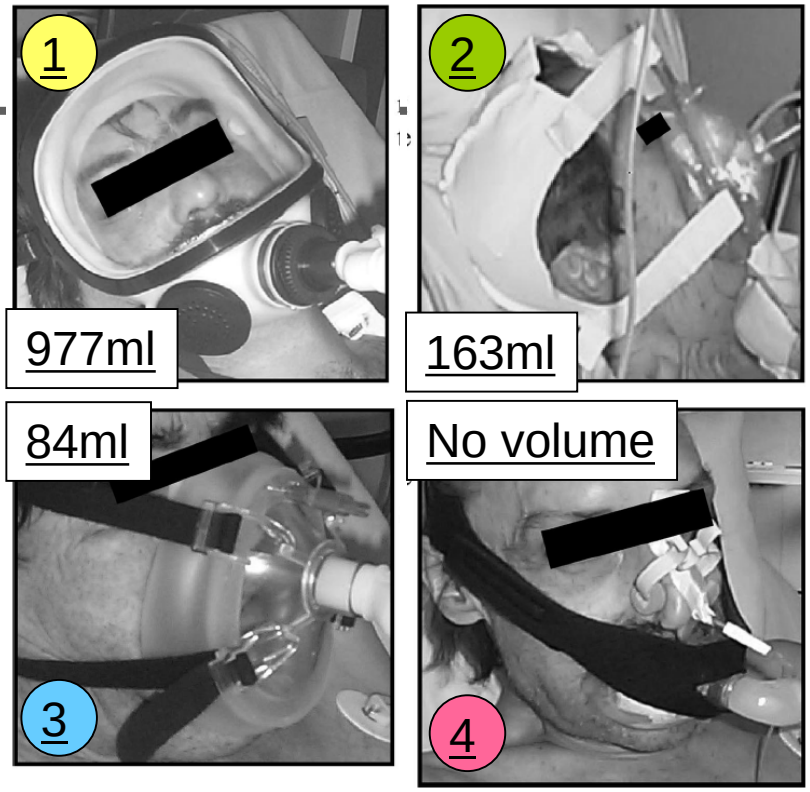


Physiological effects of different interfaces during noninvasive ventilation for acute respiratory failure*

Crit Care Med 2009 Vol. 37, No. 3

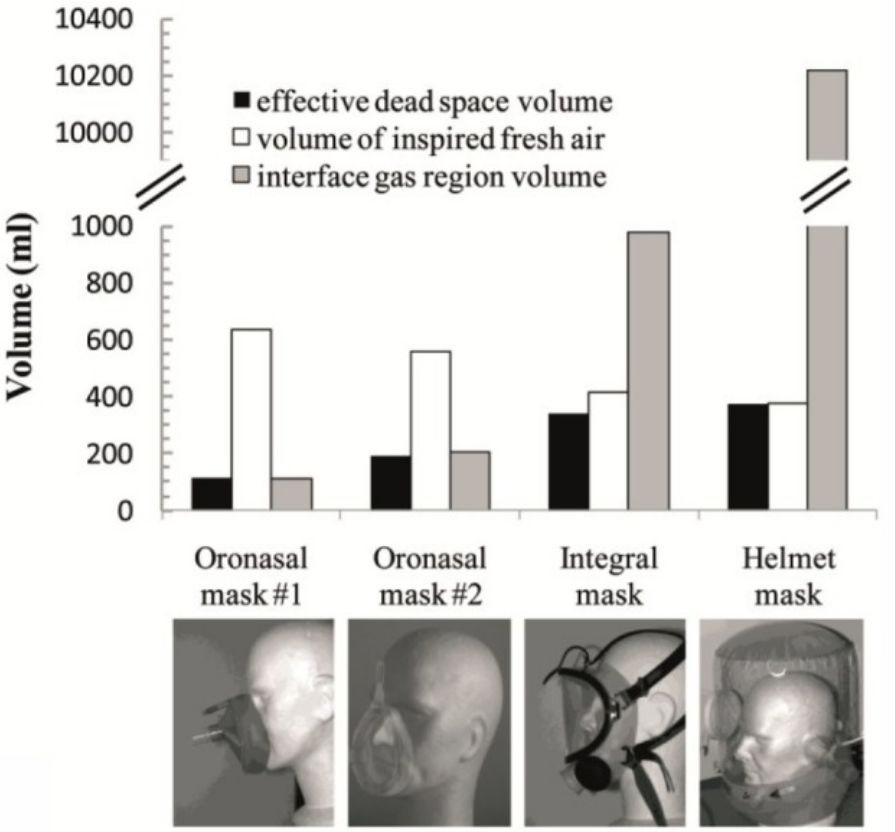


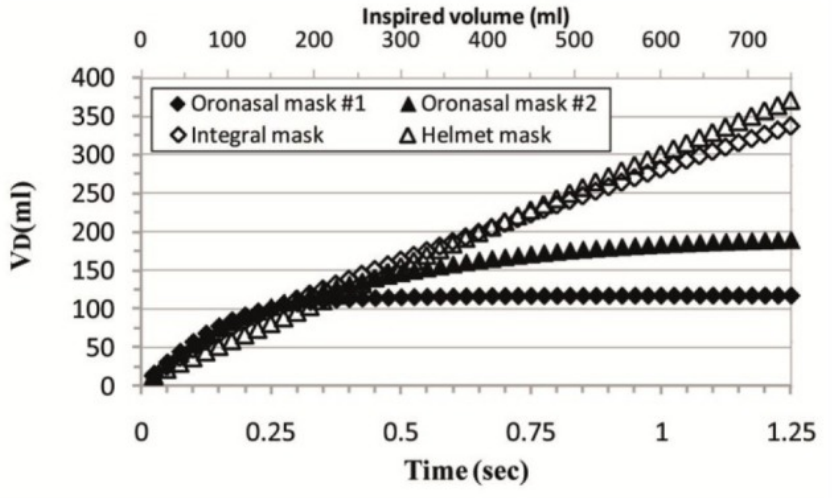




for acute respiratory failure. These findings have important clinical implications because they suggest that interfaces may be largely interchangeable, provided ad-

The effective dead space is not only related to the internal gas volume



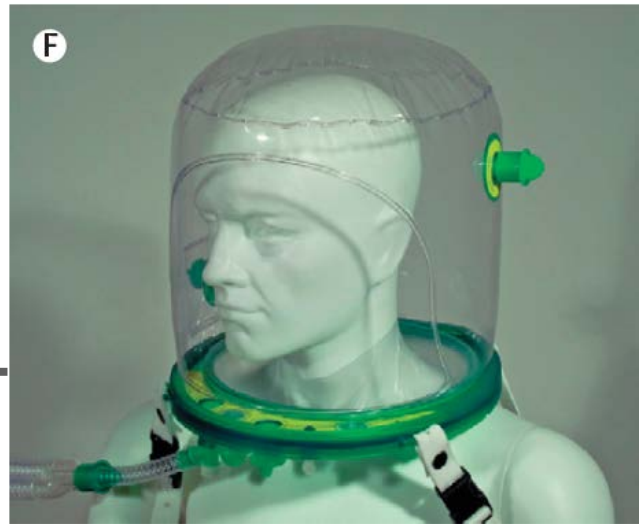


Fodil R. Intensive Care Med 2011; 37: 257-62

HELMET

- Ci permette di trattare il paziente indipendentemente dal contorno facciale, anche per un periodo prolungato di tempo.
- Sono dotati di una valvola anti soffocamento
- Esiste un ingresso che permette di effettuare un igiene di minima del paziente e degli ingressi per far passare il SNG o una cannuccia per bere

HELMET



3
Major issues

- Noise
- CO_2 rebreathing
- Asynchronies

NOISE

Inside the helmet noise exceeded 100 dB (during NIV with nasal or facial masks the noise did not exceed 70 dB)
Noise intensity is poorly affected by pressure support level and unaffected by the presence of HME filters.
Cavaliere F et al. *Intensive Care Med. 2004;30(9):1755-60*

During PSV with the helmet, the tympanometry showed a slight increase in acoustic compliance but returned to basal values after one hour, while it did not show a change with the face mask
Cavaliere F et al. *Acta Anaesthesiol Scand. 2008;52(1):52-6.*

CO_2 Rebreathing

Noninvasive Positive Pressure Ventilation Using a Helmet in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease

Antonelli M Anesthesiology 2004; 100:16–24

A Feasibility Study

Table 4. Complications

Complications	Helmet (n = 33)	Mask (n = 33)	*P*
Severe, No. (%)			
VAP	5 (25)	4 (12)	0.50
Septic shock, severe sepsis	2 (6)	4 (12)	0.33
Acute renal failure	1 (3)	4 (12)	0.17
Sinusitis	0 (0)	2 (6)	0.24
Related to NPPV, No. (%)			
Skin breakdown	0 (0)	4 (12)	0.06
Conjunctivitis	0 (0)	2 (6)	0.24
Gastric distension	0 (0)	0 (0)	0.99
Intolerance	0 (0)	6 (18)	0.02
DVT*	1 (3)	0 (0)	0.51
Total	0 (0)	12 (36)	<0.001

Noninvasive Positive Pressure Ventilation Using a Helmet in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease

A Feasibility Study

	Helmet (n = 33)	Mask (n = 33)	*P*
After 1 h of treatment			
$Paco_2$ (mmHg), m (SD)	75 (15)	66 (15)	0.01
Pao_2:Fio_2, m (SD)	193 (43)	204 (64)	0.30
pH, m (SD)	7.32 (0.07)	7.34 (0.06)	0.12
Respiratory rate (breaths/min), m (SD)	29 (6)	28 (3)	0.72
Body temperature (C°), m (SD)	ND	ND	—
Systolic blood pressure (mmHg), m (SD)	127 (23)	131 (23)	0.26
Heart rate (bpm), m (SD)	109 (18)	91 (13)	<0.001
At end of treatment†			
$Paco_2$ (mmHg), m (SD)	68 (18)	57 (9)	0.002
Pao_2:Fio_2, m (SD)	211 (56)	204 (37)	0.60
pH, m (SD)	7.35 (0.09)	7.39 (0.05)	0.02
Respiratory rate (breaths/min), m (SD)	27 (9)	26 (4)	0.62
Body temperature (C°), m (SD)	36.9 (0.6)	37 (0.6)	0.90
Systolic blood pressure (mmHg), m (SD)	142 (20)	130 (21)	0.01
Heart rate (bpm), m (SD)	102 (22)	86 (11)	0.001

