NIV, casco, maschera e alti flussi: come scegliere

G. Foti

Dipartimento Emergenza Urgenza

UOC Anestesia e Rianimazione

Università Milano Bicocca

ASST Monza e Brianza

Sistema Socio Sanitario

Ospedale San Gerardo

Regione Lombardia

ASST Monza

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Conflict of Interest

- Dimar
- Carefusion, Drager, ThermoFisher, GE

Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Pts. Population

- COPD
- ACPE
- ARDS

Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Modality & Interfaces

- **PEEP +PSV (NIV)**
  - Face mask
  - Helmet
- **CPAP**
  - Face Mask
  - Helmet
- **High Flow Nasal Cannula (HFNC)**

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

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

[#]: all in the setting of acute respiratory failure; [¶]: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

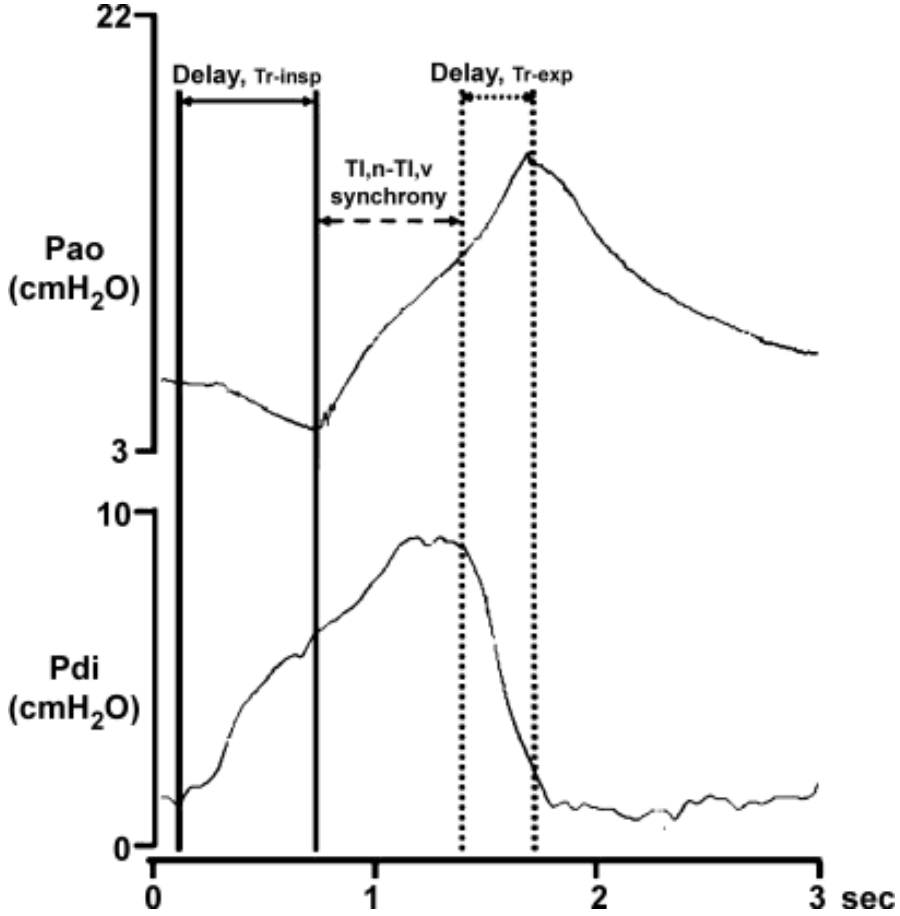
Eur Respir J 2017; 50: 1602426

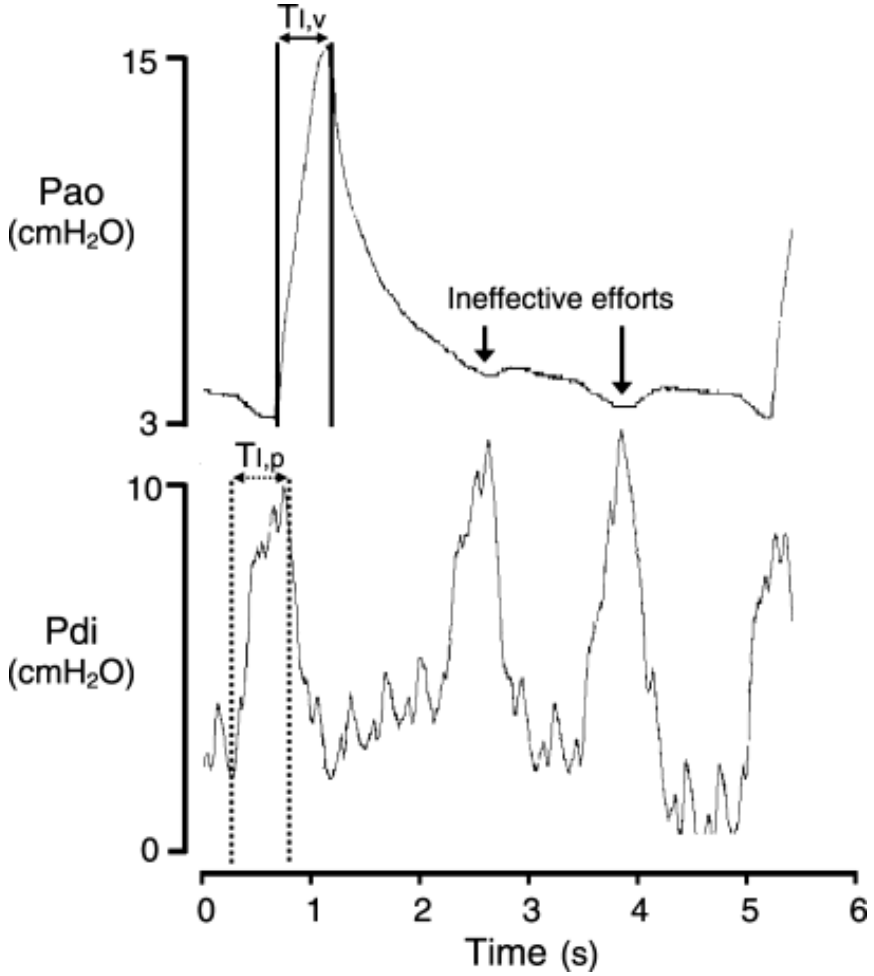
I° scelta COPD : Mask PSV +PEEP

- Questa è la tecnica che ha salvato le vite dei BPCO riacutizzati
- ..esistono altre possibilità ?

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

Paolo Navalesi[1] , Roberta Costa[2], Piero Ceriana[1], Annalisa Carlucci[1], George Prinianakis[3], Massimo Antonelli[2], Giorgio Conti[2] and Stefano Nava[1]





Navalesi P Intensive Care Med. 2007 Jan;33(1):74-81

Intensive Care Med (2013) 39:38–44
DOI 10.1007/s00134-012-2686-x

ORIGINAL

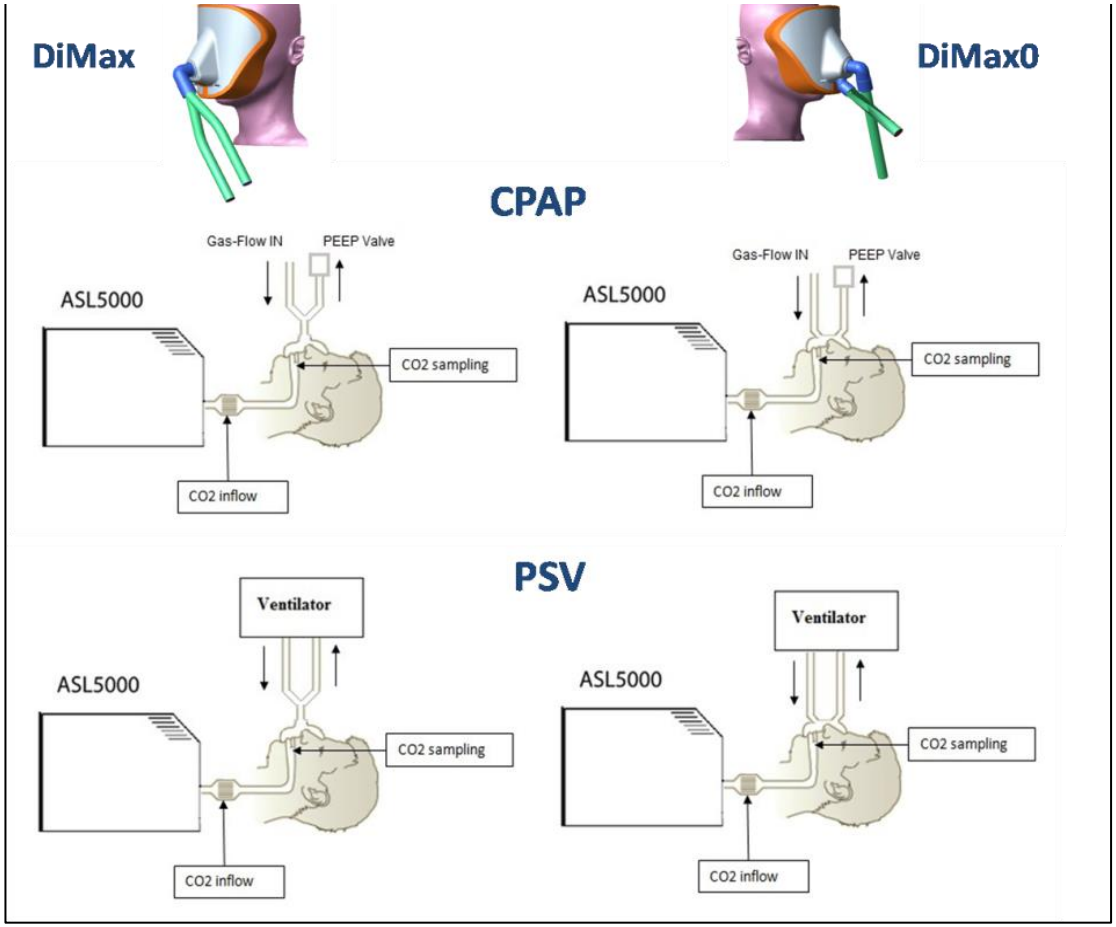
Francesco Mojoli
Giorgio A. Iotti
Ilaria Currò
Marco Pozzi
Gabriele Via
Aaron Venti
Antonio Braschi

An optimized set-up for helmet noninvasive ventilation improves pressure support delivery and patient–ventilator interaction

	Conventional set-up	Optimized set-up	*p*
Pressurization rate (%)	30.8 ± 6.9	51.0 ± 3.5	<0.002
Depressurization rate (%)	34.2 ± 4.6	48.2 ± 3.3	<0.0001
Total helmet MV (l/min)	24.6 ± 6.9	27.7 ± 7.0	<0.02
Leaks (%)	5.4 ± 4.1	2.6 ± 1.3	ns
Inspiratory delay (ms)	461 ± 181	243 ± 109	<0.005
Unassisted efforts (%)	20.3 ± 12.4	3.5 ± 5.4	<0.0001
Autotriggering (%)	4.1 ± 5.4	2.2 ± 2.7	ns

