Con il patrocinio di

Associazione Italiana Pneumologi Ospedalieri

Ospedale San Giuseppe
MultiMedica S.p.A.

PNEUMOLOGIA 2016

Milano, 16 – 18 giugno 2016 · Centro Congressi Palazzo delle Stelline

NIV and High Oxygen Flow (HOF)
in hypoxic respiratory failure:

ALTERNATIVE or COMPLEMENTARY ?

CONFLICTS of INTEREST

Speakig fee= Resmed Weinmann – Philips – Covidien

Advisory Boards= Breas, Philips – Weinmann

Travel grants= Weinmann

Research grants= Fisher and Paykel

Free use of equipments= Harol – Fisher and Paykel – Breas - Siare

Physiology: is NIV working in hypoxic acute respiratory failure ?

Physiologic Effects of Noninvasive Ventilation during Acute Lung Injury

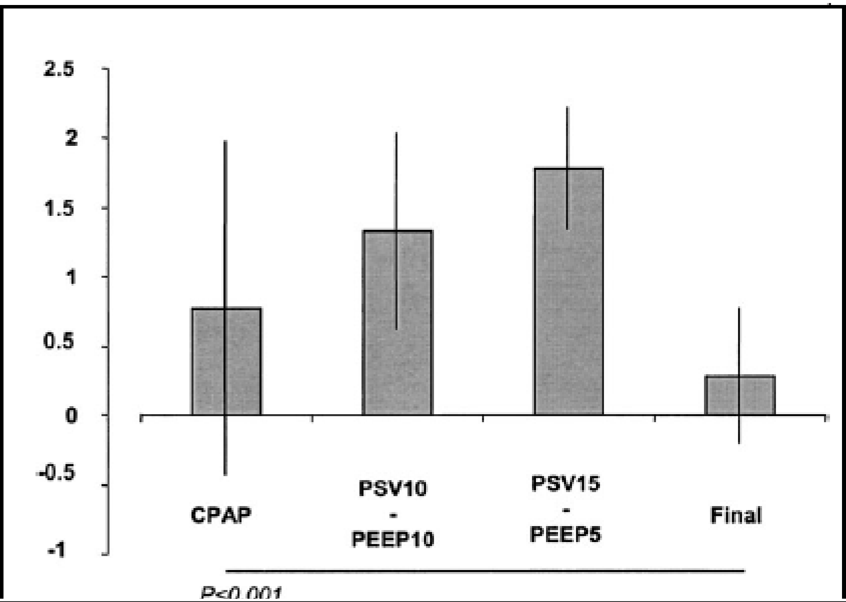
Am J Respir Crit Care Med Vol 172. pp 1112–1118, 2005

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

TABLE 3. ARTERIAL BLOOD GASES DURING THE FIVE STUDY PERIODS

Variable	Initial*	CPAP	PSV10/PEEP10	PSV15/PEEP5	Final¶
pH	7.37 ± 0.10	7.36 ± 0.12	7.39 ± 0.08	7.40 ± 0.08[†§]	7.38 ± 0.10
Pa_{O_2}/FI_{O_2} mm Hg	131 ± 61	184 ± 74[†]	206 ± 120[‡]	153 ± 41[‖]	169 ± 83
Pa_{CO_2}, mm Hg	42.0 ± 11.3	44.4 ± 17.8	40.2 ± 14.3	38.6 ± 12.3[§]	42.2 ± 14.4

Dyspnea score



THIS PHYSIOLOGICAL STUDY, compared to CPAP the application of PSV+CPAP (or PEEPext) is able to better improve Arterial Blood Gases and Dyspnea)

Pneumonia

Intensive Care Med (2009) 35:9–29
DOI 10.1007/s00134-008-1336-9

SPECIAL ARTICLE

Antoni Torres
Santiago Ewig
Harmut Lode
Jean Carlet
For The European
HAP working group

Defining, treating and preventing hospital acquired pneumonia: European perspective