Conclusions: **Helmet NPPV is feasible and can be used to treat chronic obstructive pulmonary disease patients with acute exacerbation, but it does not improve carbon dioxide elimination as efficiently as does FM NPPV.**

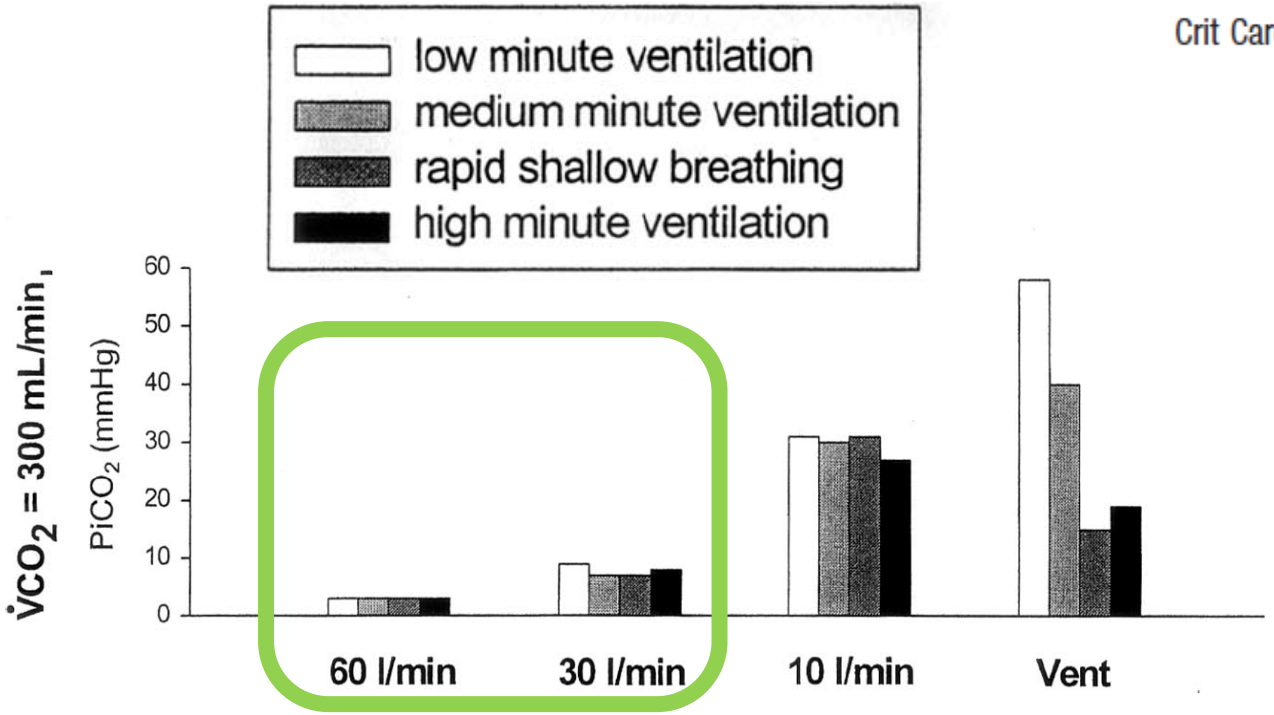
Antonelli M **Anesthesiology 2004; 100:16–24**

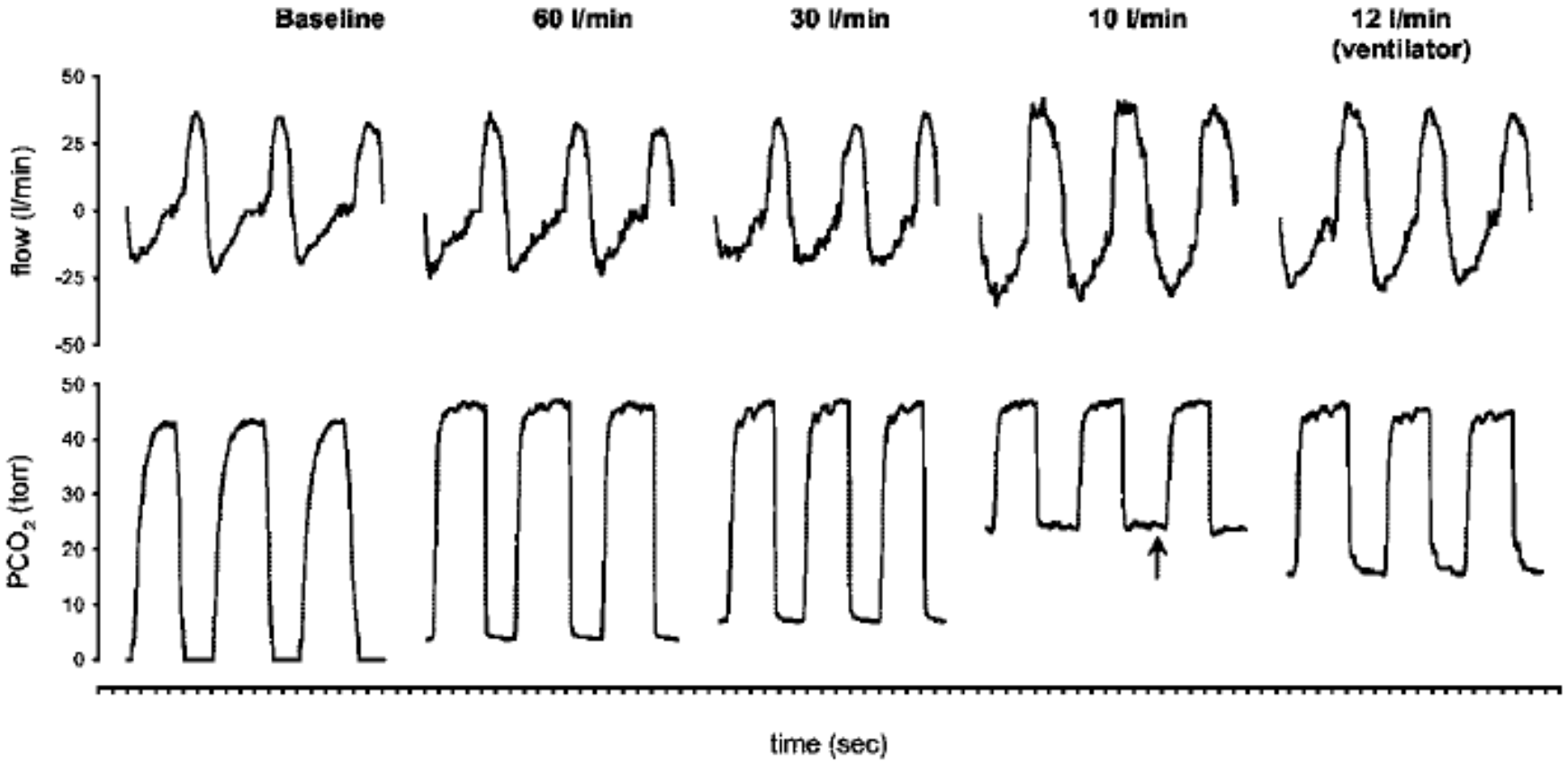
Continuous positive airway pressure delivered with a "helmet": Effects on carbon dioxide rebreathing*

Paolo Taccone, MD; Dean Hess, PhD, RRT; Pietro Caironi, MD; Luca M. Bigatello, MD

Necessita di gas ad alti flussi (>30L/min) per wash-out della CO_2

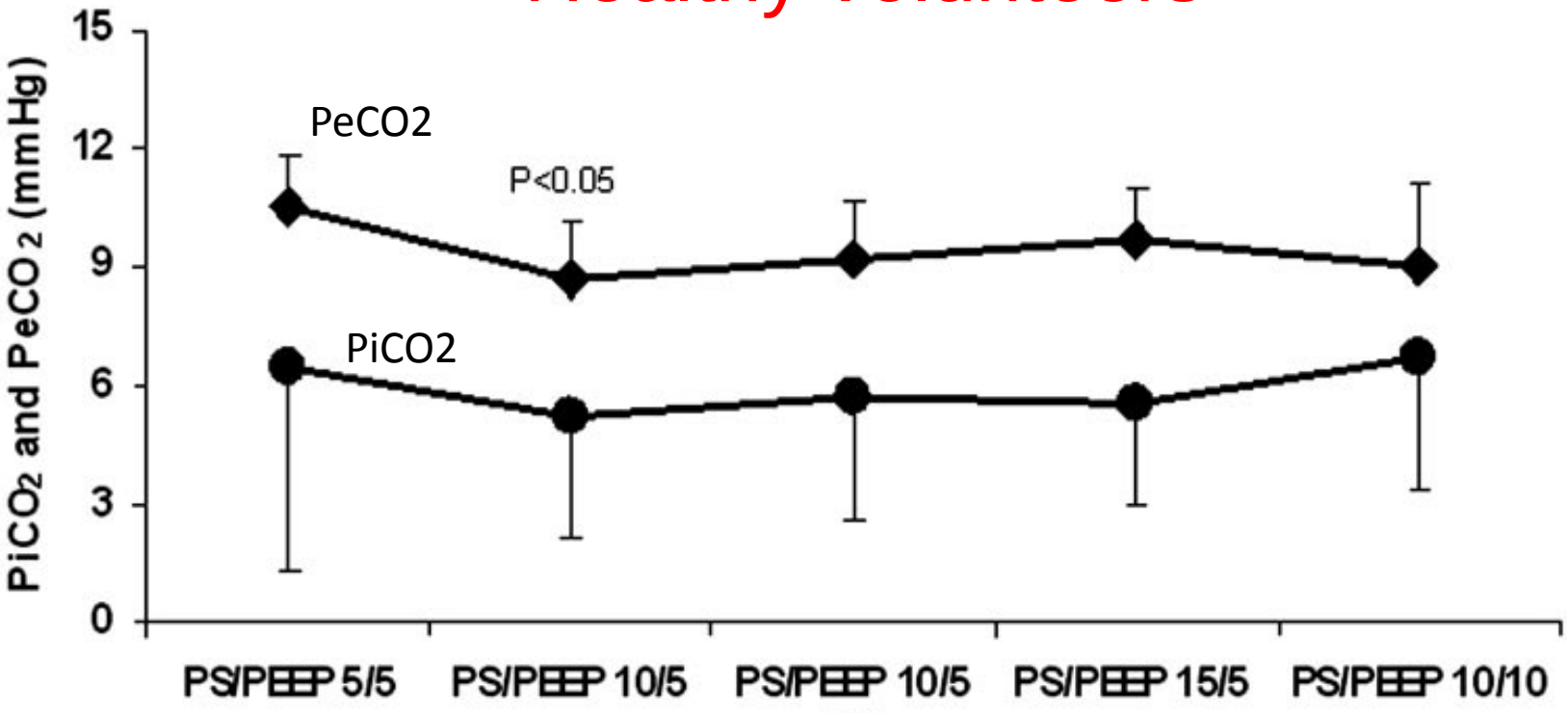
Crit Care Med 2004 Vol. 32, No. 10

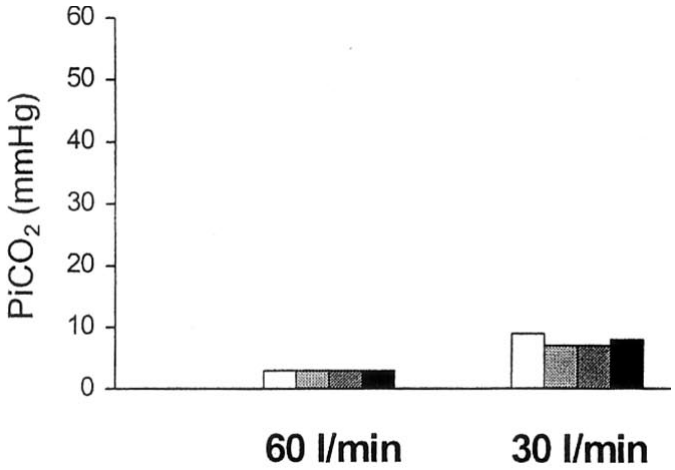




Taccone P. et al.Am J Resp Crit Care Med 167;7:A995 (2003)