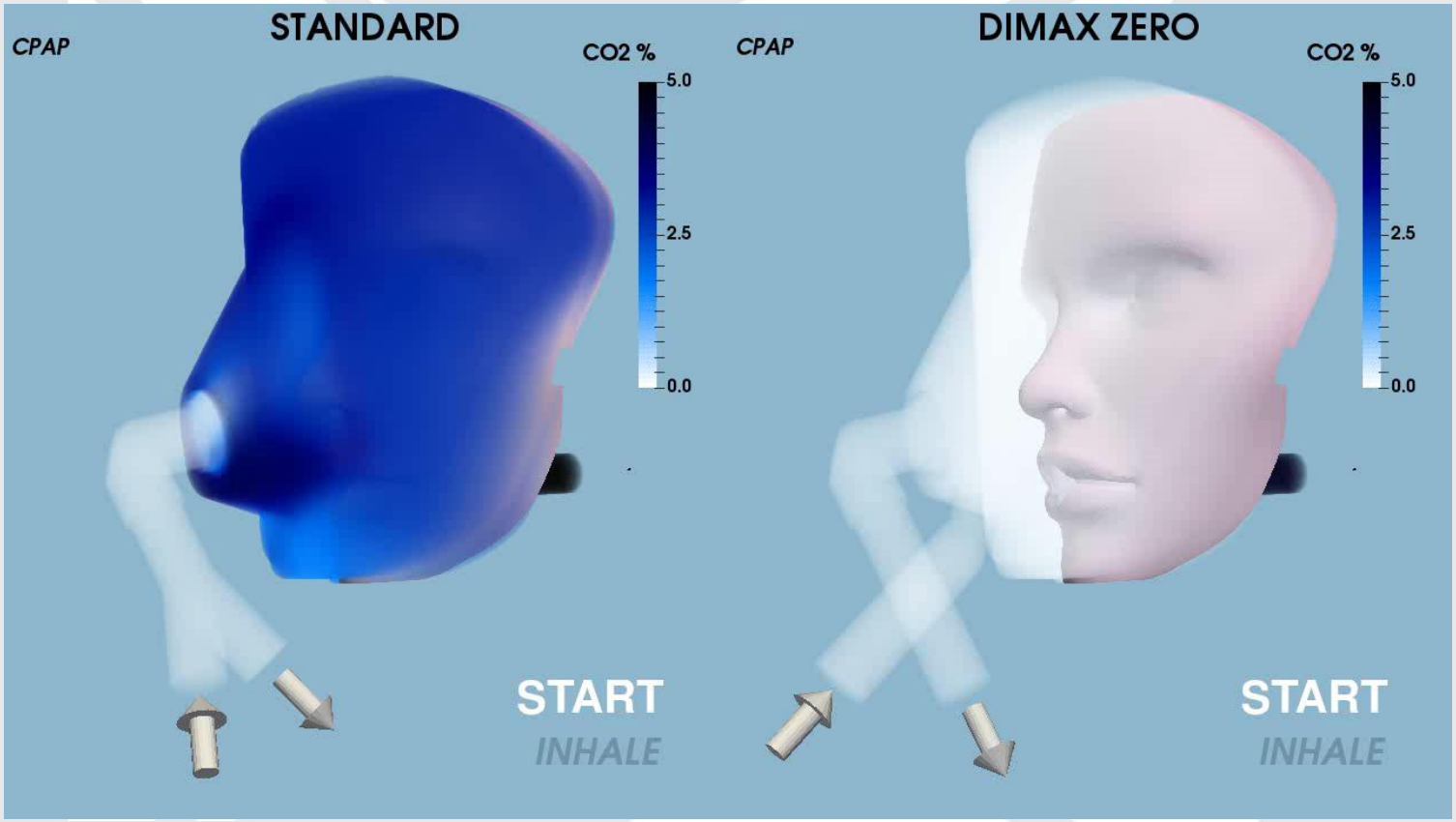
Effect of Face Mask Design and Flow-by on Rebreathing During Noninvasive Ventilation

Davide Signori, Giacomo Bellani, Serena Calcinati, Alice Grassi, Nicolò Patroniti, and Giuseppe Foti



RESPIRATORY CARE Paper in Press. Published on March 26, 2019 as DOI: 10.4187/respcare.06269

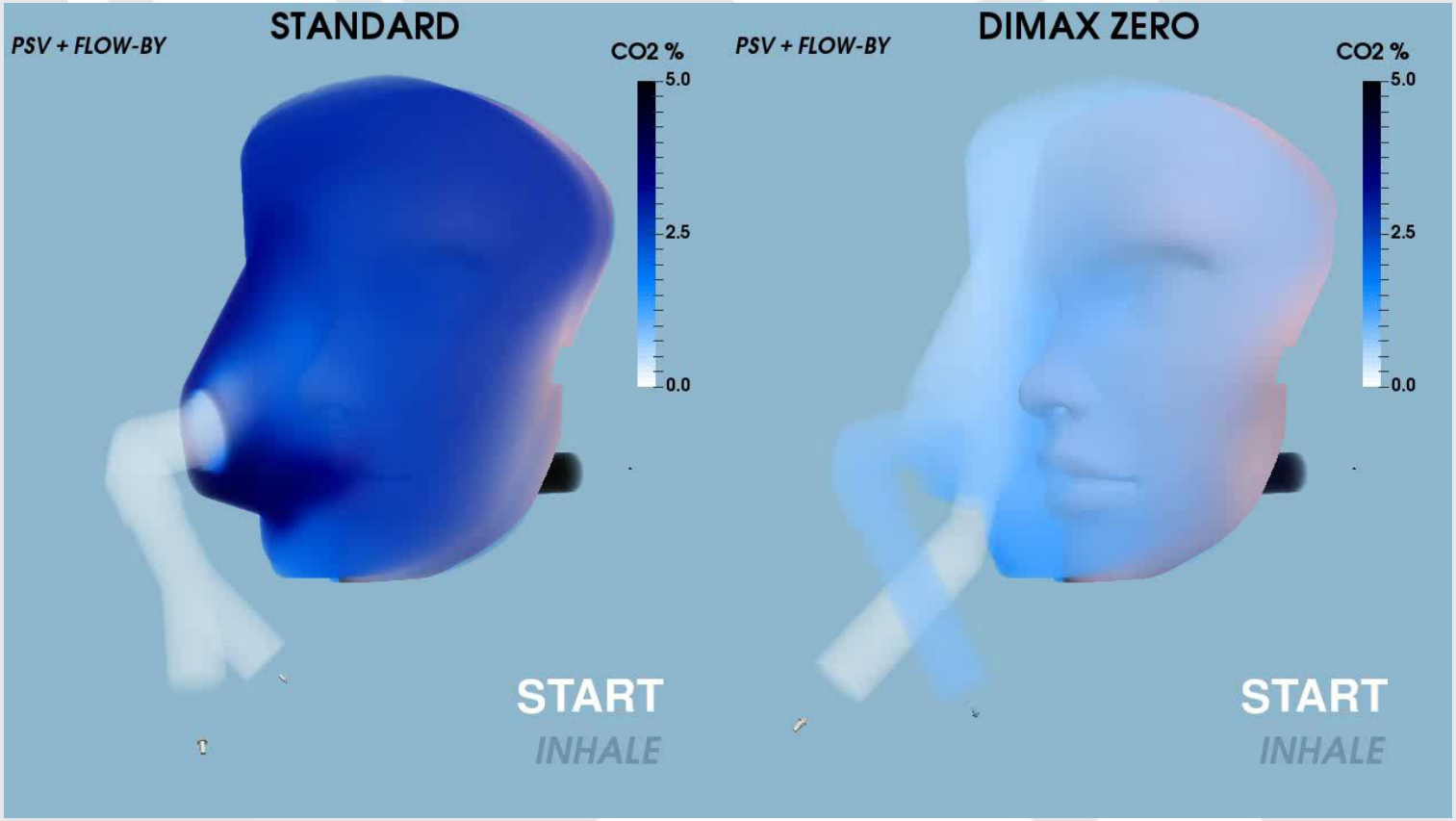
Effect of Face Mask design on CO2 rebreathing during CPAP



Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

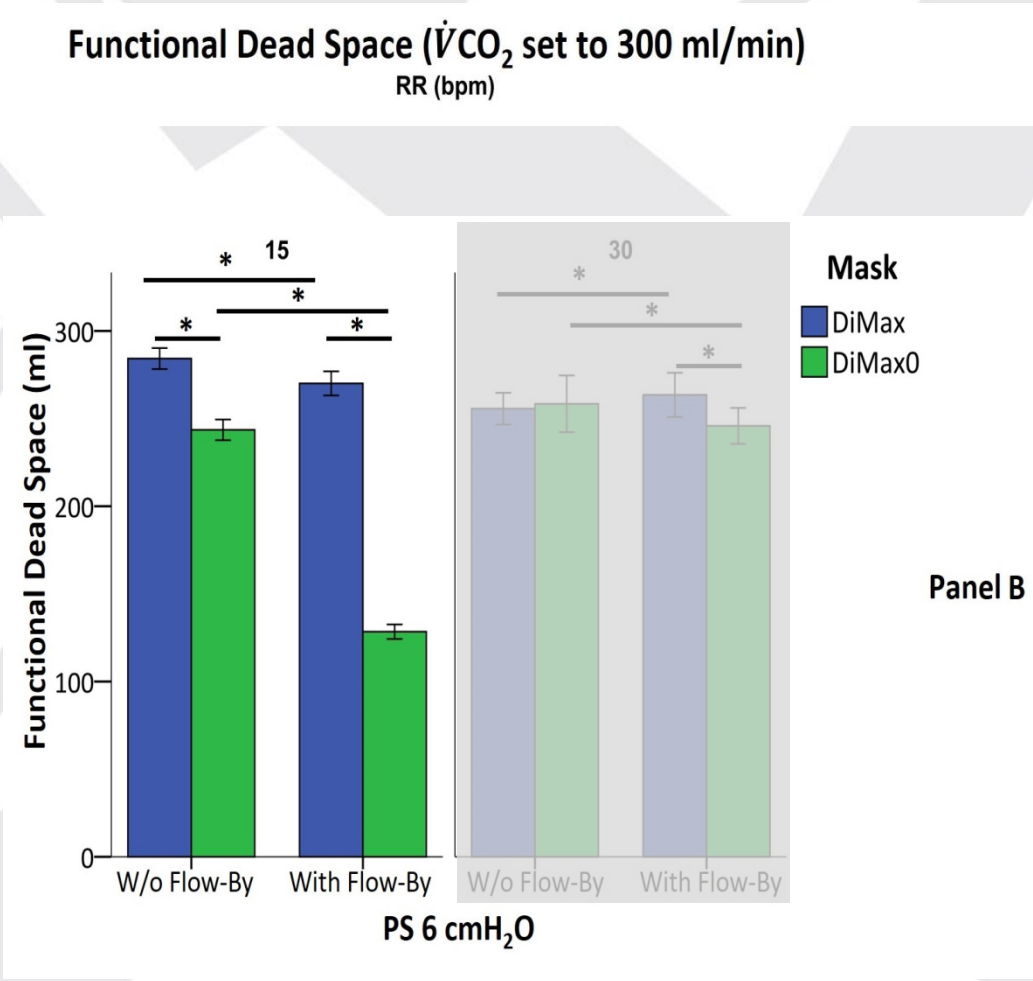
Effect of Face Mask design on CO2 rebreathing during mask PSV + Flow by



Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Effect of Face Mask design and bias flow on CO2 rebreathing during mask PSV



Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Nasal High-Flow oxygen therapy (Optiflow™)

- High flows of inspired gas up to 60 L/min
- Full humidification (37 ° C, 100 RH, 44 mg H_2O/L)

High-flow nasal cannula oxygen therapy decreases postextubation neuroventilatory drive and work of breathing in patients with chronic obstructive pulmonary disease