Table 4 Recommended measures for prevention of VAP

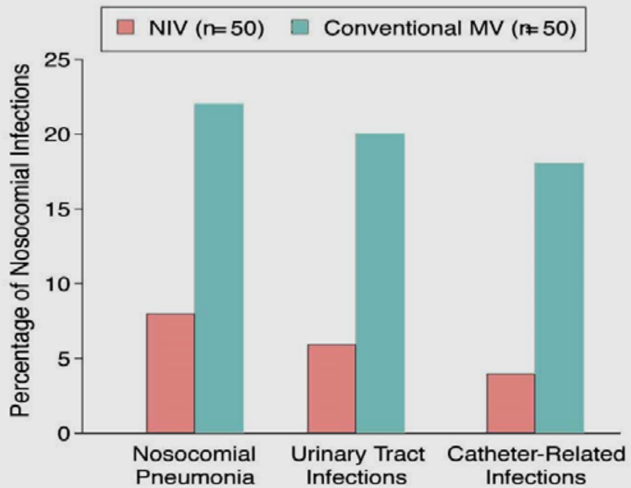
Generally recommended general measures:
Alcohol-based hand disinfection
Use of microbiologic surveillance
Monitoring and early removal of invasive devices
Programs to reduce antimicrobial prescriptions
Generally recommended specific measures
Avoidance of endotracheal intubation
Avoidance of reintubation
Preference of noninvasive ventilation (NIV)
Preference of orotracheal intubation and orogastric tubes
Maintenance of the ET cuff pressure at approximately 20 cmH_2O
Avoidance of flushing the condensate into the lower airway or to in-line medication nebulizers
Patient positioning (semirecumbent position)
Additional measures which might be helpful in distinct settings and populations:
Continuous aspiration of subglottic secretions
Endotracheal tubes coated with antiseptics or silver
Preference of heat-moisture exchangers (HMEs) over heater humidifiers (HH)
Oral decontamination
Selective decontamination of the digestive tract (SDD)

PREVENTION of VAP

Treatment of ARF
and occurence of pneumonia

Outcome Variables
Nosocomial Infections

Frequency of Nosocomial Infections in the 2 Groups



Frequency of nosocomial infections in 50 cases treated with noninvasive ventilation (NIV) and 50 controls treated with conventional mechanical ventilation (MV). P values between the 2 groups are .04 for nosocomial pneumonia, .03 for urinary tract infections, and .002 for catheter-related infections.

Table 2. Comparison of Outcome Variables in Cases and Controls*

Outcome Variables	NIV Cases (n = 50)	Conventional MV Controls (n = 50)	*P* Value
Nosocomial infections			
Patients with nosocomial infection, No. (%)	7 (14)	19 (38)	.006
Nosocomial infections, No. (%)	9 (18)	30 (60)	<.001
Nosocomial infections per patient, mean (SD)	0.2 (0.5)	0.6 (1.0)	.006
Incidence density of nosocomial infections†	19	39	.05
Nosocomial pneumonia, No. (%)	4 (8)	11 (22)	.04
Incidence density of nosocomial pneumonia‡	14	23	.40

Girou et al. *JAMA* 2000; 284:2361-7.

Randomized Studies: Incidence of Sepsis and Pneumonia

	Severe sepsis		Pneumonia	
	ETI-MV CT	NPPV	ETI-MV CT	NPPV
Brochard, NEJM 1995	7%	5%	17%	5%*
Wysocki, Chest 1995	NR	NR	NR	NR
Antonelli, NEJM 1998	34%	19%	25%	3%*
Wood, Chest 1998	NR	NR	18%	0%*
Confalonieri, AJRCCM, 1999	NR	NR	7%	0%*
Antonelli, JAMA; 2000	50%	20%*	20%	10%
Martin, AJRCCM 2000	0%	0%	0%	0%
Hilbert, NEJM,2001	46%	31%*	12%	4%*

* differences statistically relevant

NIV and ARF due to CAP

The “odd” couple ?

C.A.P. and NIV

BASELINE AND OUTCOME VARIABLES IN PATIENTS WITH AND WITHOUT COPD

	Patients with COPD			Patients without COPD		
	Noninvasive Ventilation	Standard Treatment	p Value	Noninvasive Ventilation	Standard Treatment	p Value
Number	12	11		16	17	
Age	68.4 ± 4.8	73.0 ± 5.1	0.52	64.2 ± 4.2	53.3 ± 4.1	0.07
pH	7.28 ± 0.04	7.27 ± 0.06	0.13	7.39 ± 0.1	7.37 ± 0.1	0.57
Pa_{O_2}:$F_{I_{O_2}}$	194 ± 31	170 ± 42	0.64	165 ± 30	164 ± 52	0.94
Pa_{CO_2}	73 ± 7	68 ± 9	0.15	32 ± 7	34 ± 5	0.35
APACHE II score	20.1 ± 1.5	21.4 ± 1.5	0.55	19.9 ± 1.3	16.3 ± 1.2	0.05
Met intubation criteria	0 (0.0%)	6 (54.6%)	0.005	6 (37.5%)	8 (47.1%)	0.73
Avoided intubation	12 (100%)	5 (45.5%)	0.005	10 (62.5%)	9 (52.9%)	0.73
Nurse workload						
Day 1	7.3 ± 0.5	8.7 ± 0.5	0.06	8.5 ± 0.5	6.4 ± 0.5	0.005
Days 1–3	6.1 ± 0.6	8.1 ± 0.7	0.04	7.1 ± 0.7	5.5 ± 0.6	0.08
Duration of intubation, d	0	12.3 ± 3.9	0.00	6.8 ± 4.2	8.0 ± 3.4	0.41
Duration of use of MV, h	69 ± 36	220 ± 281	0.07	119 ± 105	195 ± 282	0.31
Duration of ICU stay, d	0.25 ± 2.1	7.6 ± 2.2	0.02	2.9 ± 1.8	4.8 ± 1.7	0.44
Duration of hospital stay, d	14.9 ± 3.4	22.5 ± 3.5	0.13	17.9 ± 2.9	15.1 ± 2.8	0.48
Hospital mortality	1 (8.3%)	2 (18.2%)	0.59	6 (37.5%)	4 (23.5%)	0.47
2-mo mortality	1/9 (11.1%)	5/8 (62.5%)	0.05	6/14 (42.9%)	5/15 (33.3%)	0.71