Healthy volunteers





Costa R *(CHEST 2005; 128:2984–2990)*

Paolo Navalesi
Roberta Costa
Piero Ceriana
Annalisa Carlucci
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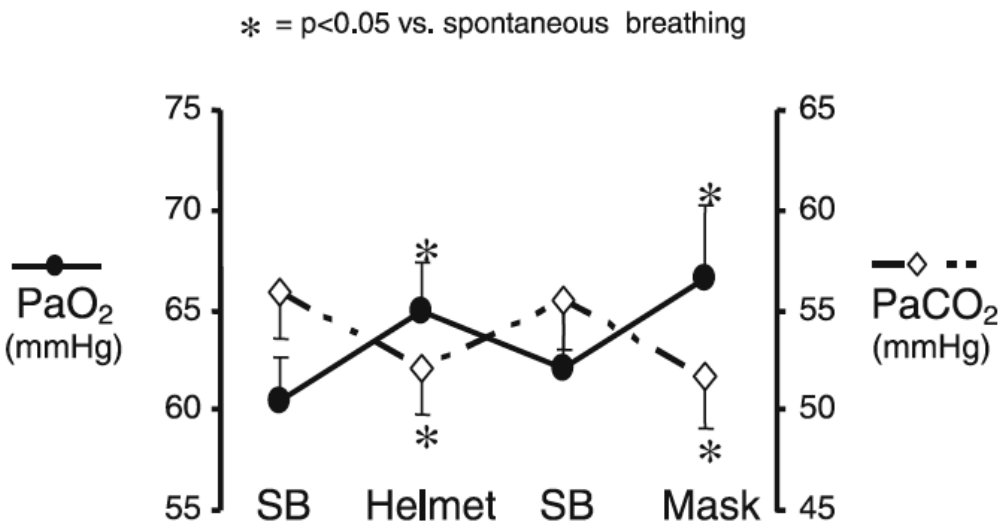
Stefano Nava

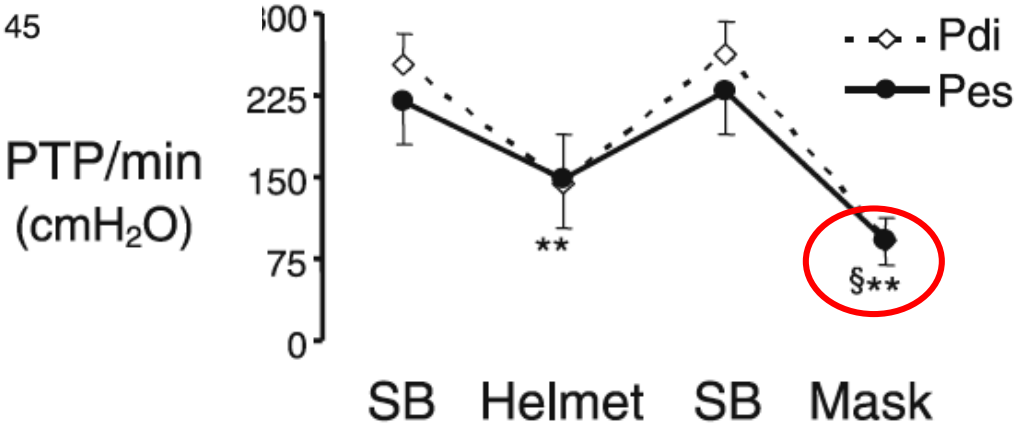
Non-invasive ventilation in chronic obstructive pulmonary disease patients: helmet versus facial mask

Intensive Care Med (2007) 33:74–81



10 COPD patients

PS 12; PEEP 5



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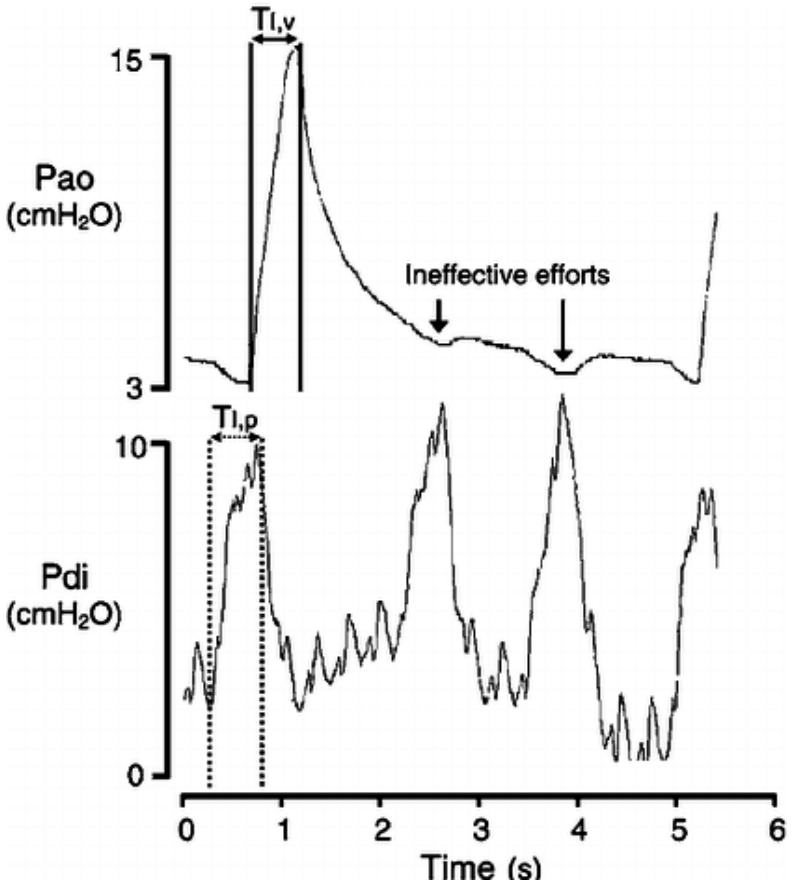
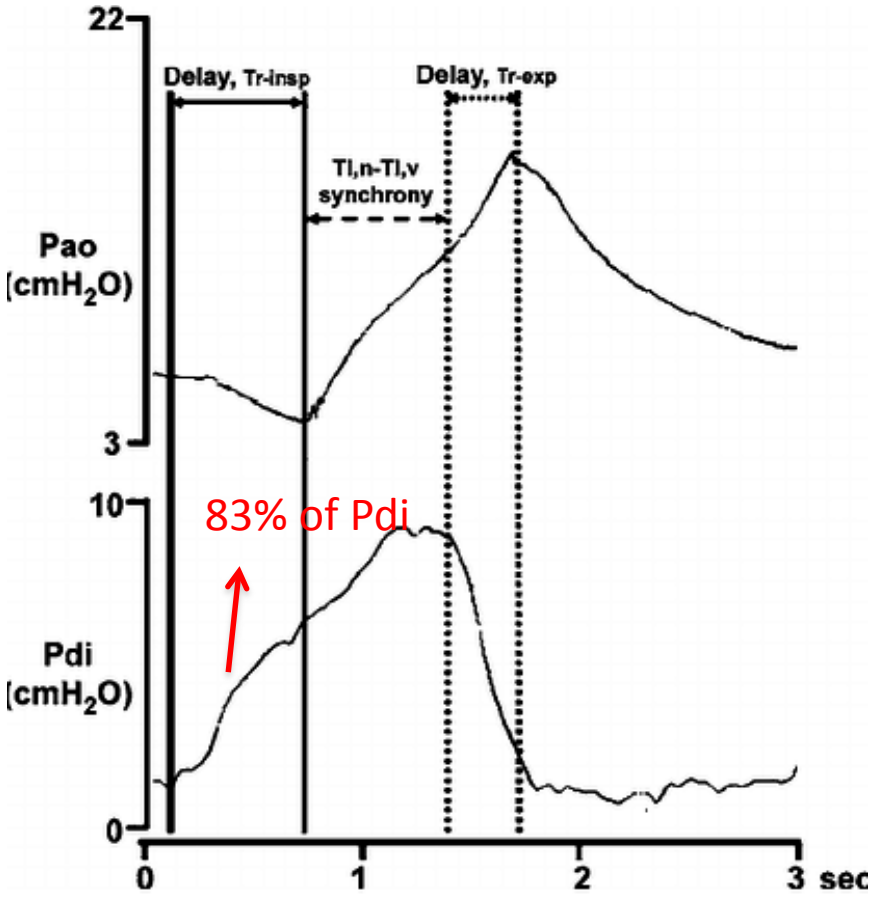
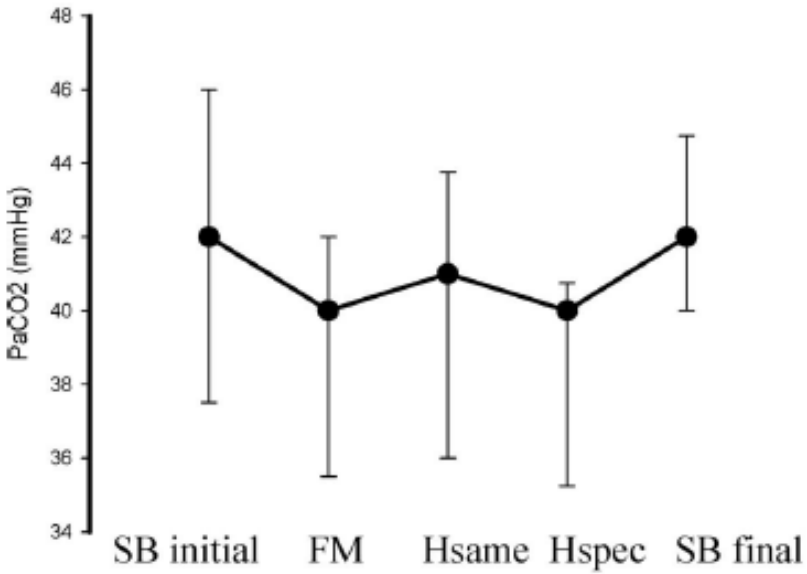




How to overcome the problem of asynchrony and CO_2 rebreathing?