Rosa Di mussi[1], Savino Spadaro[2], Tania Stripoli[1], Carlo Alberto Volta[2], Paolo Trerotoli[3], Paola Pierucci[4], Francesco Staffieri[5], Francesco Bruno[1], Luigi Camporota[6] and Salvatore Grasso[1*]

Di mussi *et al. Critical Care* (2018) 22:180
https://doi.org/10.1186/s13054-018-2107-9

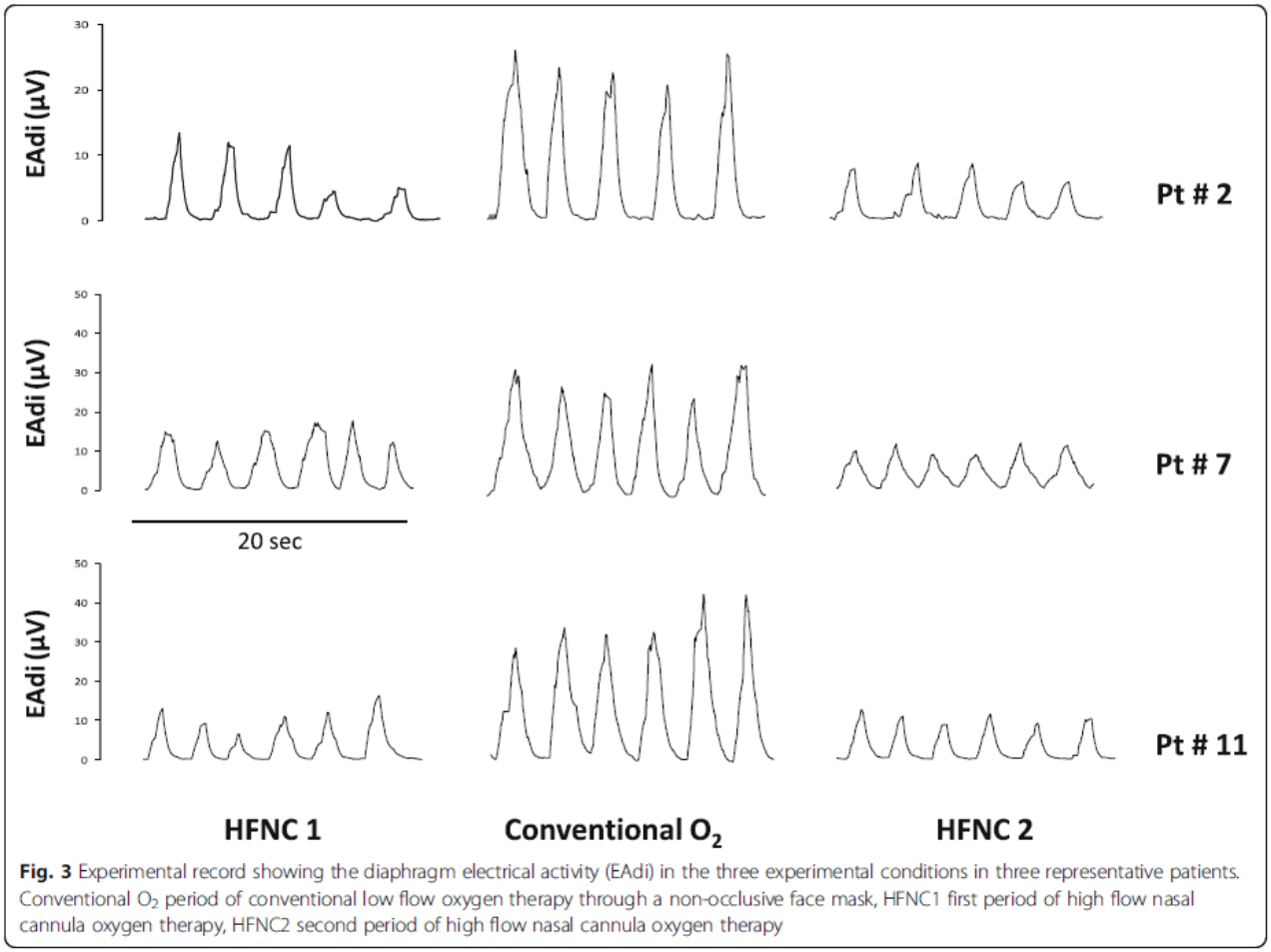
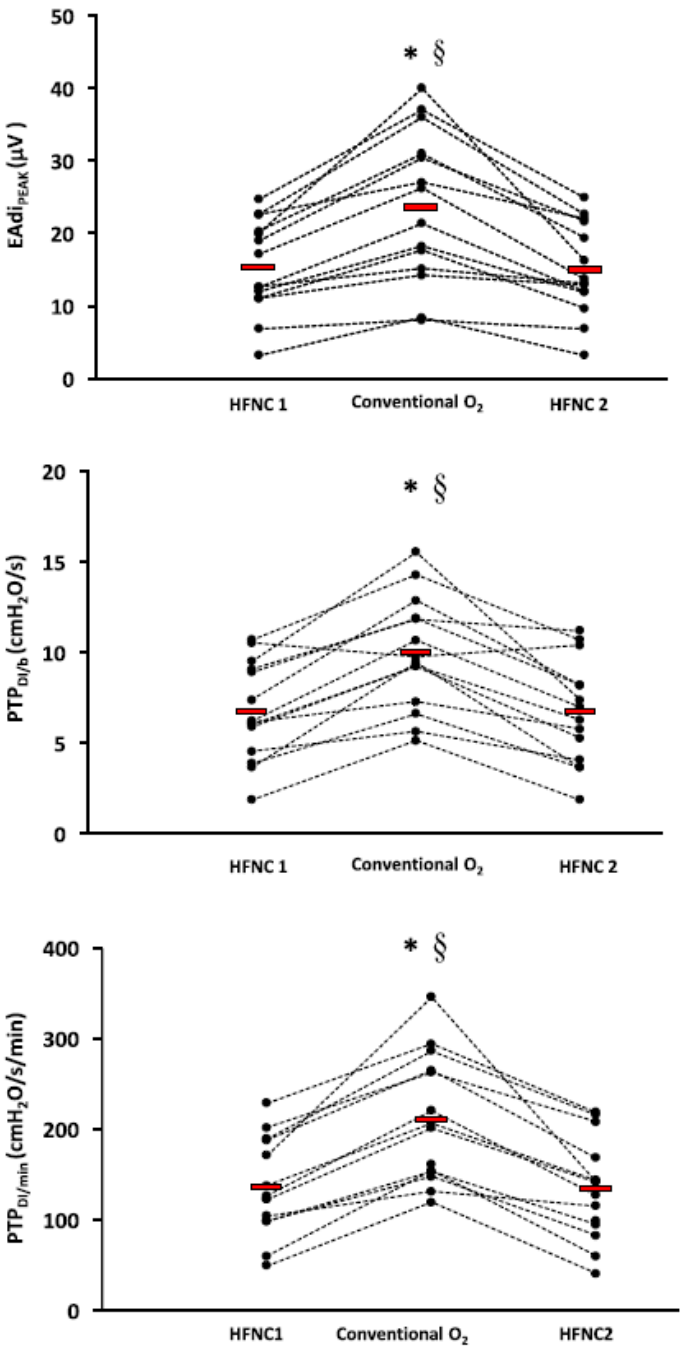


Fig. 3 Experimental record showing the diaphragm electrical activity (EAdi) in the three experimental conditions in three representative patients. Conventional O_2 period of conventional low flow oxygen therapy through a non-occlusive face mask, HFNC1 first period of high flow nasal cannula oxygen therapy, HFNC2 second period of high flow nasal cannula oxygen therapy

High-flow nasal cann
decreases postextuba
drive and work of bre
with chronic obstruct

Rosa Di mussi[1], Savino Spadaro[2], Tania Stripoli[1],
Francesco Staffieri[5], Francesco Bruno[1], Luigi Can

i mussi *et al. Critical Care* (2018) 22:180
ttps://doi.org/10.1186/s13054-018-2107-9



Intensive Care Med
DOI 10.1007/s00134-008-1354-7

ORIGINAL

Giuseppe Foti
Fabio Sangalli
Lorenzo Berra
Stefano Sironi
Marco Cazzaniga
Gian Piera Rossi
Giacomo Bellani
Antonio Pesenti

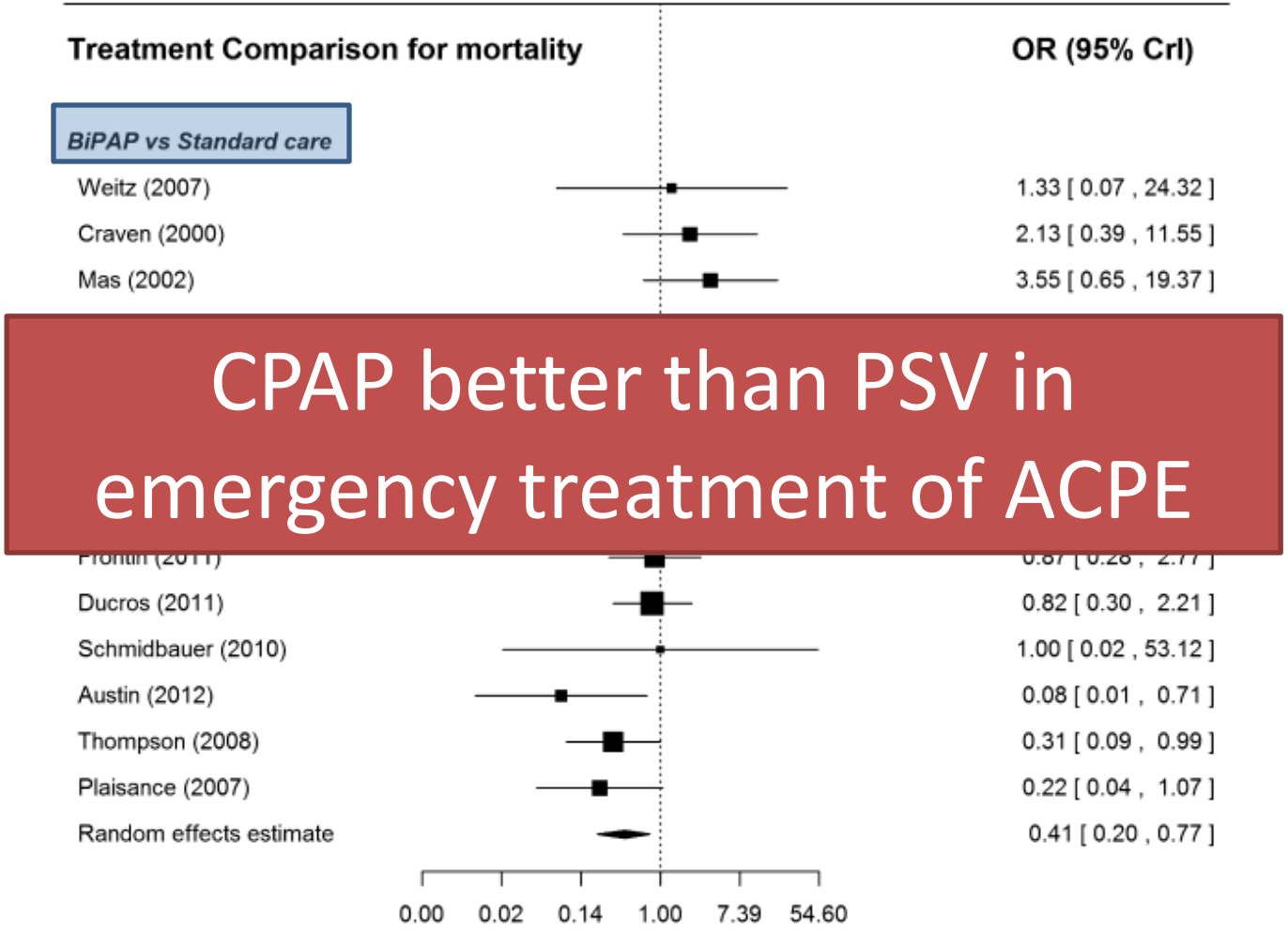
Is helmet CPAP first line pre-hospital treatment of presumed severe acute pulmonary edema?