Definition of abbreviation: MV = mechanical ventilation (either noninvasive or invasive).

Confalonieri et al.

AM J RESPIR CRIT CARE MED 1999;160:1585–1591.

Helmet Continuous Positive Airway Pressure vs Oxygen Therapy To Improve Oxygenation in Community-Acquired Pneumonia

CHEST 2010; 138(1):114–120

A Randomized, Controlled Trial

Roberto Cosentini, MD; Anna Maria Brambilla, MD; Stefano Aliberti, MD; Angelo Bignamini, PhD; Stefano Nava, MD; Antonino Maffei, MD; Renato Martinotti, MD; Paolo Tarsia, MD; Valter Monzani, MD; and Paolo Pelosi, MD

Discussion

The main finding of this study is that in moderate hypoxemic ARF due to CAP, CPAP improved oxygenation faster and in a greater proportion of patients in comparison with standard oxygen therapy.

Table 1—*Demographics and Baseline Characteristics of the Two Study Groups*

Characteristic	CPAP	Controls	*P* Value
Patients, No.	20	27	
Demographics			
Age, mean ± SD, y	65 ± 17	72 ± 13	.133[a]
Female, No. (%)	6 (30)	11 (41)	.449[b]
Comorbidities			
Cardiovascular disease, No. (%)	10 (50)	15 (58)	.604[b]
COPD, No. (%)	5 (25)	5 (19)	.591[b]
Liver disease, No. (%)	2 (10)	1 (3.7)	.383[b]
Diabetes mellitus, No. (%)	3 (15)	5 (19)	.751[b]
Current smokers, No. (%)	9 (45)	12 (44)	.970[b]
Severity of the disease			
Glasgow Coma Scale	15	15	
SAPS II score ± SD	21 ± 7.4	21 ± 5.7	.848[c]
Physical findings			
Systolic BP, mm Hg ± SD	132 ± 26	135 ± 22	.689[a]
Diastolic BP, mm Hg ± SD	78 ± 14	73 ± 12	.181[a]
Heart rate, beats/min ± SD	89 ± 15	94 ± 16	.316[a]
Respiratory rate, breaths/min ± SD	27 ± 4.5	27 ± 4.4	.799[a]
Temperature, °C ± SD	37.3 ± 1.1	37.7 ± 1.0	.186[a]
Arterial blood gas analysis			
Pa_{O_2}, mm Hg ± SD	125 ± 13	123 ± 10	.582[a]
Pa_{O_2}/F_{IO_2} ratio ± SD	249 ± 25	246 ± 20	.680[a]
pH ± SD	7.46 ± 0.05	7.45 ± 0.06	.341[a]
Pa_{CO_2}, mm Hg ± SD	34 ± 6	36 ± 5	.150[a]
Bicarbonates, mmol/L ± SD	24 ± 3	25 ± 3	.370[a]
Radiologic findings			
Multilobar pneumonia, No. (%)	1 (5)	3 (11)	.626[b]
Pleural effusion, No. (%)	3 (15)	6 (23)	.494[b]

<u>On average ICU patients are however much sicker</u>

Intensive Care Med
DOI 10.1007/s00134-014-3325-5

ORIGINAL

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Helmet CPAP vs. oxygen therapy in severe hypoxemic respiratory failure due to pneumonia