Helmet with specific settings versus facemask for noninvasive ventilation*

Frédéric Vargas, MD; Arnaud Thille, MD; Aissam Lyazidi, Biomed Eng Master; Ferran Roche Campo, MD; Laurent Brochard, MD, PhD



Hsame= Helmet with same setting of the mask

Hspec= PEEP and PS increased of 50%

	SB Initial	FM	Hsame	Hspec
Pdi (cm H_2O)	6.6 (5.1–10.3)	3.0 (1.8–4.9)[a]	4.9 (2.4–5.2)[b]	2.5 (1.5–3.7)[a]
PTPdi/min (cm H_2O·s·min^{-1})	209.3 (129.8–259.6)	63.8 (27.3–85.9)[a]	81.8 (36.0–111.5)[b]	58.0 (25.4–79.5)[a]

(Crit Care Med 2009; 37:1921–1928)

Helmet with specific settings versus facemask for noninvasive ventilation*

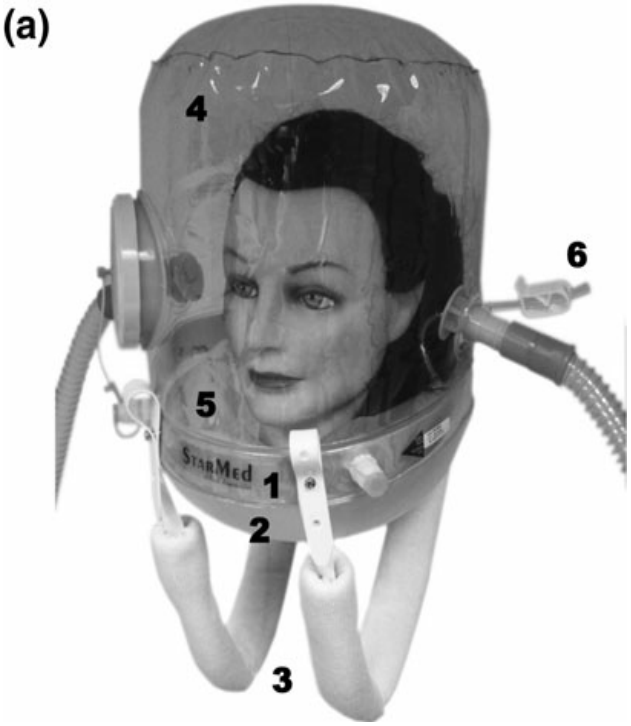
Frédéric Vargas, MD; Arnaud Thille, MD; Aissam Lyazidi, Biomed Eng Master; Ferran Roche Campo, MD; Laurent Brochard, MD, PhD

Conclusions: **Our results suggest that increasing both the pressure-support level and positive end-expiratory pressure and using the highest pressurization rate may be advisable when providing NPSV via a helmet. (Crit Care Med 2009; 37:1921–1928)**

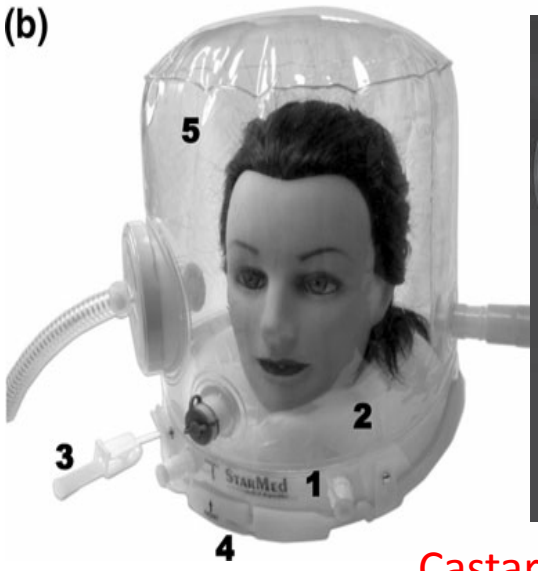
NEW HELMET

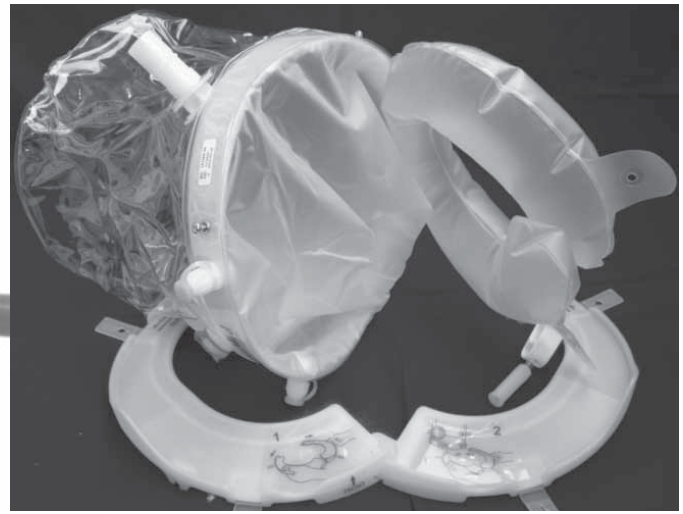
Bench comparative evaluation of a new generation and standard helmet for delivering non-invasive ventilation

Olivieri C Intensive Care Med (2013) 39:734–73



SH





NH

Castar-R Next, Intersurgical (ex-StarMed) Italy

4. Anello apribile
2. Cuscino gonfiabile che stabilizza il casco
3. Linea per gonfiaggio cuscino

RESEARCH Open Access

Comparative evaluation of three interfaces for non-invasive ventilation: a randomized cross-over design physiologic study on healthy volunteers

Rosanna Vaschetto[1,2], Audrey De Jong[2], Matthieu Conseil[2], Fabrice Galia[2], Martin Mahul[2], Yannael Coisel[2], Albert Prades[2], Paolo Navalesi[3,4,5] and Samir Jaber[2,6*]

CRITICAL CARE

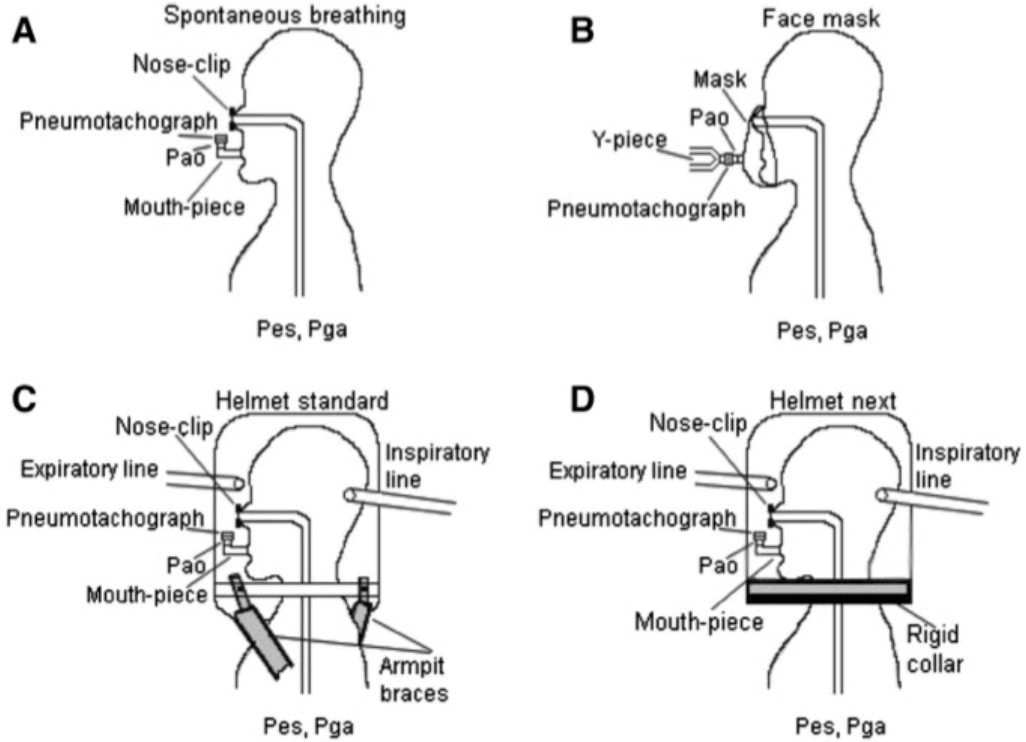


Figure 1 Schematic representation of the experimental design. (A) Spontaneous breathing; **(B)** face mask; **(C)** helmet standard; **(D)** helmet next. Pao, pressure at the airway opening; Pes, esophageal pressure; Pga, gastric pressure.