Academic Emergency Medicine
Official Journal of the Society for Academic Emergency Medicine

PROGRESSIVE CLINICAL PRACTICE

Prehospital Noninvasive Ventilation for Acute Respiratory Failure: Systematic Review, Network Meta-analysis, and Individual Patient Data Meta-analysis

Steve Goodacre, PhD, John W. Stevens, PhD, Abdullah Pandor, MSc, Edith Poku, MBChB, Shijie Ren, PhD, Anna Cantrell, MA, Vincent Bounes, PhD, Arantxa Mas, MD, Didier Payen, PhD, David Petrie, MD, Markus Soeren Roessler, PhD, Gunther Weitz, MD, Laurent Ducros, MD, and Patrick Plaisance, PhD



CPAP better than PSV in emergency treatment of ACPE

High-Flow Nasal Cannula Versus Conventional Oxygen Therapy in Emergency Department Patients With Cardiogenic Pulmonary Edema: A Randomized Controlled Trial

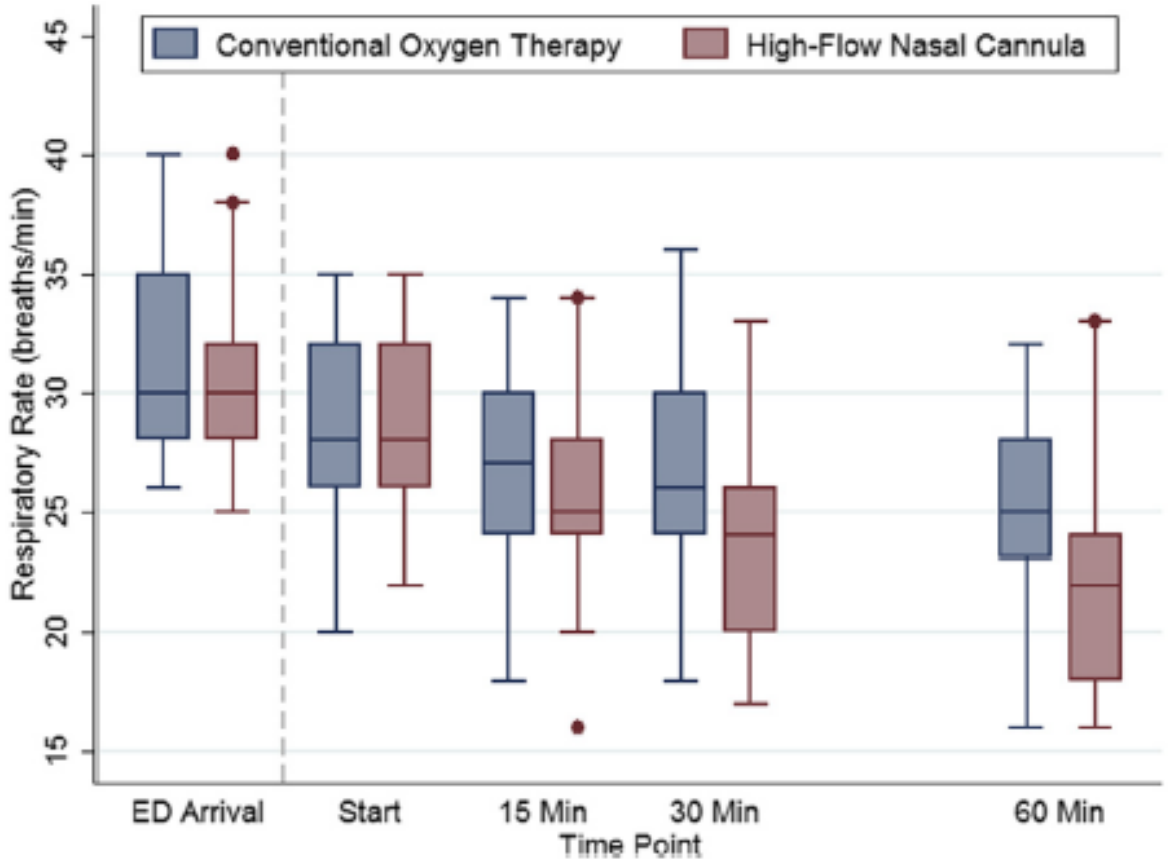


Figure 3. Respiratory rate at each point.

CPAP should be utilized as FIRST-LINE INTERVENTION in the out/in hospital treatment of Severe Acute Pulmonary Edema

NIV in ARDS pts?

Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

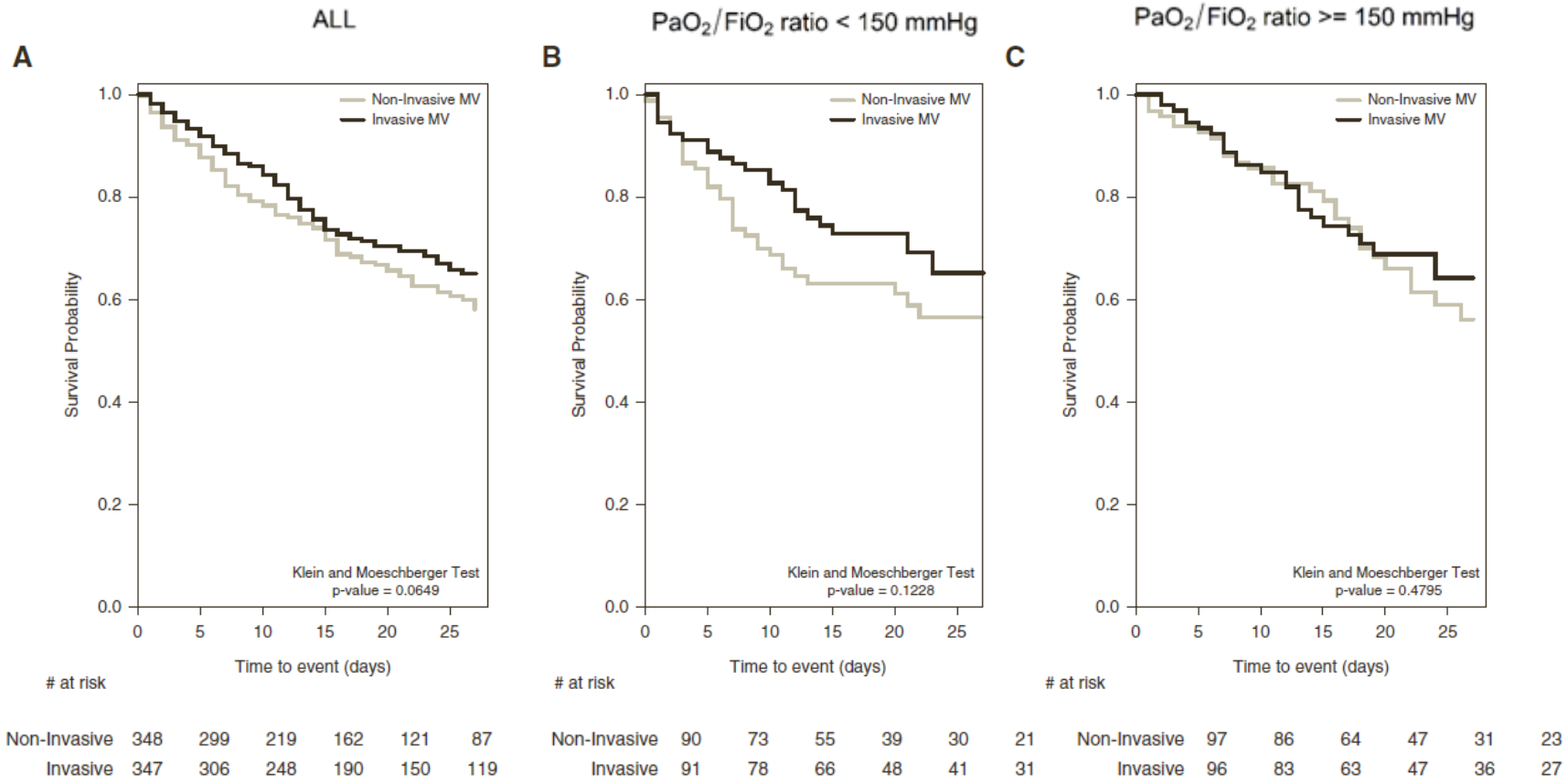
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

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

[#]: all in the setting of acute respiratory failure; [¶]: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

Eur Respir J 2017; 50: 1602426

Large observational study to UNderstand the Global impact of Severe Acute respiratory FailurE (LUNG-SAFE): NIV in ARDS



PSV > 90% pts

SILI

Self Induced Lung Injury

Physiologic Effects of Noninvasive Ventilation during Acute Lung Injury

Erwan L'Her, Nicolas Deye, François Lellouche, Solenne Taille, Alexandre Demoule, Amanda Fraticelli, Jordi Mancebo, and Laurent Brochard

Réanimation Médicale–Unité INSERM U492, Hôpital Henri Mondor, Creteil Cedex, France