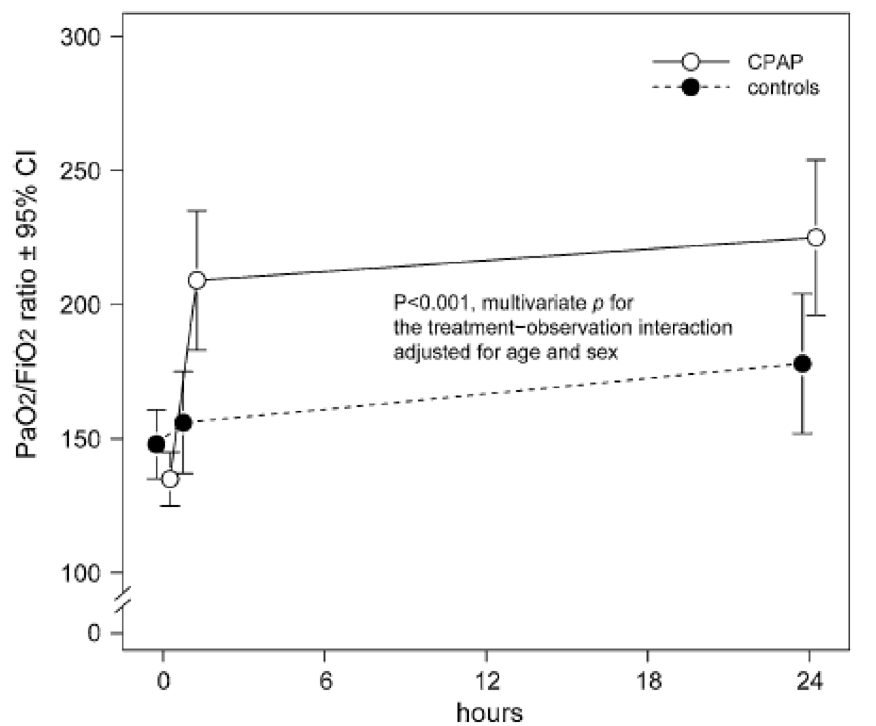

Fig. 3 Time course of PaO_2/FiO_2 ratio. *CPAP* continuous positive airway pressure

Intensive Care Med
DOI 10.1007/s00134-014-3325-5

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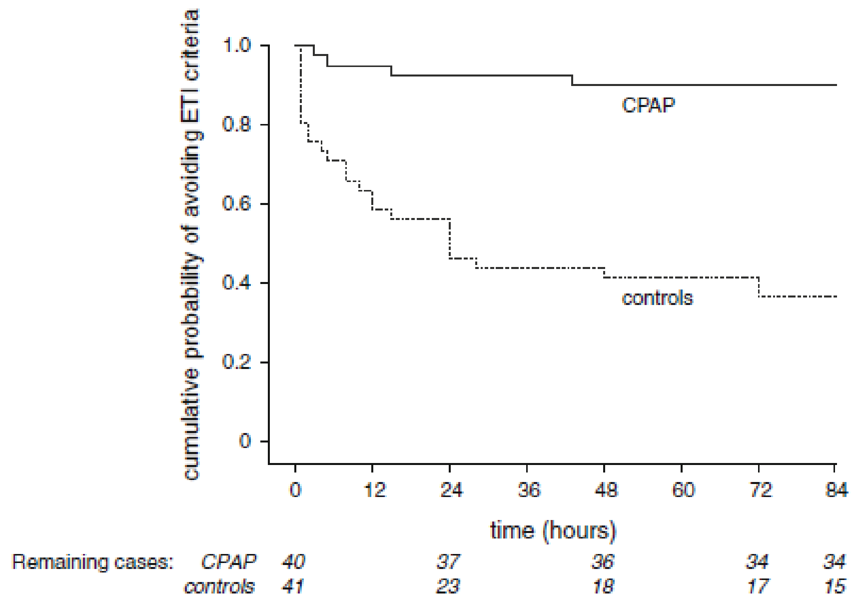


Fig. 2 Kaplan–Meier analysis of time to the primary endpoint. *CPAP* continuous positive airway pressure, *ETI* endotracheal intubation

NIV vs HOF ?

OR

NIV and HOF ?

Definition of High Oxygen Flow (HOF)

- Addition of sufficient warmth and high levels of humidification to breathing gas at high flow rates by a modified nasal cannula

Lee JH at al Intensive Care Med 2013

Nasal High-Flow oxygen therapy (HOF)

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

RCT of HOF v NIV v SO in AHRF

Frat J-P et al, NEJM 2015

- 2506 pts with AHRF – 525 eligible - 313 enrolled
- P/F ≤ 300, RR > 25, No $PaCO_2$ > 45 mmHg
- Baseline RR 33/min, P/F 155, 75-80% C.A.P.
- SO ≥ 10 l/min, HOF 50 l/min, FIO_2 1.0 (82 %), NIV VT 7-10 ml/kg (PS 8, PEEP 5, 67%, 9.3 ml/kg), 8 hrs daily X 2d

RCT of HOF v NIV v SO in AHRF

Frat J-P et al, NEJM 2015

	HFNO	SO	NIV
n	106	94	110
Intubation (%)	38	47	50
Intub P/F < 200	35	53	58*
Vent free days	24	21	18
Death ICU (%)	11	19	25*
Death 90d (%)	30	45	49*