	PS 5; PEEP 5			PS 8; PEEP 8	
	Baseline settings			Increased settings	
	FM	H_S	H_N	H_S	H_N
V_T ml	596 ± 147	794 ± 250	821 ± 240	882 ± 276	853 ± 278
RRn breath/minute	15 ± 7	14 ± 5	14 ± 5	13 ± 4	14 ± 5
V_E L/minute	8.1 ± 2.3	10.2 ± 2.7	11.1 ± 4.9	10.6 ± 3.0	11.6 ± 4.7
PTPdi/breath	17.0 ± 11.0	16.6 ± 10.0	15.7 ± 10.7	13.0 ± 10.5	10.7 ± 9.9
PTPdi/minute	204 ± 81	201 ± 92	198 ± 109	142 ± 80	128 ± 96
PTPdi/L	30.2 ± 16.8	21.6 ± 10.5	20.9 ± 13.2	15.2 ± 10.0	12.6 ± 9.9

Vaschetto *et al. Critical Care* 2014, **18**:R2

PS 5; PEEP 5

	FM		H_S	H_N
Delay,TR-insp (s)	0.181 ± 0.086	≠	0.354 ± 0.081	0.276 ± 0.091
Delay,TR-exp (s)	0.275 ± 0.038		0.395 ± 0.093	0.301 ± 0.044
TI,Synchrony (%)	90 ± 4		79 ± 7	83 ± 4

PS 8; PEEP 8

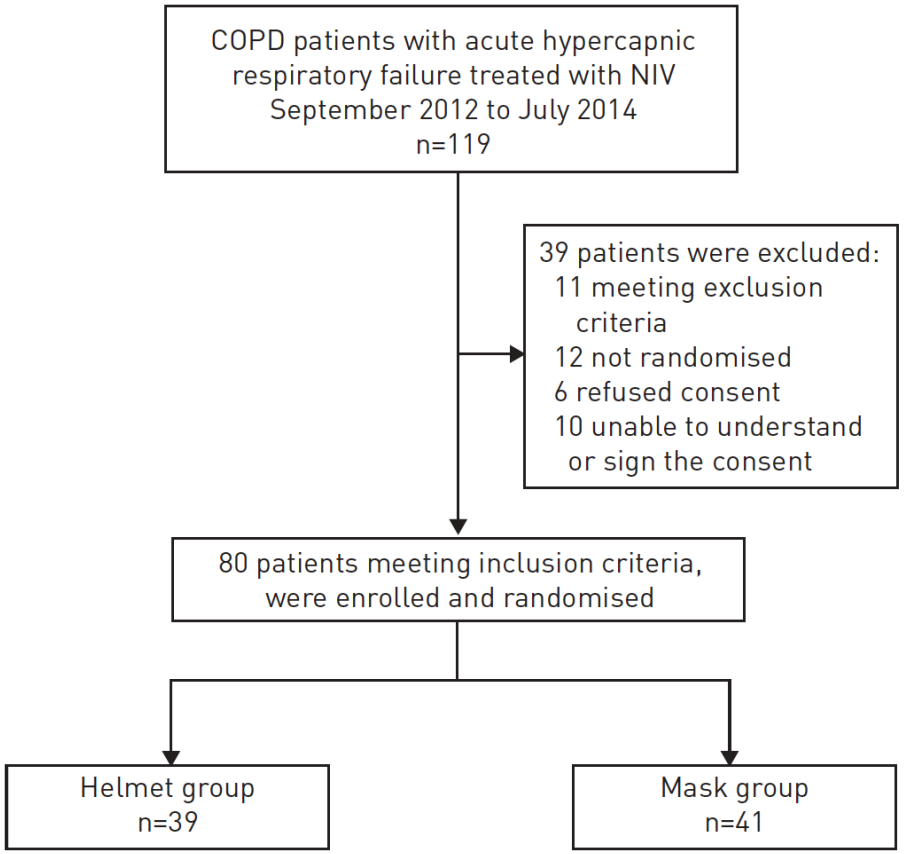
	H_S	=	H_N
Delay,TR-insp (s)	0.345 ± 0.073		0.230 ± 0.061
Delay,TR-exp (s°	0.367 ± 0.074		0.290 ± 0.099
TI,Synchrony (%)	80 ± 5		85 ± 2

Vaschetto *et al. Critical Care* 2014, **18**:R2

CLINICAL APPLICATION

Oronasal mask *versus* helmet in acute hypercapnic respiratory failure

Lara Pisani[1], Chiara Mega[1], Rosanna Vaschetto[2], Andrea Bellone[3], Raffaele Scala[4], Roberto Cosentini[5], Muriel Musti[6], Manuela Del Forno[1], Mario Grassi[7], Luca Fasano[8], Paolo Navalesi[9,10,11] and Stefano Nava[1]



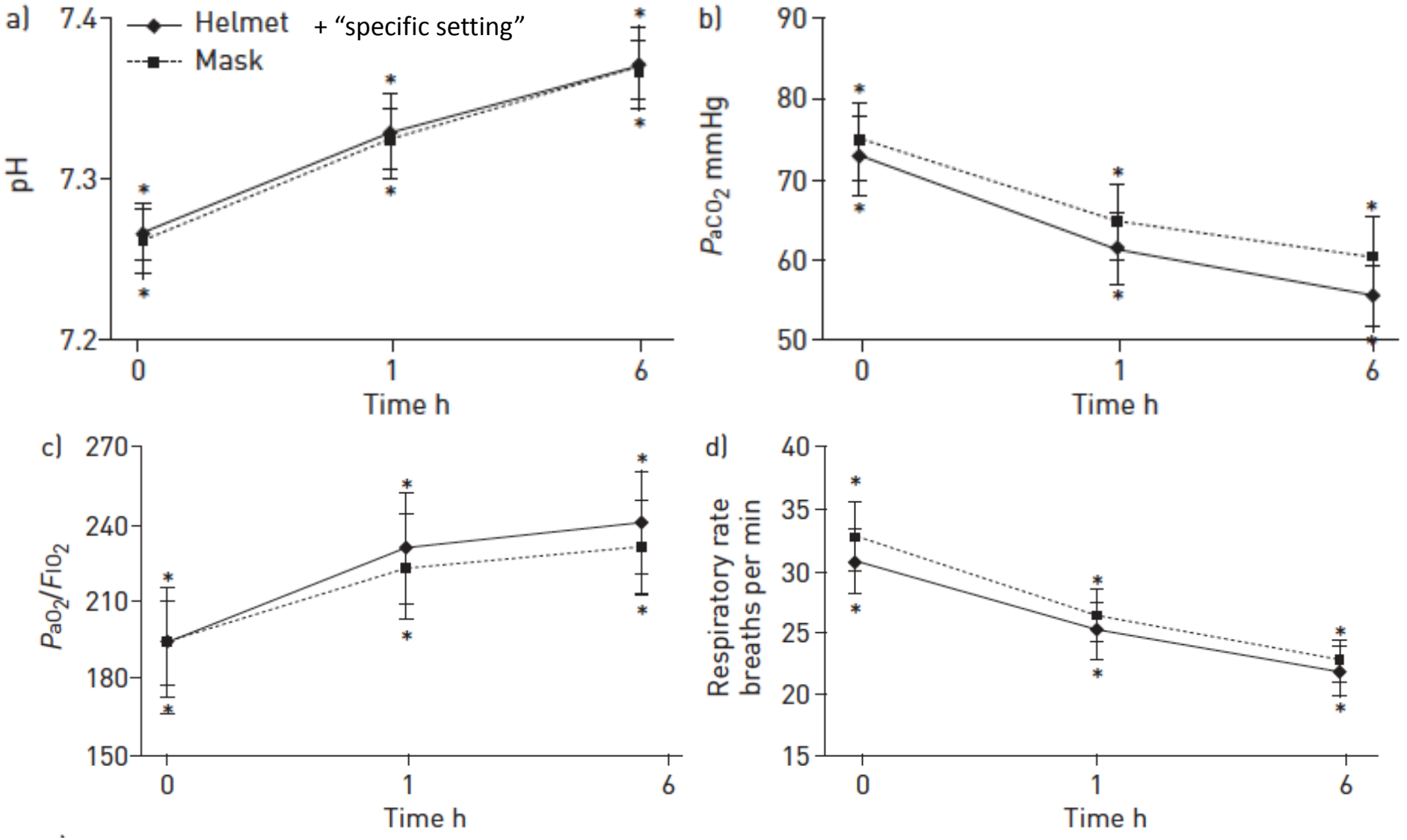
Eur Respir J 2015; 45: 691–699

Baseline characteristics of the patients

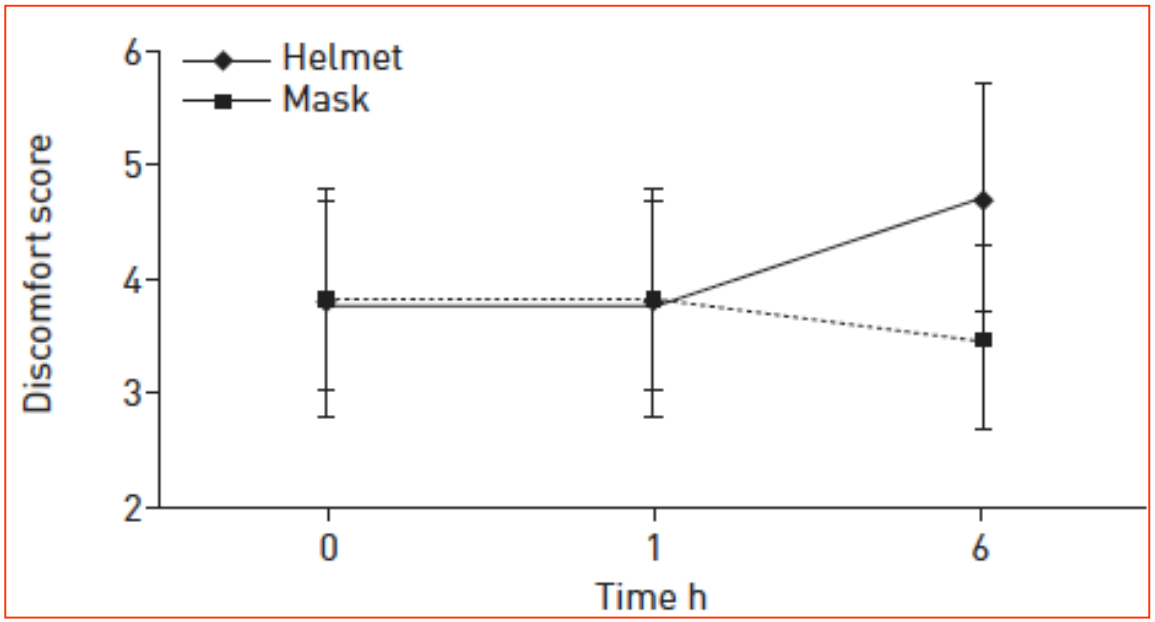
	Helmet	Mask
Subjects n	39	41
Age years	78.36±10.58	78.48±7.75
Kelly score	2.28±1.21	2.19±1.23
SAPS II	35.41±10.36	35.68±10.51
Dyspnoea score	7.68±2.20	7.06±2.75
Charlson index	3.49±1.60	3.49±1.88
Secretions	1.78±0.95	2.10±1.04
Systolic blood pressure mmHg	139.15±31.03	140.8±31.85
Diastolic blood pressure mmHg	73.23±17.47	73.38±21.26
Heart rate beats per min	98.08±17.58	98.02±20.27
Respiratory rate breaths per min	30.82±8.10	32.88±8.75
Body temperature °C	36.40±0.42	36.70±0.85
Arterial pH	7.27±0.05	7.26±0.06
P_{aO_2} mmHg	70.84±31.05	68.95±39.97
P_{aCO_2} mmHg	72.58±14.87	74.45±15.25
HCO_3^- mmol·L^{-1}	30.68±6.97	31.32±7.24
P_{aO_2}/F_{IO_2}	193.33±50.74	194.05±67.89