TABLE 2. RESPIRATORY PATTERN AND HEMODYNAMIC PARAMETERS DURING THE FIVE STUDY PERIODS

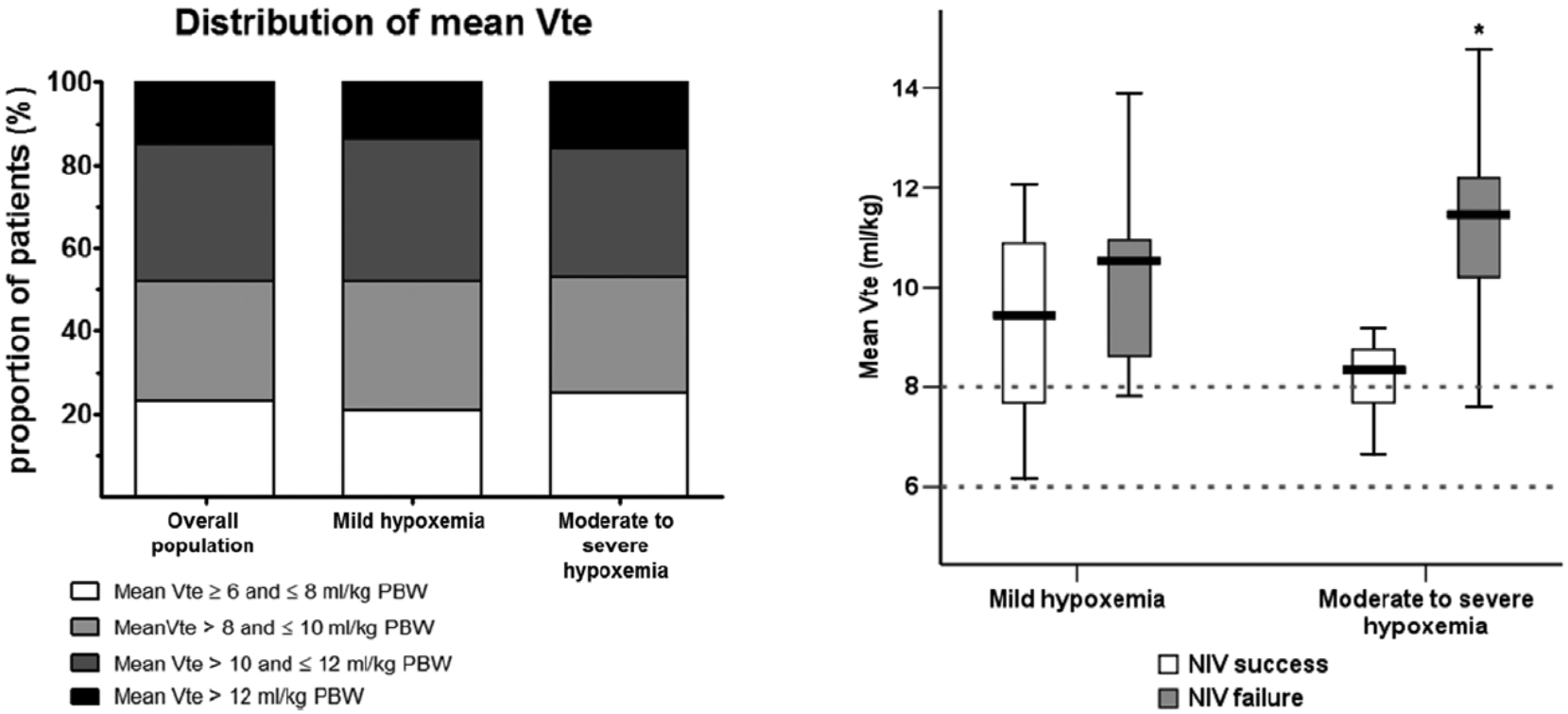
Variable	Initial*	CPAP	PSV10/PEEP10	PSV15/PEEP5	Final‖
V_{TE}, Ml	524 ± 212	394 ± 224†	483 ± 247	591 ± 279‡§	535 ± 229
RR, breaths/min	29 ± 10	28 ± 11	28 ± 11	26 ± 9†	30 ± 12
$\dot{V}_E$, L/min	15.7 ± 4.4	12.3 ± 3.4	14.6 ± 3.8	17.6 ± 5.4‡	15.6 ± 5.3
Leaks, %	25 ± 13	39 ± 18†	36 ± 18	37 ± 22†	24 ± 15
MAP, mm Hg	77 ± 13	79 ± 16†	77 ± 16	75 ± 16	84 ± 17†
HR, beats/min	100 ± 13	100 ± 9	95 ± 14	96 ± 16	99 ± 14

Is it good boost the Tidal Volume ?

Am J Respir Crit Care Med Vol 172. pp 1112–1118, 2005

Failure of Noninvasive Ventilation for De Novo Acute Hypoxemic Respiratory Failure: Role of Tidal Volume*

Guillaume Carteaux, MD[1,2,3]; Teresa Millán-Guilarte, MD[4]; Nicolas De Prost, MD, PhD[1,2,3]; Keyvan Razazi, MD[1,2,3]; Shariq Abid, MD, PhD[3]; Arnaud W. Thille, MD, PhD[5]; Frédérique Schortgen, MD, PhD[1,3]; Laurent Brochard, MD[3,6,7]; Christian Brun-Buisson, MD[1,2,8]; Armand Mekontso Dessap, MD, PhD[1,2,3]



Higher TV during NIV – PSV is associated to worst outcome

Critical Care Medicine
February 2016 • Volume 44 • Number 2

What about Helmet CPAP ARDS pts?

Azienda Ospedaliera San Gerardo

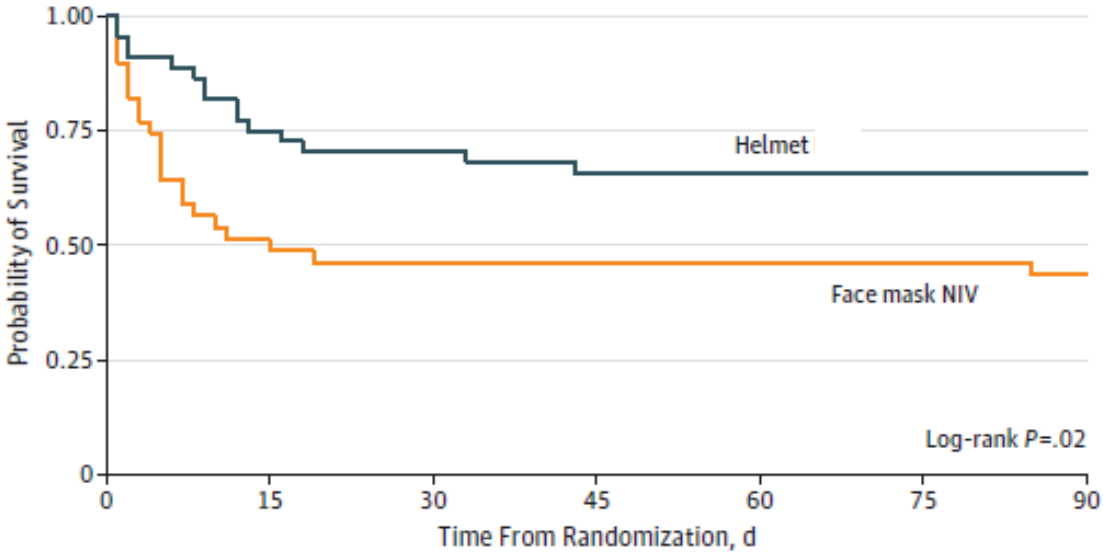
UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

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

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

Figure 2. Probability of Survival From Randomization to Day 90



Original Article
Yonsei Med J 2016 Jul;57(4):936-941
http://dx.doi.org/10.3349/ymj.2016.57.4.936
Yonsei Medical Journal YMJ
pISSN: 0513-5796 · eISSN: 1976-2437

Helmet CPAP versus Oxygen Therapy in Hypoxemic Acute Respiratory Failure: A Meta-Analysis of Randomized Controlled Trials

Yuwen Luo[1*], Yan Luo[1*], Yun Li[1*], Luqian Zhou[2*], Zhe Zhu[1], Yitai Chen[1], Yuxia Huang[1], and Xin Chen[1]

[1]Department of Respiratory Medicine, Zhujiang Hospital, Southern Medical University, Guangzhou;
[2]The State Key Laboratory of Respiratory Disease, Guangzhou Institute of Respiratory Disease, Guangzhou Medical University, Guangzhou, China.

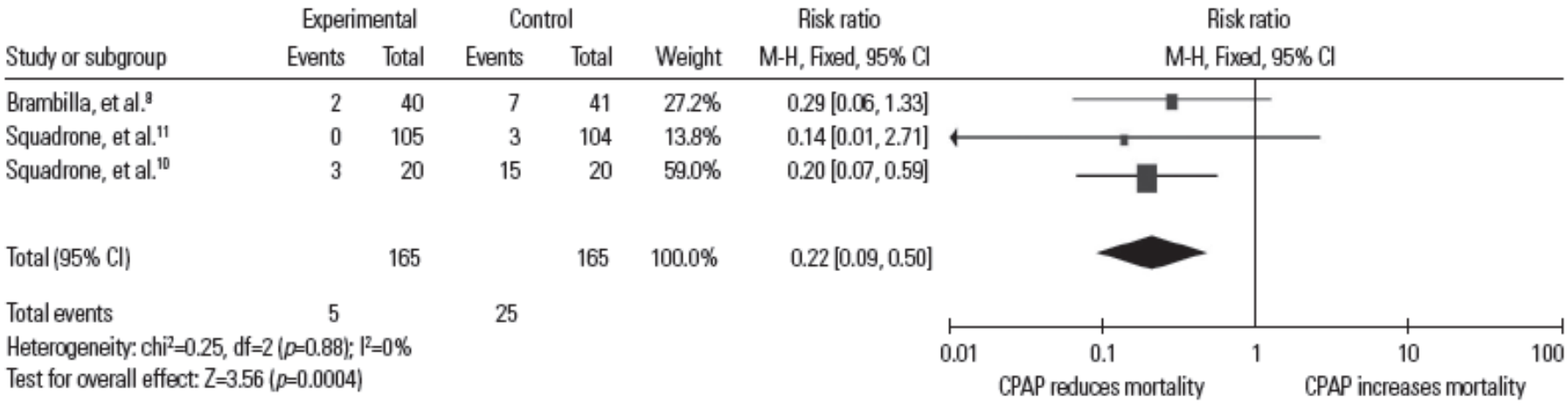
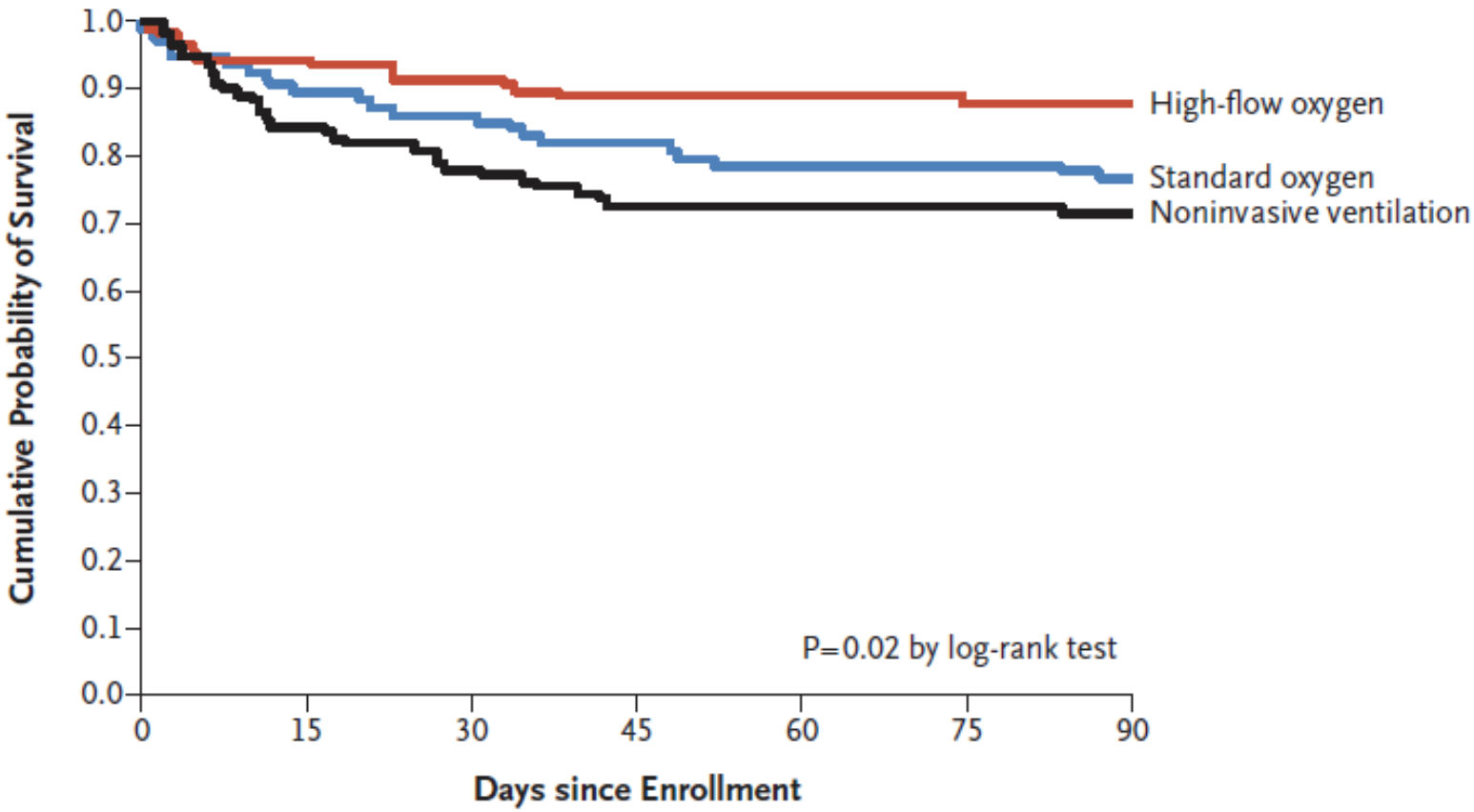


Fig. 6. Forest plot: effect of helmet CPAP on in-hospital mortality in patients with hARF. CI, confidence interval; CPAP, continuous positive airway pressure; hARF, hypoxemic acute respiratory failure.