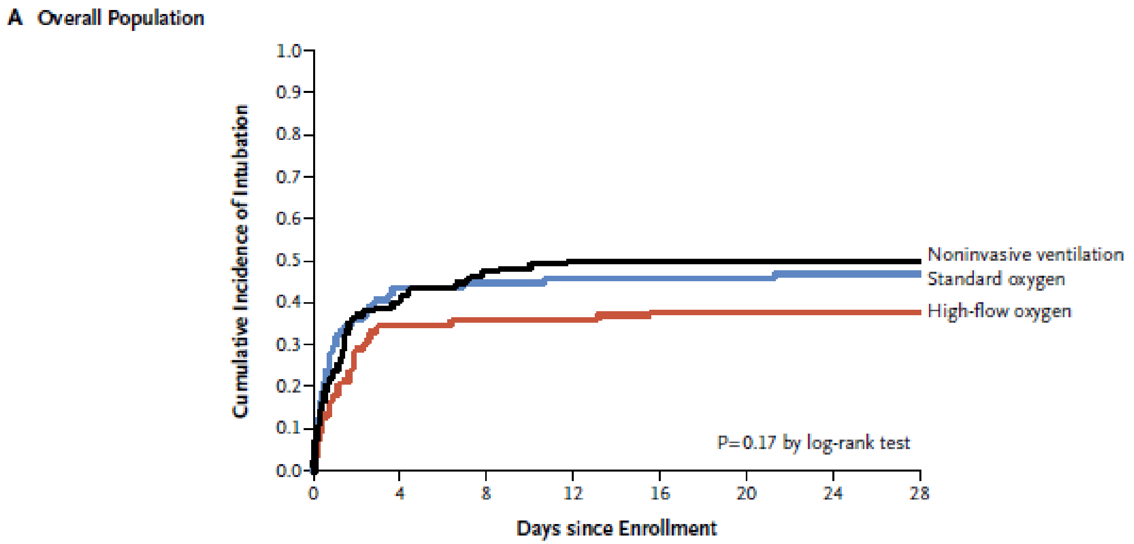
* P<0.05

Primary Outcome

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., Elise Morawiec, M.D., Alice Cottereau, M.D., Jérôme Devaquet, M.D., Saad Nseir, M.D., Ph.D., Keyvan Razazi, M.D., Jean-Paul Mira, M.D., Ph.D., Laurent Argaud, M.D., Ph.D., Jean-Charles Chakarian, M.D., Jean-Damien Ricard, M.D., Ph.D., Xavier Wittebole, M.D., Stéphanie Chevalier, M.D., Alexandre Herbland, M.D., Muriel Fartoukh, M.D., Ph.D., Jean-Michel Constantin, M.D., Ph.D., Jean-Marie Tonnelier, M.D., Marc Pierrot, M.D., Armelle Mathonnet, M.D., Gaëtan Béduneau, M.D., Céline Delétage-Métreau, Ph.D., Jean-Christophe M. Richard, M.D., Ph.D., Laurent Brochard, M.D., and René Robert, M.D., Ph.D., for the FLORALI Study Group and the REVA Network*

This article was published on May 17, 2015, at NEJM.org.