Eur Respir J 2015; 45: 691–699

PRIMARY OUTCOME



Eur Respir J 2015; 45: 691–699



	Helmet	Mask
Subjects n	39	41
Change of interface	2 (5.1)	1 (2.4)
Reason	Claustrophobia in 2 (5.1)	Deterioration of ABGs in 1 (2.4)
ETI	0 (0)	2 (4.8)
Side-effects		
Noise	4 (10.2)	0 (0)
Claustrophobia	2 (5.1)	1 (2.4)
Gastric distension	2 (5.1)	2 (4.8)
Vomiting	0 (0)	1 (2.4)
Sweating	0 (0)	0 (0)
Tightness	3 (7.6)	5 (12.1)

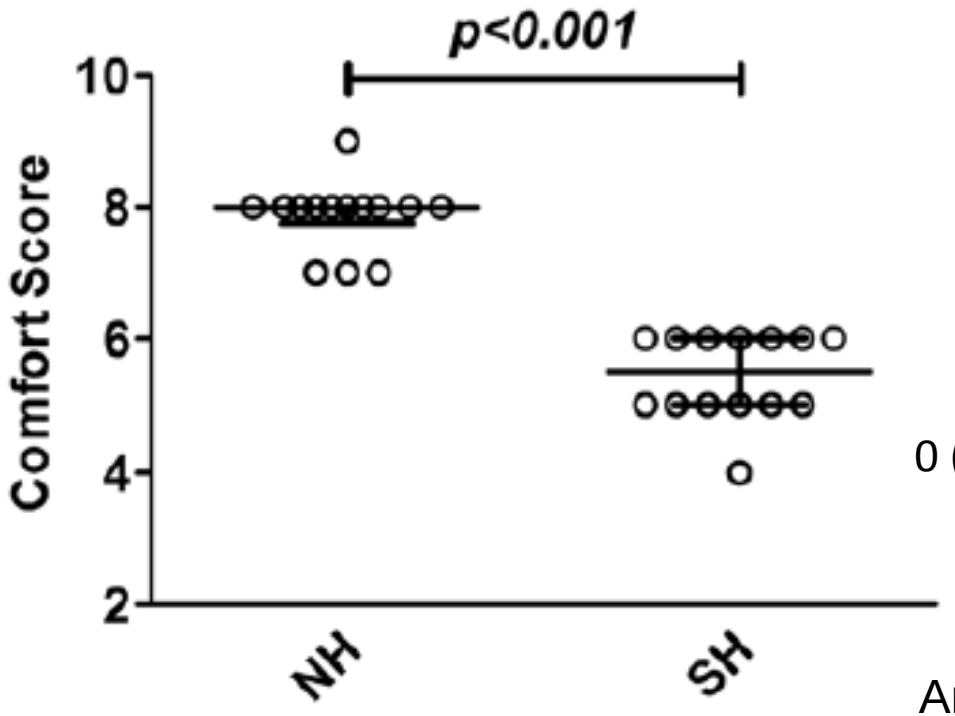
Eur Respir J 2015; 45: 691–699

EXTENDING CLINICAL INDICATION

New *versus* Conventional Helmet for Delivering Noninvasive Ventilation

A Physiologic, Crossover Randomized Study in Critically Ill Patients

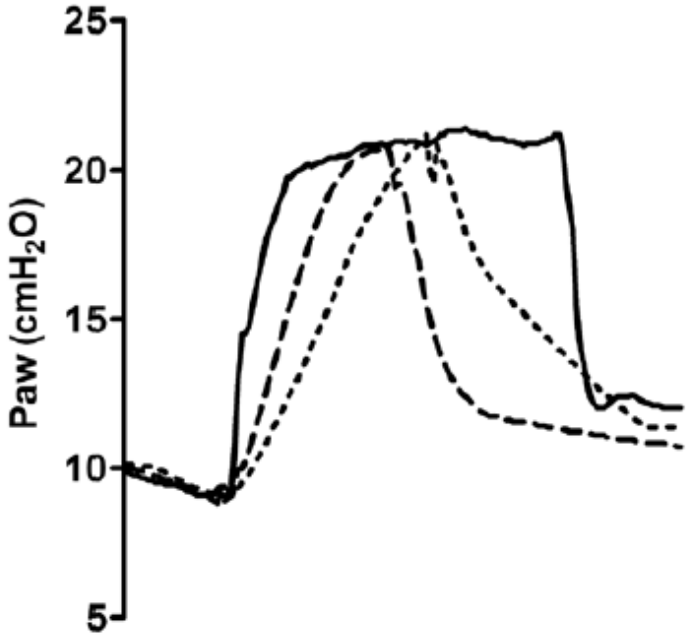
Patients at risk for post-extubation failure



PRIMARY OUTCOME

0 (worst possible) and 10 (best possible)

Anesthesiology. 2016 Jan;124(1):101-8.



SECONDARY OUCOMES

IET
NH
SH

	ET	NH	SH
pH	7.42 (7.40–7.46)	7.44 (7.40–7.46)	7.42 (7.40–7.43)
$PaCO_2$ (mmHg)	39.5 (37.1–43.6)	38.7 (36.1–44.7)	40.1 (38.3–53.3)
PaO_2:FIO_2	219 (184–240)	242 (192–269)	224(204–289)
$Delay_{TR-insp}$ (s)	0.12 (0.09–0.19)	0.25 (0.18–0.31)*	0.31 (0.22–0.43)†‡
$Delay_{TR-exp}$ (s)	0.17 (0.15–0.24)	0.10 (0.05–0.14)*	0.13 (0.08–0.21)
$Time_{synch}/Ti_{neu}$	0.85 (0.77–0.90)	0.71 (0.61–0.81)*	0.64 (0.48–0.72)†‡

Anesthesiology. 2016 Jan;124(1):101-8.

Preliminary Communication | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Noninvasive Ventilation Delivered by Helmet vs Face Mask on the Rate of Endotracheal Intubation in Patients With Acute Respiratory Distress Syndrome

A Randomized Clinical Trial

JAMA. doi:10.1001/jama.2016.6338
Published online May 15, 2016.

Bhakti K. Patel, MD; Krysta S. Wolfe, MD; Anne S. Pohlman, MSN; Jesse B. Hall, MD; John P. Kress, MD

A single-center trial of 83 patients with ARDS

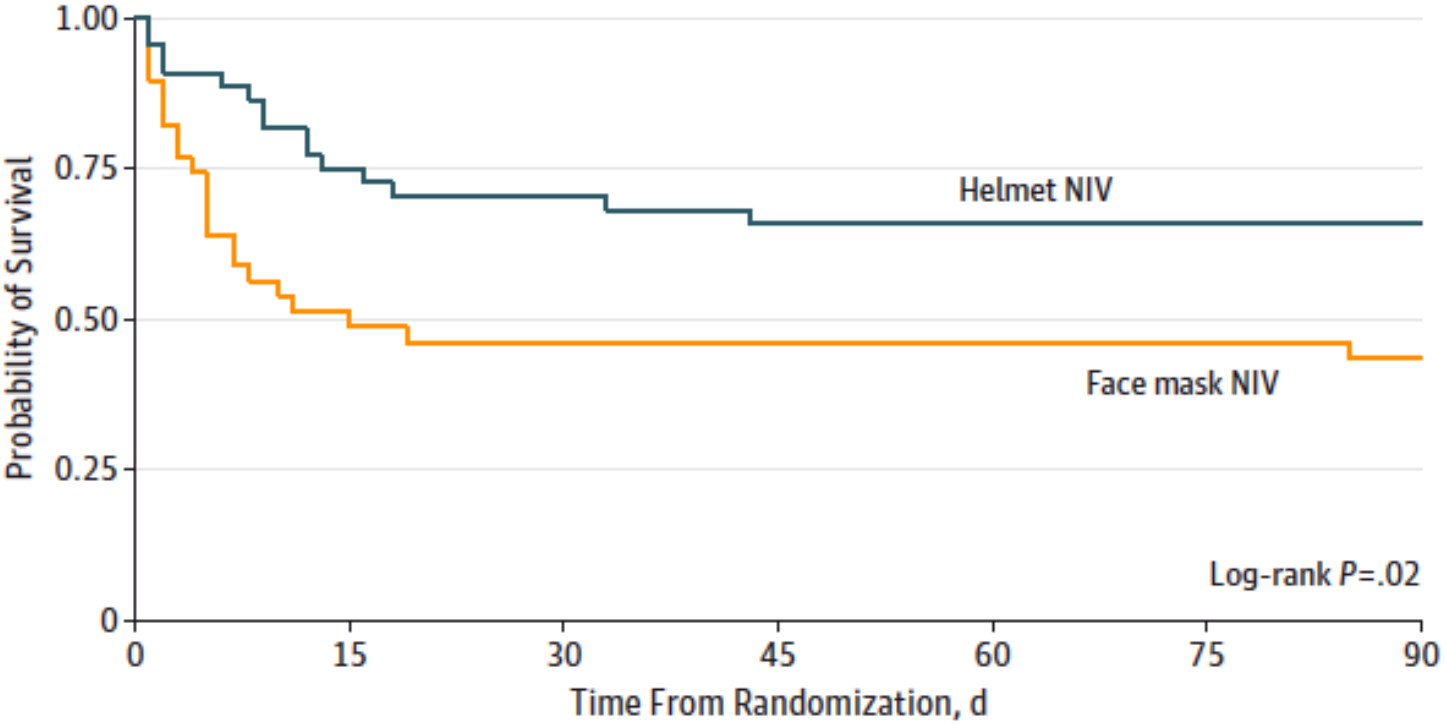
AIM: To determine whether NIV delivered by helmet improves intubation rate among patients with ARDS

Eligible patients had received facemask NIV for at least 8 hours as part of their usual clinical care

Table 2. Primary and Secondary Outcomes and Adverse Events

	Face Mask (n = 39)	Helmet (n = 44)	Absolute Difference (95% CI)	*P* Value
Primary outcome, No. (%)				
Endotracheal intubation	24 (61.5)	8 (18.2)	−43.3 (−62.4 to −24.3)	<.001
Reason for intubation				
Respiratory failure	20 (83.3)	3 (37.5)	−45.3 (−82.5 to −9.1)	.01
Circulatory failure	3 (12.5)	0 (0)	−12.5 (−25.7 to 0.7)	.55
Neurologic failure	1 (4.2)	5 (62.5)	58.3 (24.8 to 92.8)	.001
Secondary outcomes, median (IQR), d				
Ventilator-free days	12.5 (0.49-28)	28 (13.7-28)	8.4 (13.4 to 3.4)	<.001
ICU length of stay	7.8 (3.9-13.8)	4.7 (2.5-8.7)	−2.76 (−6.07 to 0.54)	.04
Hospital length of stay	15.2 (7.8-19.7)	10.1 (6.5-15.9)	−2.92 (−8.47 to 2.63)	.16
Mortality, No. (%)				
Hospital	19 (48.7)	12 (27.3)	−21.4 (−41.9 to −1.0)	.04
90 d[a]	22 (56.4)	15 (34.1)	−22.3 (−43.3 to −1.4)	.02
Adverse events				
Mask deflation	0 (0)	2 (4.5)		
Skin ulceration	3 (7.6)	3 (6.8)		

JAMA. doi:10.1001/jama.2016.6338
Published online May 15, 2016.