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



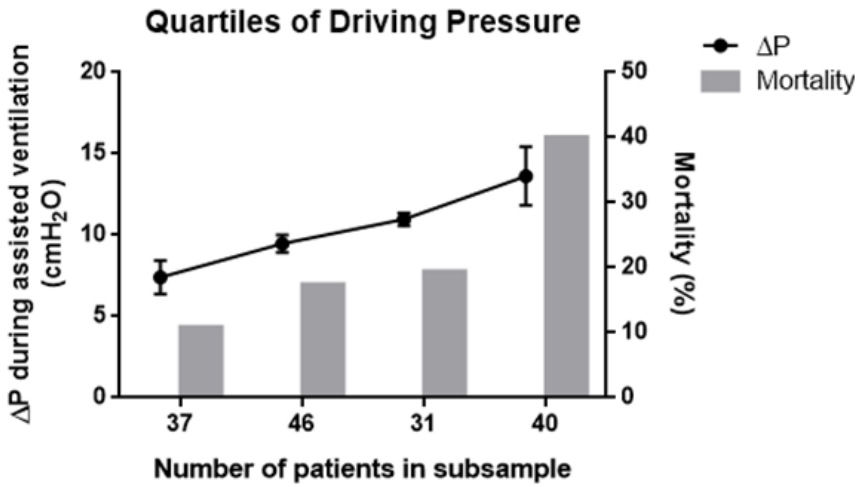
NIV in ARDS: cosa faccio

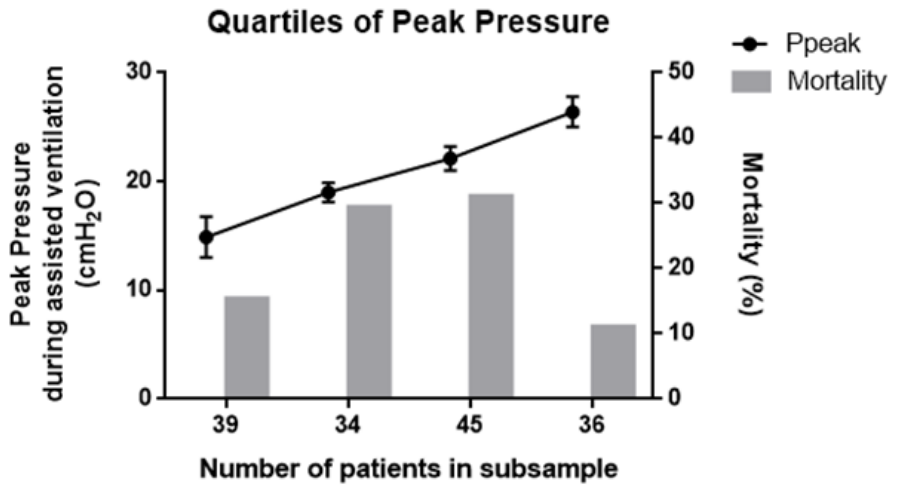
- NO PSV
- CPAP and HFNC ⇒OK
  - CPAP in PEEP Responders
  - HFNC in PEEP non Responders
  - HFNC between Helmet CPAP cycles
- **<u>Be Aware of High TV</u>** during spontaneous breathing
  - Persistent Low PaCO2 is not a good sign

Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA

Association with outcome

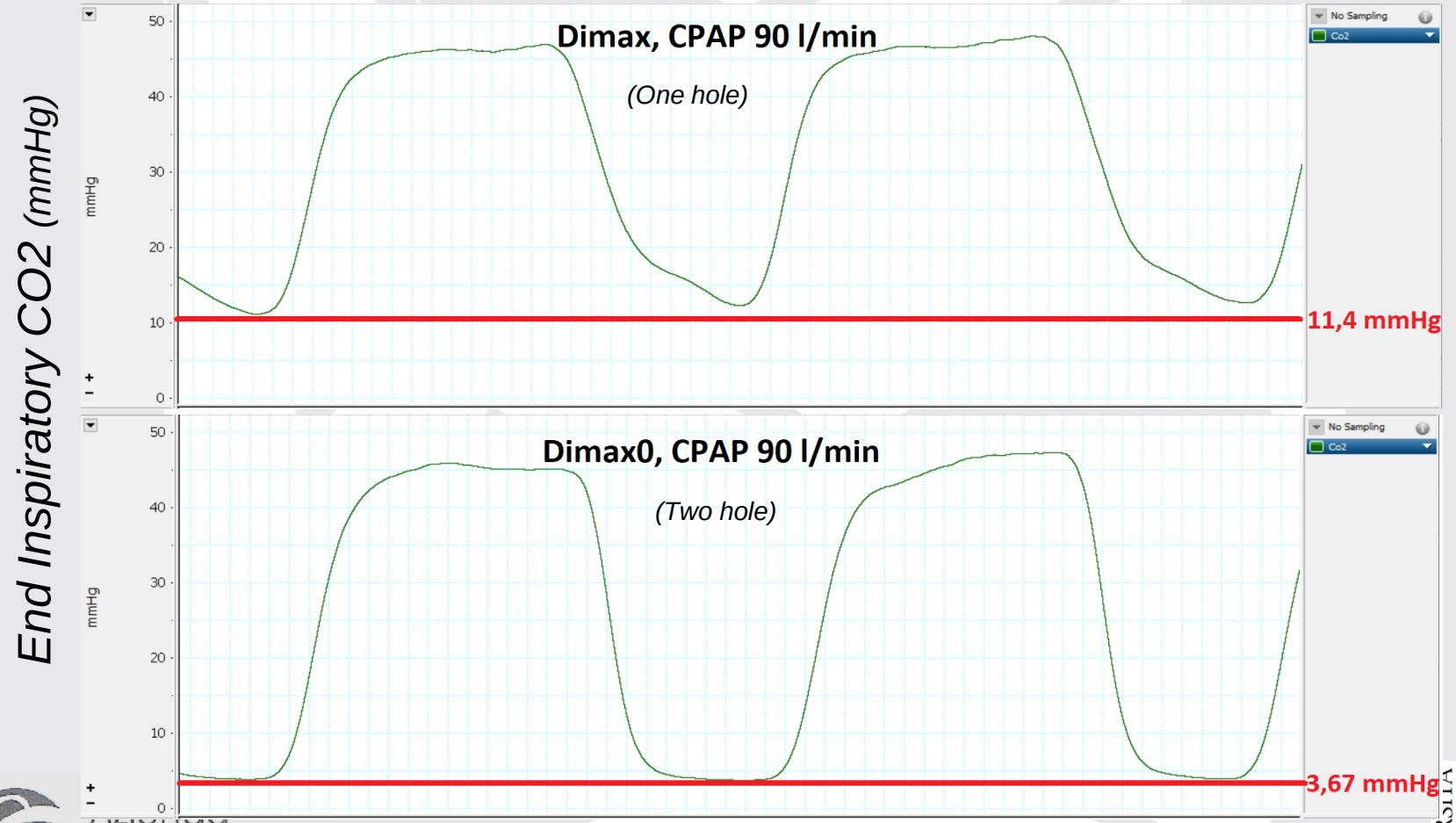




	Odds Ratio (95% CI)	P-Value
MODEL 1 (includes Driving Pressure)		
Age (years)	1.05 (1.04, 1.07)	0.004
SOFA Score	1.2 (1.13, 1.27)	0.007
PEEP during PSV (cmH_2O)	0.84 (0.77, 0.92)	0.028
ΔP during PSV (cmH_2O)	1.34 (1.25, 1.44)	0.001
PaO_2/FiO_2 during PSV	1.00 (1.00, 1.01)	0.666
pH during PSV	1.12 (0.35, 1.88)	0.884

Bellani G, Grassi A, Sosio S, Gatti S, Kavanagh BP, Pesenti A, Foti G.
Driving Pressure is associated with Outcome during Assisted Ventilation in Acute Respiratory Distress Syndrome. Anesthesiology, in press

Effect of Face Mask design on CO2 rebreathing during CPAP: Healthy Volunteers



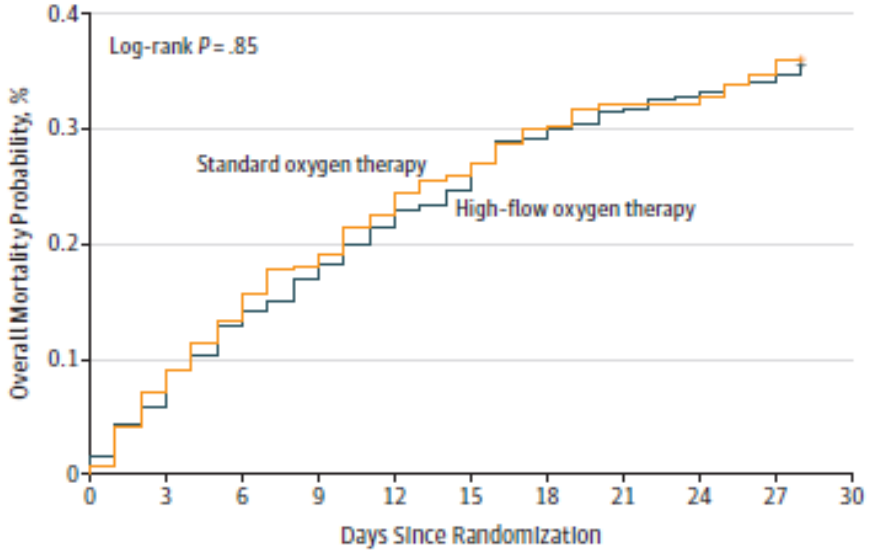
Azienda Ospedaliera San Gerardo

Università degli Studi di Milano Bicocca

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

The HIGH Randomized Clinical Trial

Figure 2. Probability of Day-28 Mortality in Immunocompromised Patients With Acute Respiratory Failure Receiving High-Flow Oxygen Therapy or Standard Oxygen Therapy



No. at risk

High-flow oxygen therapy	388	365	338	322	305	292	275	266	261	256	0
Standard oxygen therapy	388	360	336	318	301	287	272	263	263	253	0

Median survival was not reached in either group.