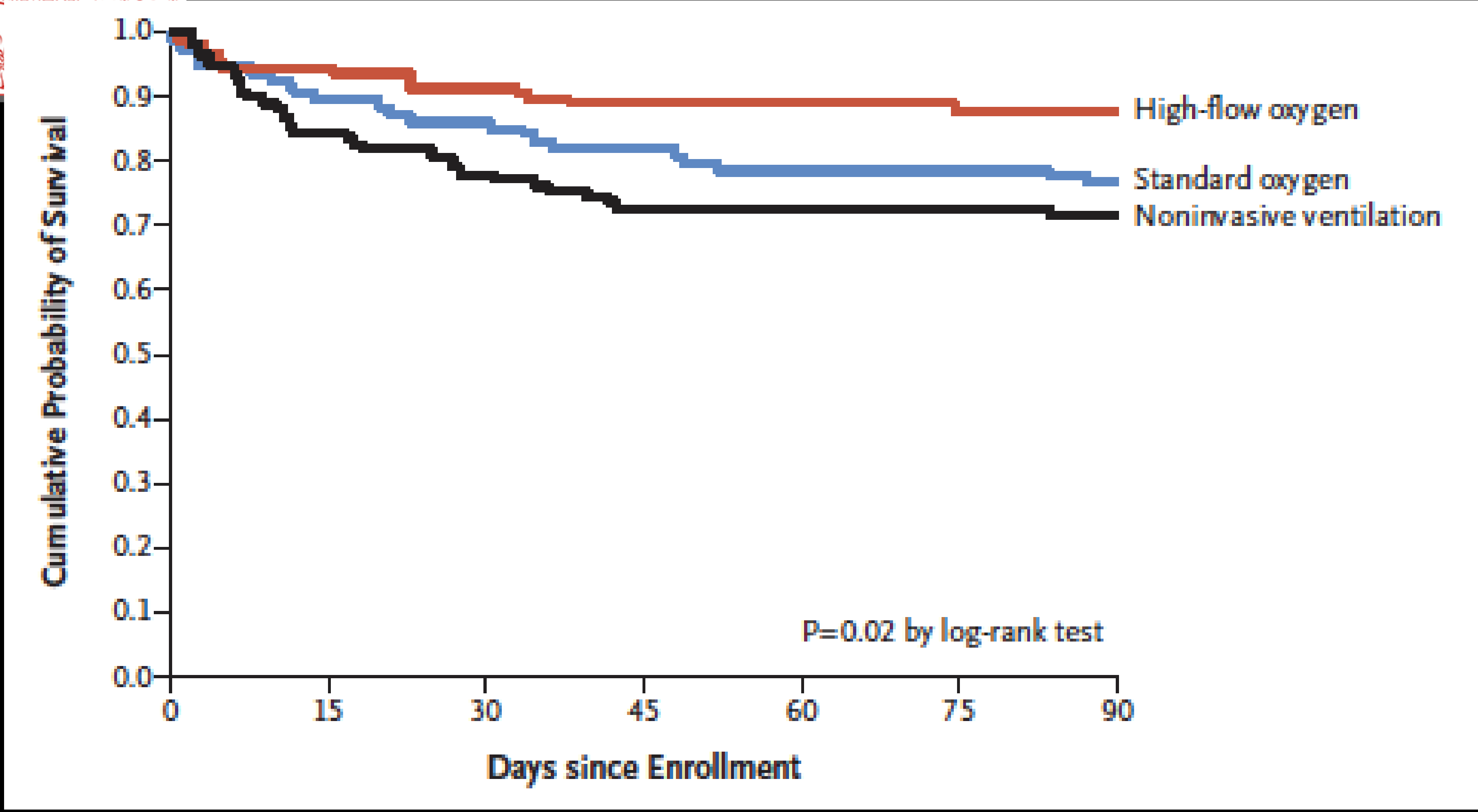


No. at Risk

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

ETI primary outcome

RCT of HOF v NIV v SO in AHRF



Frat J-P et al, NEJM 2015

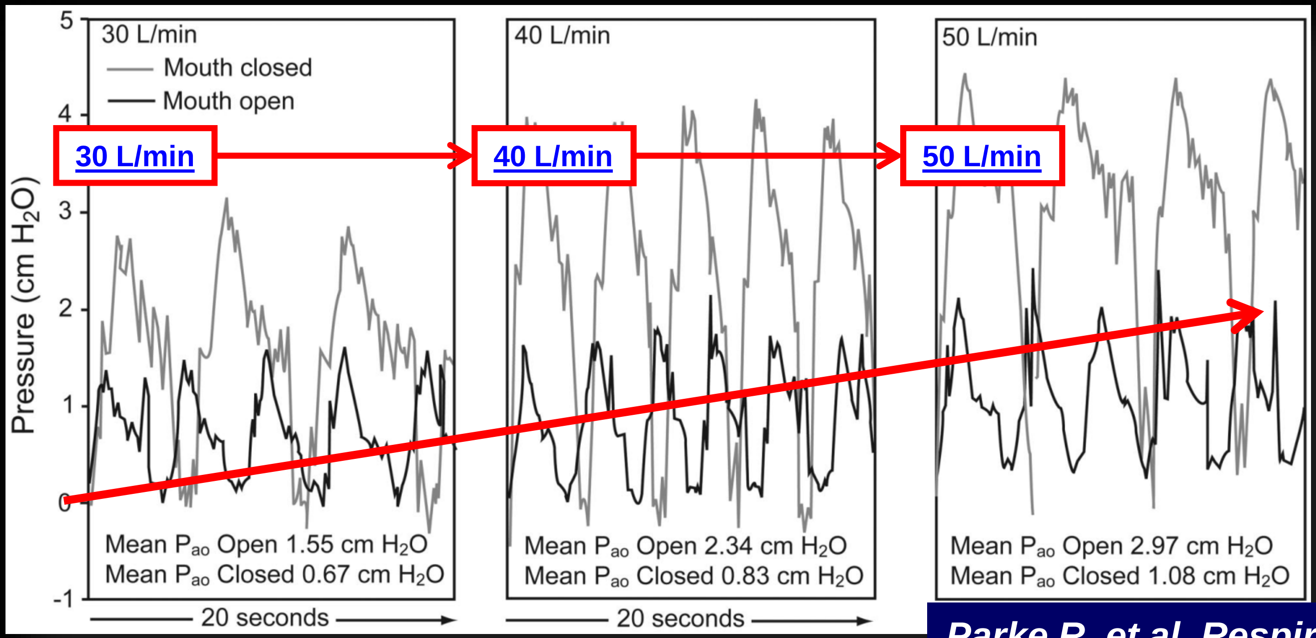
Biases:

- primary outcome not reached

- high tidal volumes during NIV (WHY ?)= during PSV you add the effort of the patient on top of the assitance of the ventilator. So the patients were “under-assisted” ?