No. at risk							
Face mask	39	20	18	18	18	18	17
Helmet	44	33	31	29	29	29	29

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The data and safety monitoring board stopped the trial early, citing superior efficacy of helmet NIV and new data from another trial that raised concerns about the efficacy of facemask NIV in patients with AHRF*(Frat NEJM 2015;372(23):2185-2196)*

NHF vs O_2 vs NIV in hypoxemic ARF

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

Jean-Pierre Frat, M.D., Arnaud W. Thille, M.D., Ph.D., Alain Mercat, M.D., Ph.D., Christophe Girault, M.D., Ph.D., Stéphanie Ragot, Pharm.D., Ph.D., Sébastien Perbet, M.D., Gwénael Prat, M.D., Thierry Boulain, M.D.,

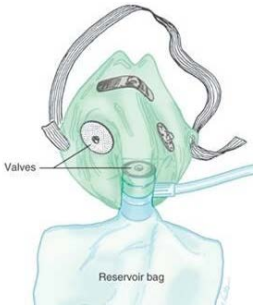
PEEP= 2-10 cmH2O (5±1)
PS to reach VT 7-10 mL/kg (8±3)

310 pz
RR >25 a/min; PaO2/FiO2 ≤300, PaCO2 ≤45 mmHg
No chronic respiratory diseases

O2> 10 L/min

For 2 days

>8hrs/day x 2 days



SpO2 ≥92%

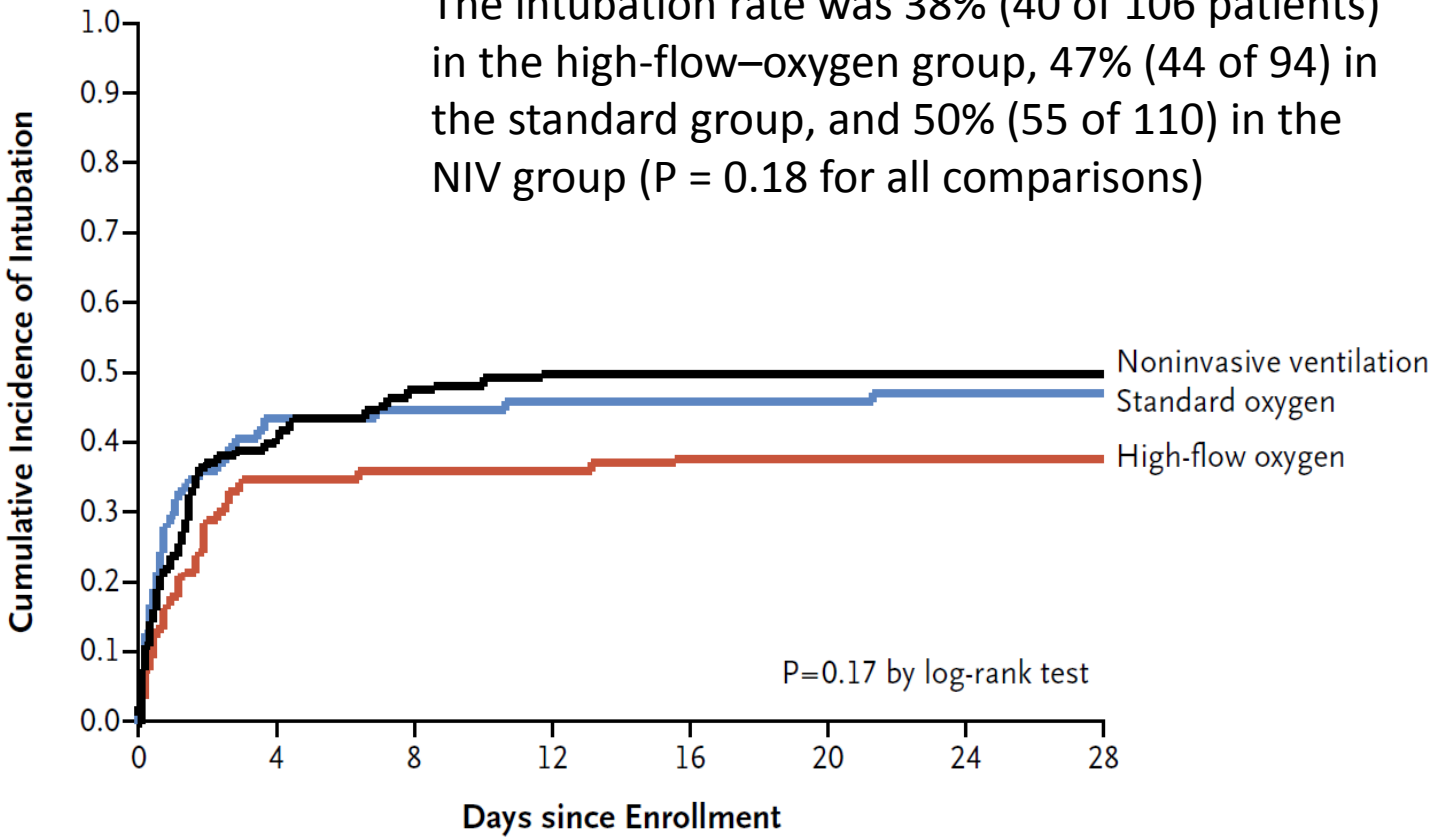
94	106	110
Oxygen group	HFNC group	NIV/HFNC group

Frat J-P et al. NEJM 2015;372:2185-96

Primary outcome

A **Overall Population**

The intubation rate was 38% (40 of 106 patients) in the high-flow–oxygen group, 47% (44 of 94) in the standard group, and 50% (55 of 110) in the NIV group (P = 0.18 for all comparisons)

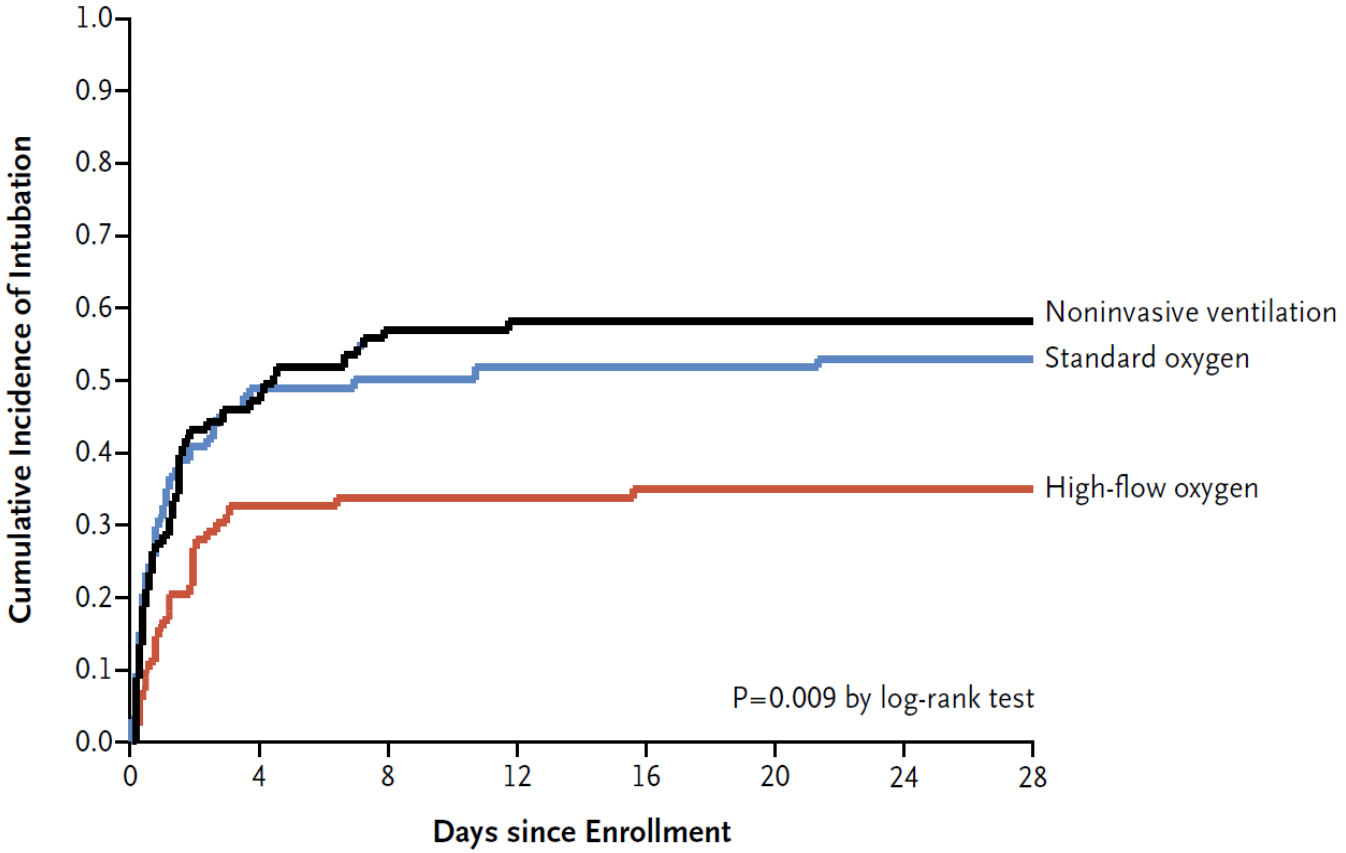


No. at Risk								
High-flow oxygen	106	68	67	67	65	65	65	65
Standard oxygen	94	52	50	49	49	49	48	48
Noninvasive ventilation	110	64	57	53	53	53	53	52