Nasal High-Flow oxygen therapy: potential advantages

1) Accurate FiO_2 delivery

2) Washout of nasopharyngeal dead space

3) Provision of a small degree of positive airway pressure

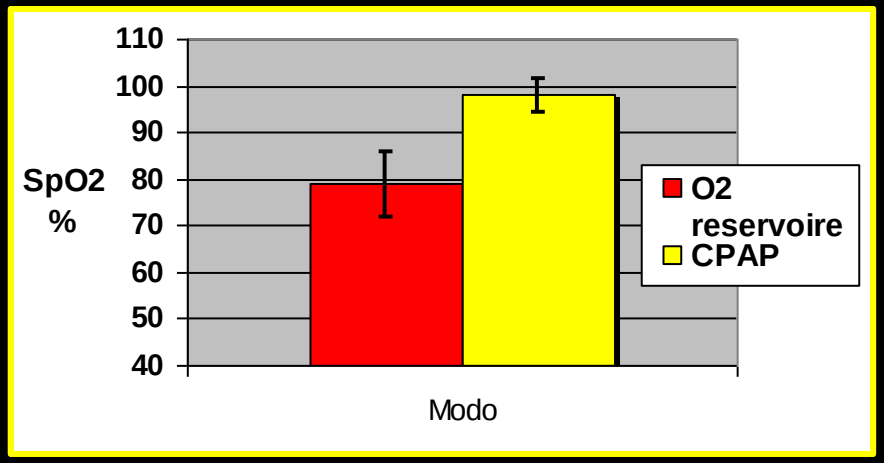
4) Improved comfort and compliance

Intensive Care Med
DOI 10.1007/s00134-008-1354-7

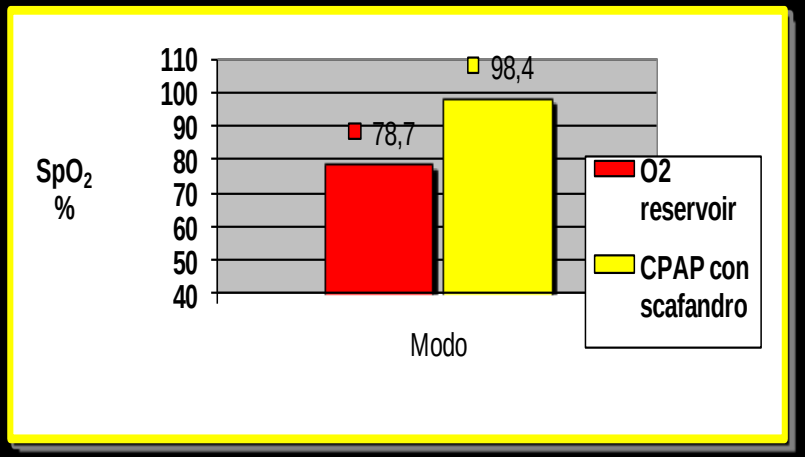
ORIGINAL

Giuseppe Foti
Fabio Sangalli
Lorenzo Berra
Stefano Sironi
Marco Cazzaniga
Gian Piera Rossi
Giacomo Bellani
Antonio Pesenti

Is helmet CPAP first line pre-hospital treatment of presumed severe acute pulmonary edema?

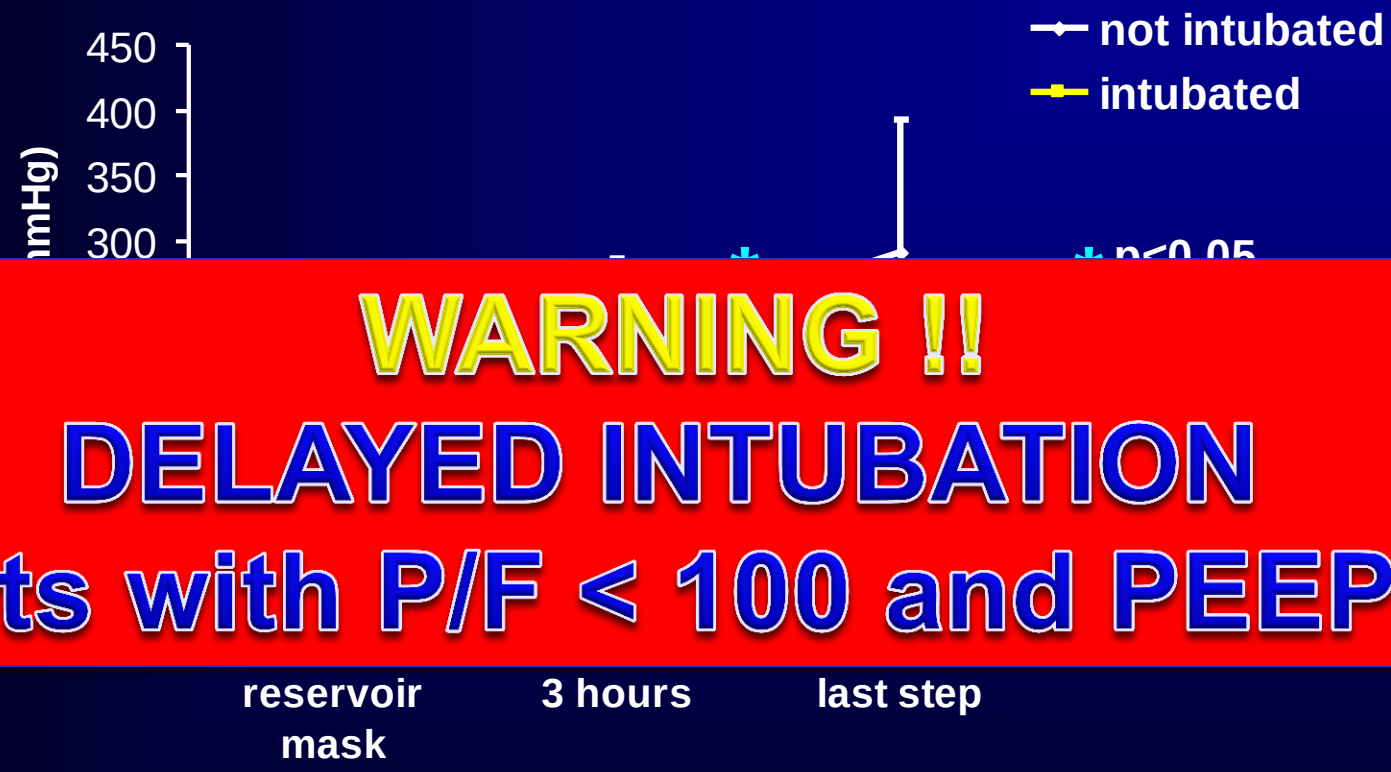


Con Farmaci



Senza Farmaci

HelmetCPAP in ARDS: when to STOP



WARNING !!

DELAYED INTUBATION

in pts with P/F < 100 and PEEP 10

The use of helmets to deliver non-invasive continuous positive airway pressure in hypoxemic acute respiratory failure

G. BELLANI [1, 2], N. PATRONITI [1, 2], M. GRECO [1, 2], G. FOTI [2], A. PESENTI [1, 2]

MINERVA ANESTESIOL 2008;74

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

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

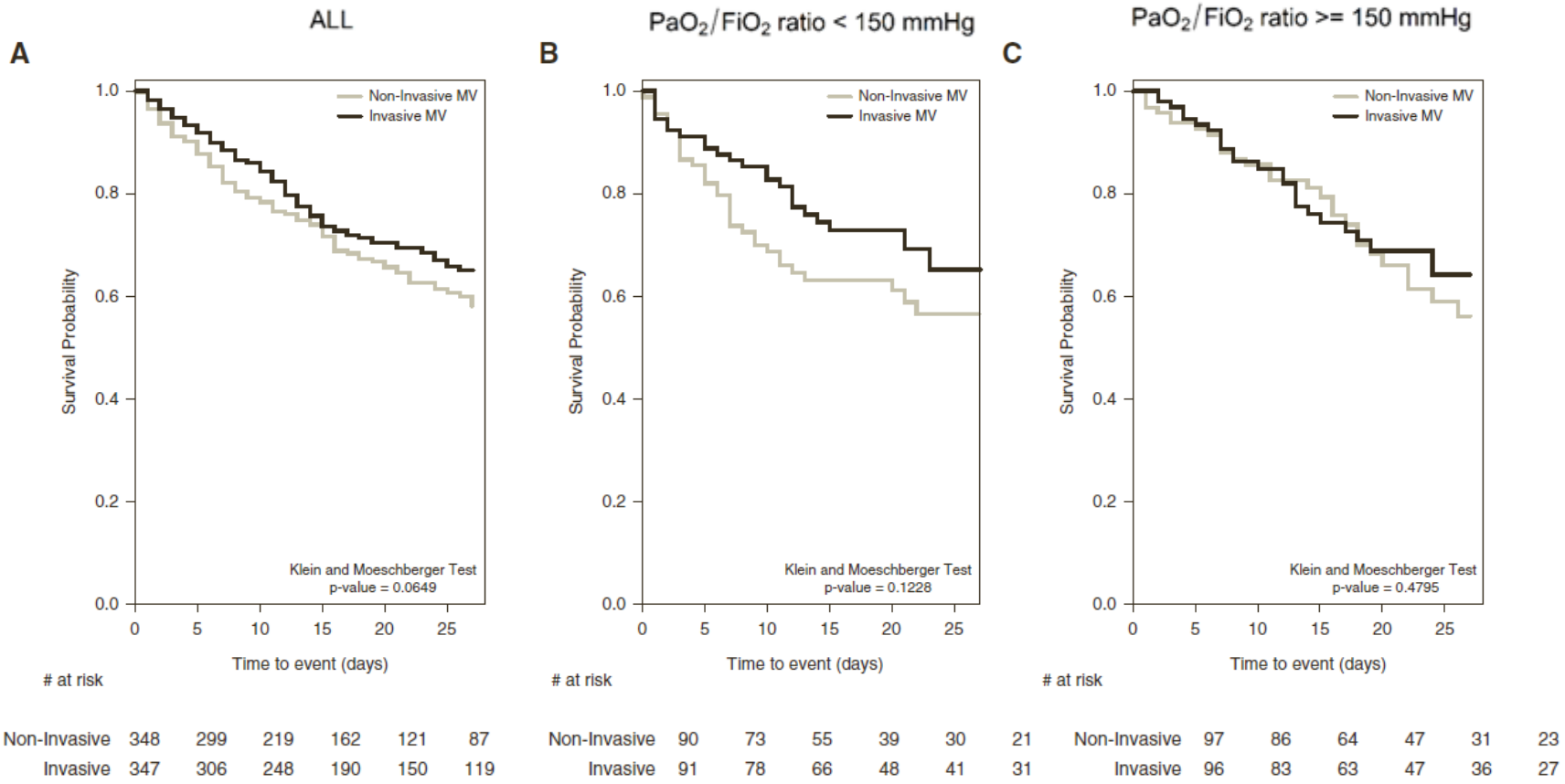
Video demonstration of how a helmet interface for noninvasive ventilation is assembled and applied to the patient and description of initial ventilator settings.