- no use of humidification during NIV

HOF may can provide a distending pressure



Parke R, et al. Respir Care 2011;56:1151-5

Low CPAP effect, increasing linearly with flow

CARING FOR THE
CRITICALLY ILL PATIENT

JAMA. 1999;282:54-61

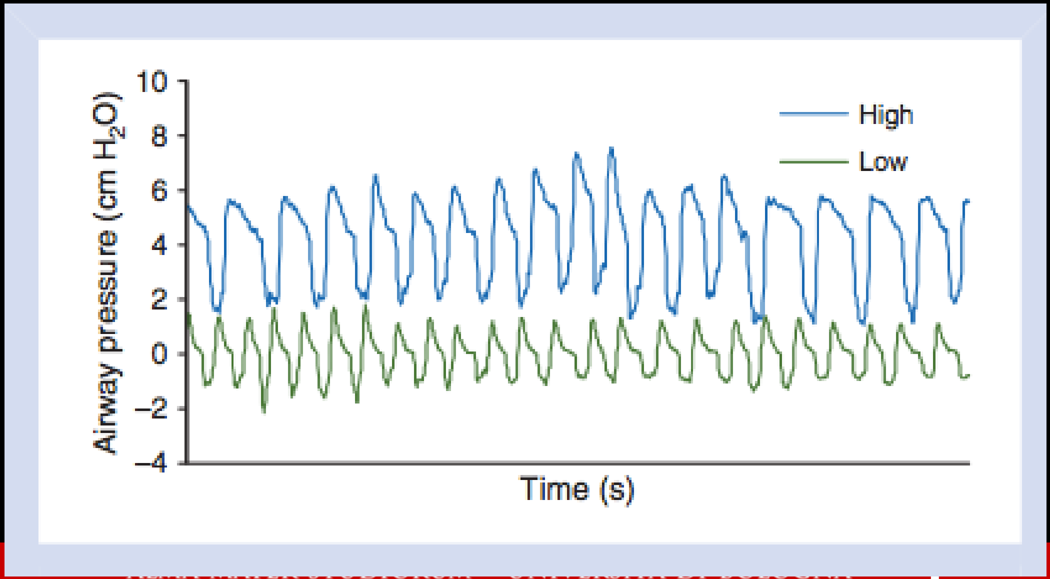
Effect of Mechanical Ventilation on Inflammatory Mediators in Patients With Acute Respiratory Distress Syndrome

A Randomized Controlled Trial

V. Marco Ranieri, MD
Peter M. Suter, MD
Cosimo Tortorella, MD, PhD
Renato De Tullio, MD
Jean Michel Dayer, MD
Antonio Brienza, MD
Francesco Bruno, MD
Arthur S. Slutsky, MD

Mechanical ventilation can induce a cytokine response that may be attenuated by a strategy to minimize overdistention and recruitment-derecruitment of the lung "