Frat J-P et al. NEJM 2015;372:2185-96

Primary outcome

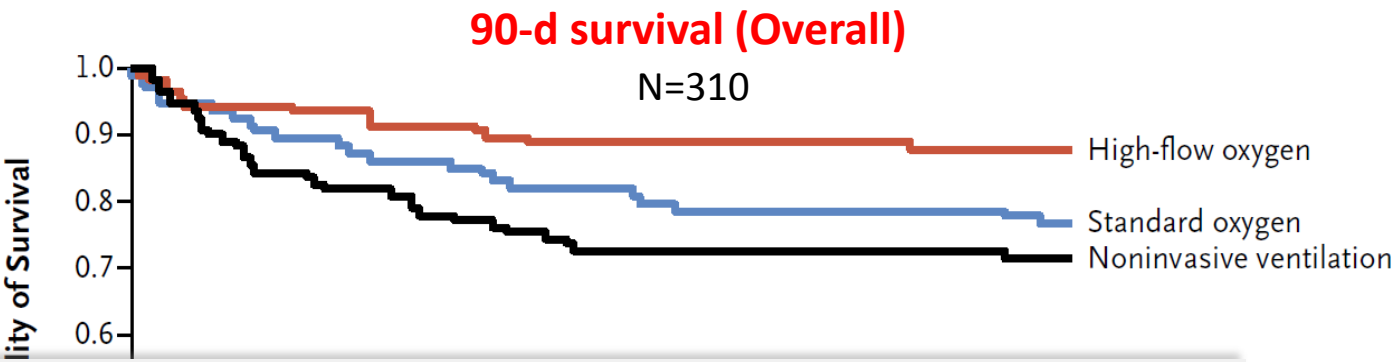
B Patients with a Pao_2:FIO_2 ≤200 mm Hg



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

Frat J-P et al. NEJM 2015;372:2185-96

NHF vs O_2 vs NIV in hypoxemic ARF



With NHF:

- Lower dyspnea
- Lower patient's discomfort
- Lower respiratory rate

VS O2 and NIV group

No. at Ri
High-flow
Standard
Noninvas

Frat J-P et al. NEJM 2015;372:2185-96

Take home messages

- La NIV con il casco presenta dei problemi tecnici (re-breathing CO2 e asincronie) che possono comprometterne il successo

- Il ventilatore sarebbe da evitare in CPAP e in NIV salvo che non vengano effettuate le dovute modifiche di setting

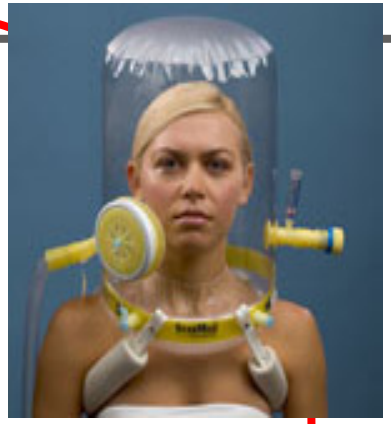
Take home messages

Il nuovo casco:

- ✓ Nell'ipercapnico è efficace quanto la FM nel ridurre la PaCO2, ma sempre migliorando il setting
- ✓ Nell'ipossiemico migliora il comfort e la sincronia paziente/ventilatore rispetto al SH a parità di efficacia

Sono necessari ulteriori studi per confermare i dati nei pazienti con ARDS (NHF vs HELMET?).

Rotating strategy…



…. Prevention is BETTER!


BASTA!

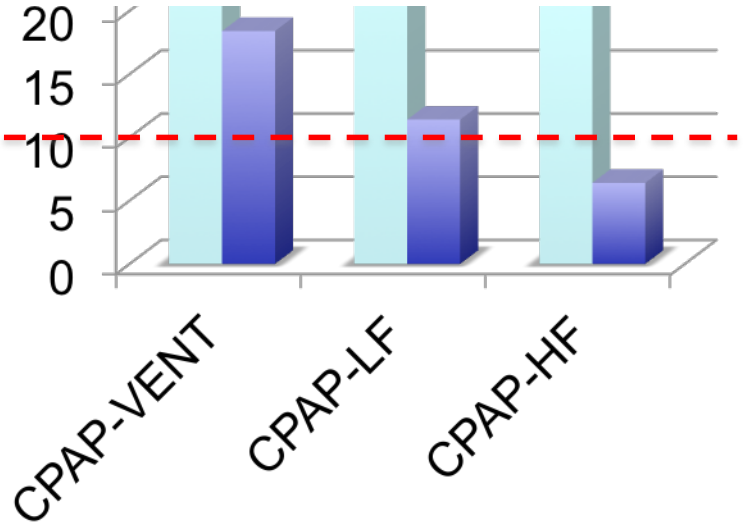
Effect of a heated humidifier during continuous positive airway pressure delivered by a helmet

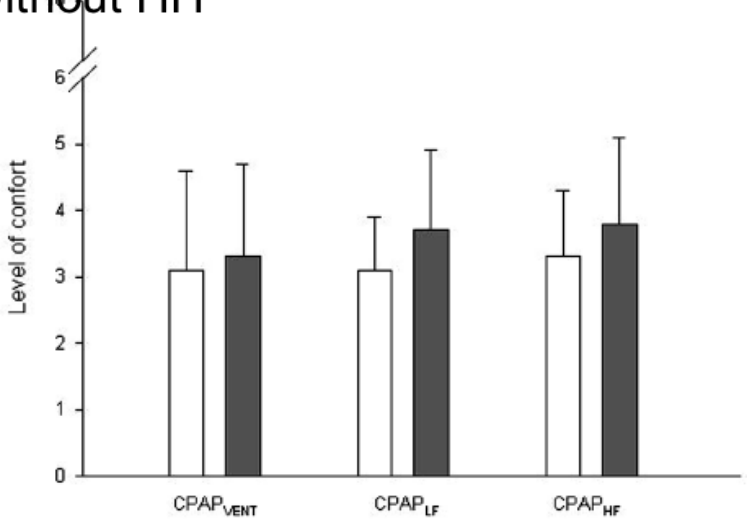
Chiumello D *Critical Care* 2008, 12:R55

Temperature and humidity of the medical gas with and without the heated humidifier in patients with acute respiratory failure

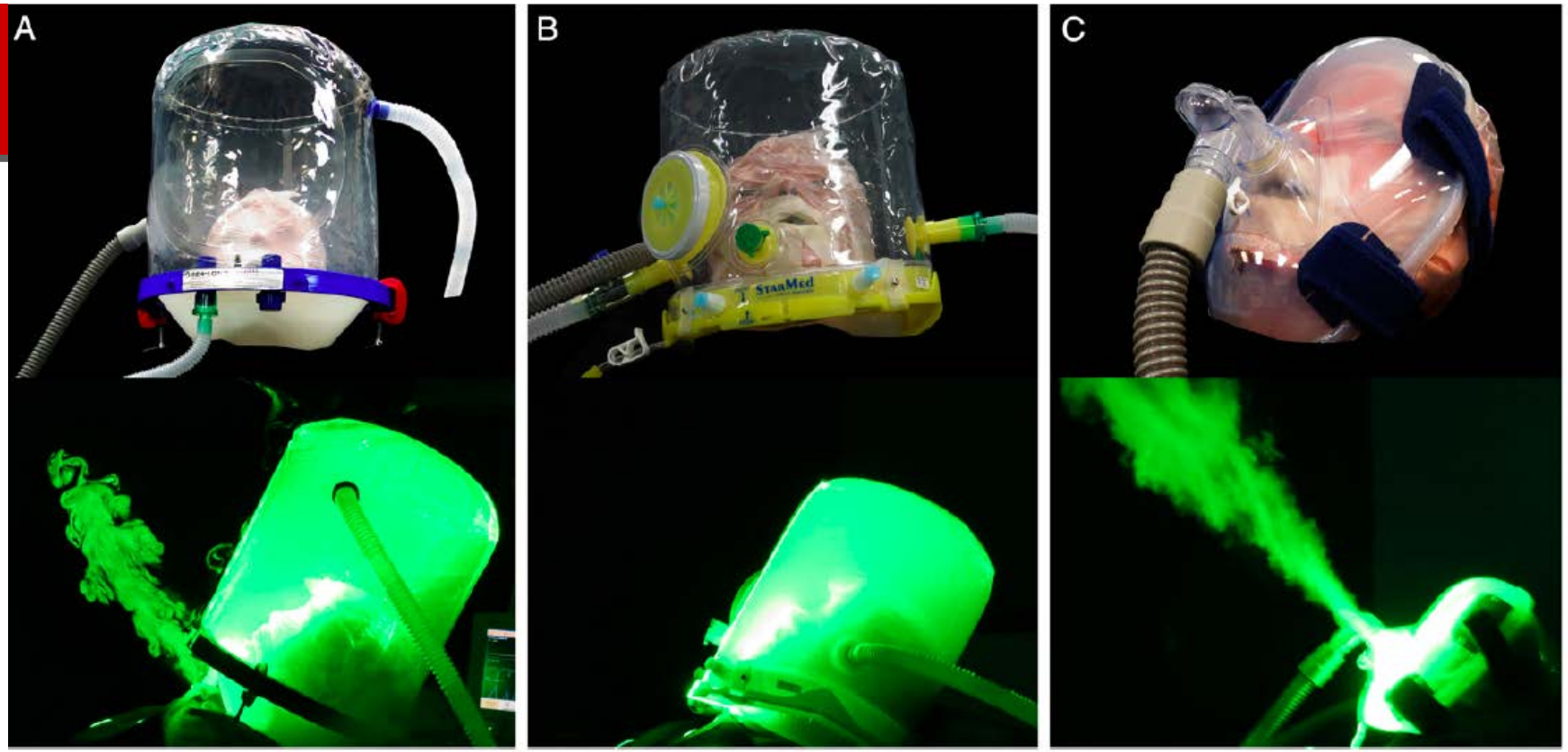
We don't know the long term effects with and without HH in term of Comfort and Efficacy of treatment

absolute minimum humidity required for medical gases during NPPV





Exhaled Air Dispersion During Noninvasive Ventilation via Helmets and a Total Facemask



Hui DS CHEST 2015; 147(5):1336-1343