Rotating Interfaces:

HELMET PSV

Large observational study to UNderstand the Global impact of Severe Acute respiratory FailurE (LUNG-SAFE):

NIV in ARDS



Physiologic Effects of Noninvasive Ventilation during Acute Lung Injury

Erwan L'Her, Nicolas Deye, François Lellouche, Solenne Taille, Alexandre Demoule, Amanda Fraticelli, Jordi Mancebo, and Laurent Brochard

Réanimation Médicale–Unité INSERM U492, Hôpital Henri Mondor, Creteil Cedex, France

TABLE 2. RESPIRATORY PATTERN AND HEMODYNAMIC PARAMETERS DURING THE FIVE STUDY PERIODS

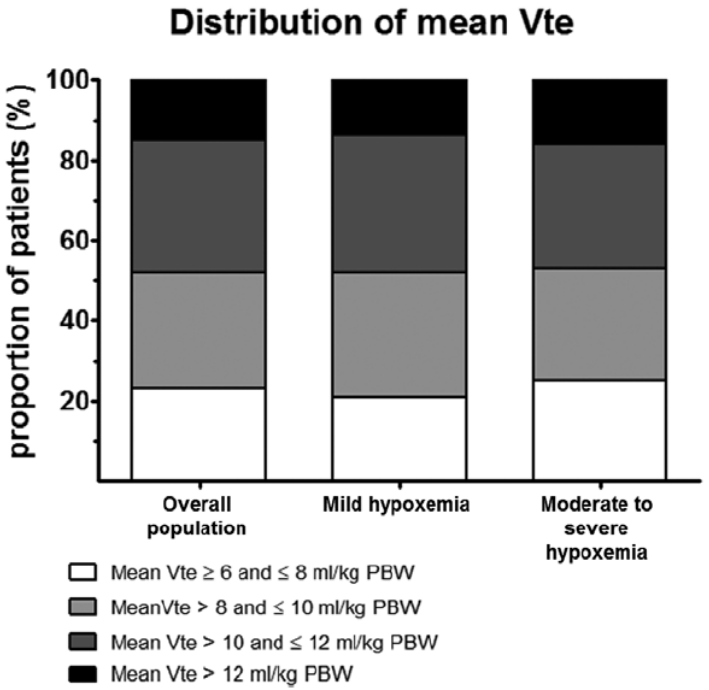
Variable	Initial*	CPAP	PSV10/PEEP10	PSV15/PEEP5	Final‖
V_{Te}, Ml	524 ± 212	394 ± 224†	483 ± 247	591 ± 279‡§	535 ± 229
RR, breaths/min	29 ± 10	28 ± 11	28 ± 11	26 ± 9†	30 ± 12
$\dot{V}_E$, L/min	15.7 ± 4.4	12.3 ± 3.4	14.6 ± 3.8	17.6 ± 5.4‡	15.6 ± 5.3
Leaks, %	25 ± 13	39 ± 18†	36 ± 18	37 ± 22†	24 ± 15
MAP, mm Hg	77 ± 13	79 ± 16†	77 ± 16	75 ± 16	84 ± 17†
HR, beats/min	100 ± 13	100 ± 9	95 ± 14	96 ± 16	99 ± 14

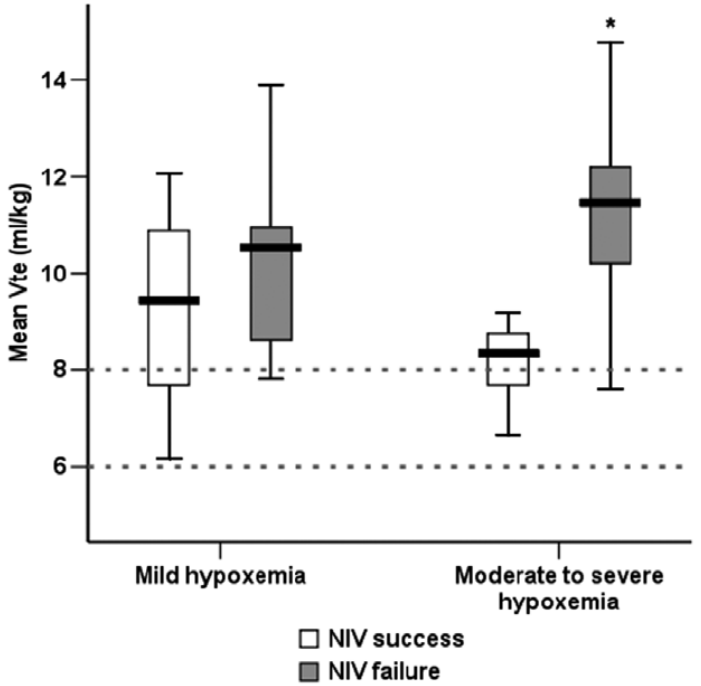
The dark side of spontaneous breathing

Risk of high Vt

High inspiratory pressure

The danger of PSV in ARDS



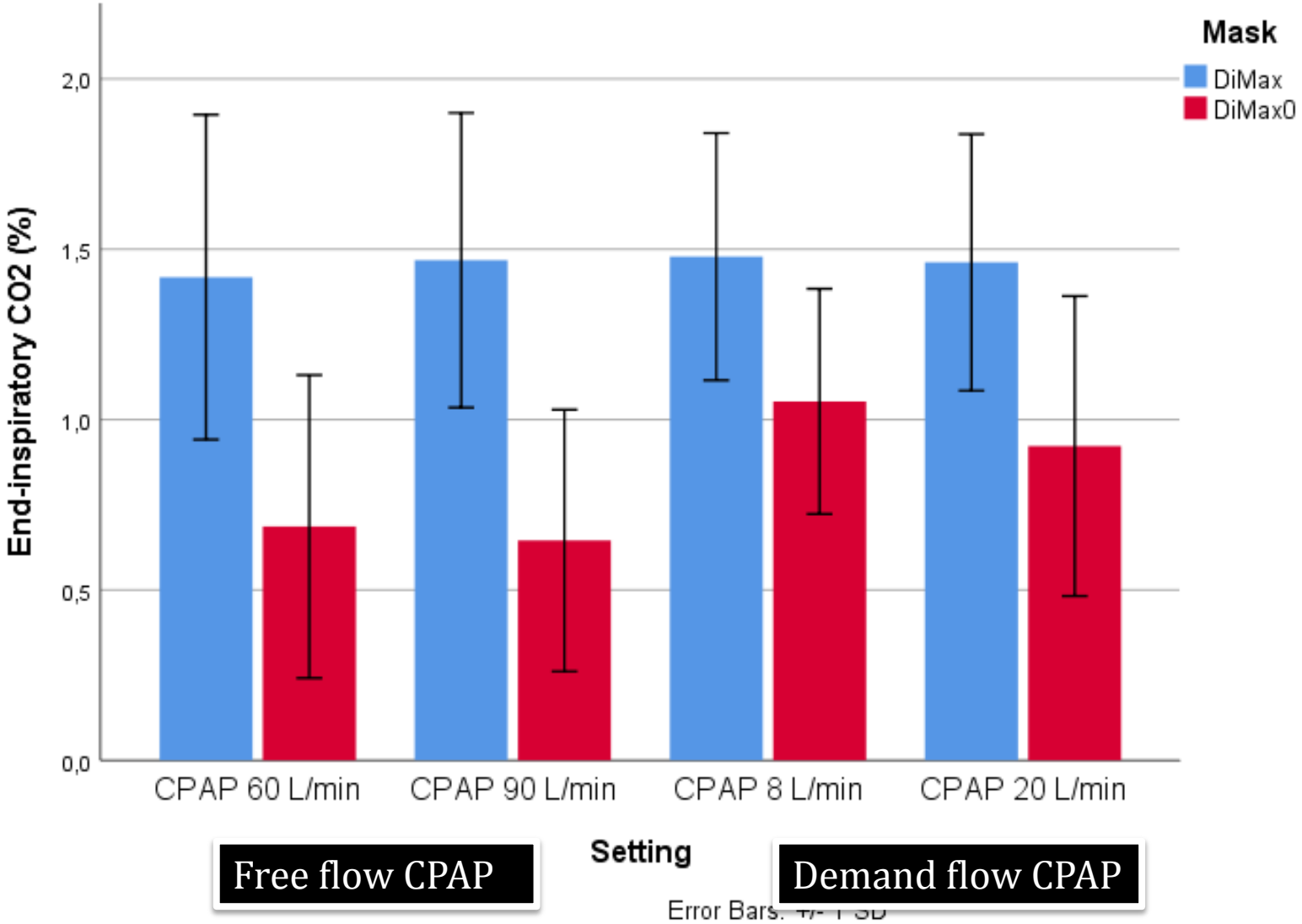


Failure of Noninvasive Ventilation for De Novo Acute Hypoxemic Respiratory Failure: Role of Tidal Volume*

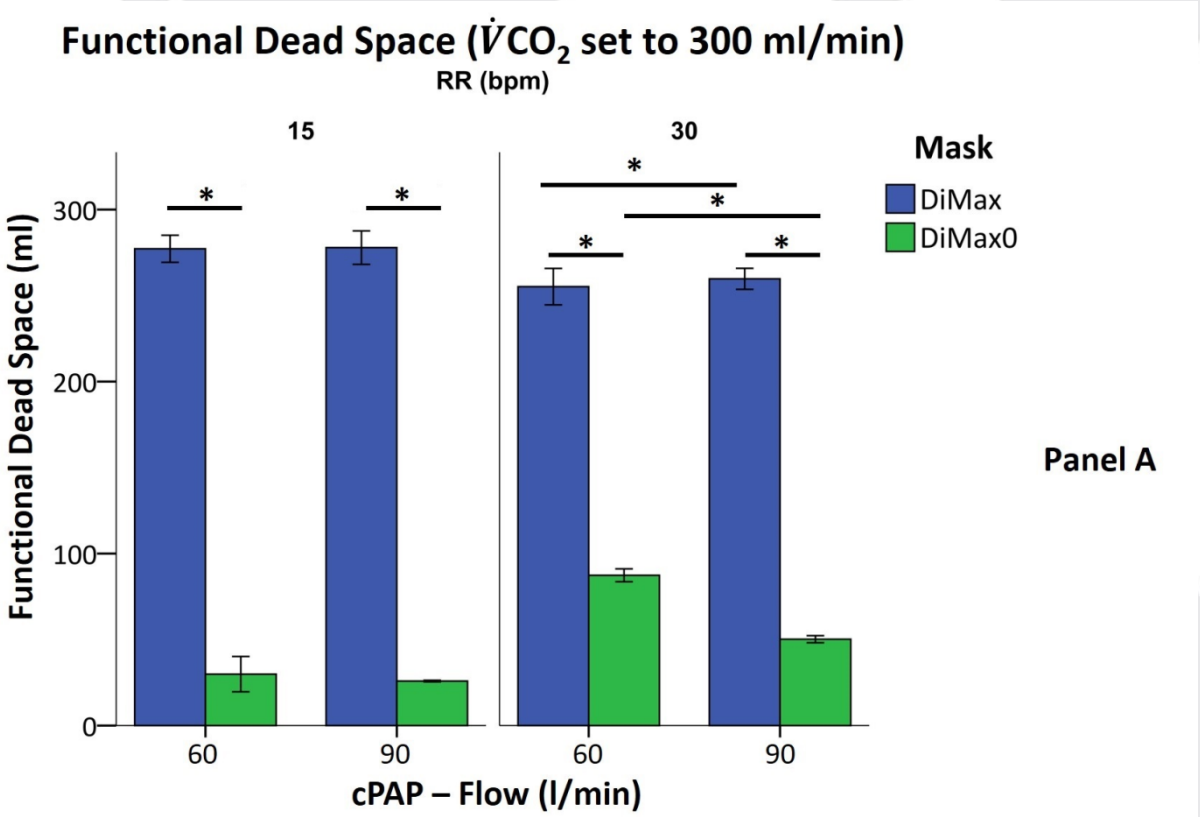
Critical Care Medicine
February 2016 • Volume 44 • Number 2

Effect of Face Mask design on CO2 rebreathing during CPAP: Healthy Volunteers

Preliminary data



Effect of Face Mask design and CPAP flow on CO2 rebreathing during non-invasive ventilation



Azienda Ospedaliera San Gerardo

UNIVERSITÀ DEGLI STUDI DI MILANO BICOCCA