PEEP VS CPAP effect
HOF provides "only"
a PEEP effect

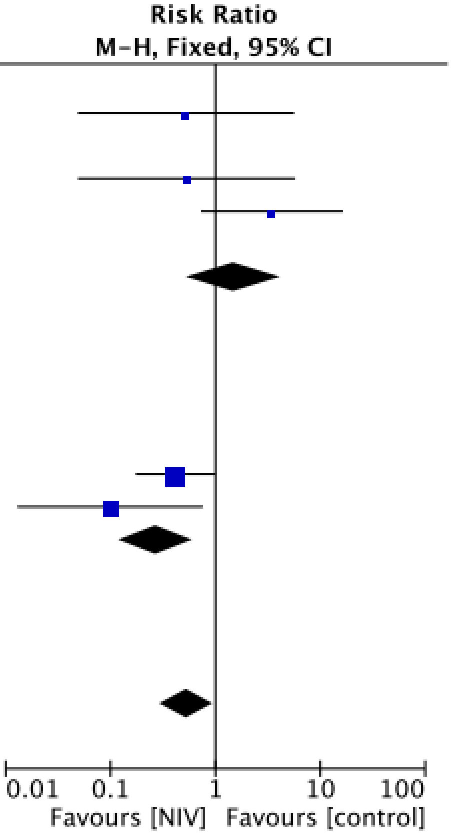


PREVENTION of POST-EXTUBATION HYPOXIC FAILURE IN SURGICAL PATIENTS

NIV VS STANDARD TREATMENT

ETI RATE

Study or Subgroup	NIV Events	NIV Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.2.1 Prevention of ARF in postop patients						
Al Jaaly 2013	1	63	2	66	7.0%	0.52 [0.05, 5.63]
Barbagallo 2012	0	26	0	26		Not estimable
Bohner 2002	1	99	2	105	6.9%	0.53 [0.05, 5.76]
Lorut 2013	7	181	2	179	7.2%	3.46 [0.73, 16.44]
Wong 2011	0	43	0	38		Not estimable
Subtotal (95% CI)		**412**		**414**	**21.1%**	**1.53 [0.54, 4.28]**
Total events	9		6			
Heterogeneity: $Chi^2 = 2.59$, df = 2 (P = 0.27); $I^2 = 23\%$						
Test for overall effect: Z = 0.80 (P = 0.42)						
1.2.2 Treatment of ARF in postop patients						
Auriant 2001	5	24	12	24	42.9%	0.42 [0.17, 1.00]
Squadrone 2005	1	105	10	104	35.9%	0.10 [0.01, 0.76]
Subtotal (95% CI)		**129**		**128**	**78.9%**	**0.27 [0.12, 0.61]**
Total events	6		22			
Heterogeneity: $Chi^2 = 1.85$, df = 1 (P = 0.17); $I^2 = 46\%$						
Test for overall effect: Z = 3.13 (P = 0.002)						
Total (95% CI)		**541**		**542**	**100.0%**	**0.54 [0.30, 0.97]**
Total events	15		28			
Heterogeneity: $Chi^2 = 8.46$, df = 4 (P = 0.08); $I^2 = 53\%$						
Test for overall effect: Z = 2.08 (P = 0.04)						
Test for subgroup differences: $Chi^2 = 6.62$, df = 1 (P = 0.01), $I^2 = 84.9\%$						

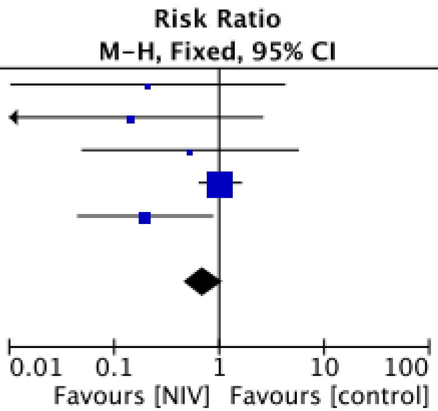


Mortality rate

Study or Subgroup	NIV Events	NIV Total	Control Events	Control Total	Weight	Risk Ratio M-H, Fixed, 95% CI
Al Jaaly 2013	0	63	2	66	5.3%	0.21 [0.01, 4.28]
Barbagallo 2012	0	26	3	26	7.6%	0.14 [0.01, 2.63]
Bohner 2002	1	99	2	105	4.2%	0.53 [0.05, 5.76]
Lorut 2013	29	181	28	179	61.1%	1.02 [0.64, 1.65]
Squadrone 2005	2	105	10	104	21.8%	0.20 [0.04, 0.88]
Total (95% CI)		**474**		**480**	**100.0%**	**0.71 [0.47, 1.08]**
Total events	32		45			

Heterogeneity: $Chi^2 = 6.90$, df = 4 (P = 0.14); $I^2 = 42\%$

Test for overall effect: Z = 1.58 (P = 0.11)



TREATMENT of HYPOXIC POST_EXTUBATION FAILURE

164. pp 1231–1235, 2001

Noninvasive Ventilation Reduces Mortality in Acute Respiratory Failure following Lung Resection

IGOR AURIANT, ANNE JALLOT, PHILIPPE HERVÉ, JACQUES CERRINA, FRANCOIS LE ROY LADURIE, JEAN LAMET FOURNIER, BERNARD LESCOT, and FRANCOIS PARQUIN

Duration of NPPV was 2.1(2.4) day with 14.3 (2.8) h per day

PS level was 8.5 (1.9)
PEEP level was 4(0.1)

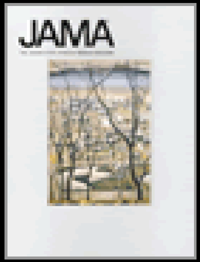
	No-NPPV (*n* = 24) Mean ± SD	NPPV (*n* = 24) Mean ± SD	p Value*
ETMV, n (%)	12 (50%)	5 (20.8%)	0.035
In-hospital deaths, n (%)	9 (37.5%)	3 (12.5%)	0.045
Length of ICU stay, d	14 ± 11.1	16.65 ± 23.6	0.52
Length of hospital stay, d	22.8 ± 10.7	27.1 ± 19.5	0.61
120 - d mortality, n (%)	9 (37.5%)	3 (12.5%)	0.045

TABLE 2. CHARACTERISTICS OF PATIENTS AT INCLUSION AND 2 h AFTER TREATMENT INITIATION*

	No-NPPV		NPPV		p Value*
	Inclusion	2 h	Inclusion	2 h	
Pa_{O_2}/FI_{O_2}	127.1 ± 42.5	155.6 ± 53.7†	126.8 ± 42.1	199.1 ± 8†§	

nCPAP and post-op hypoxemia: A randomized controlled trial

Squadrone V et al JAMA 2005;293:589-595

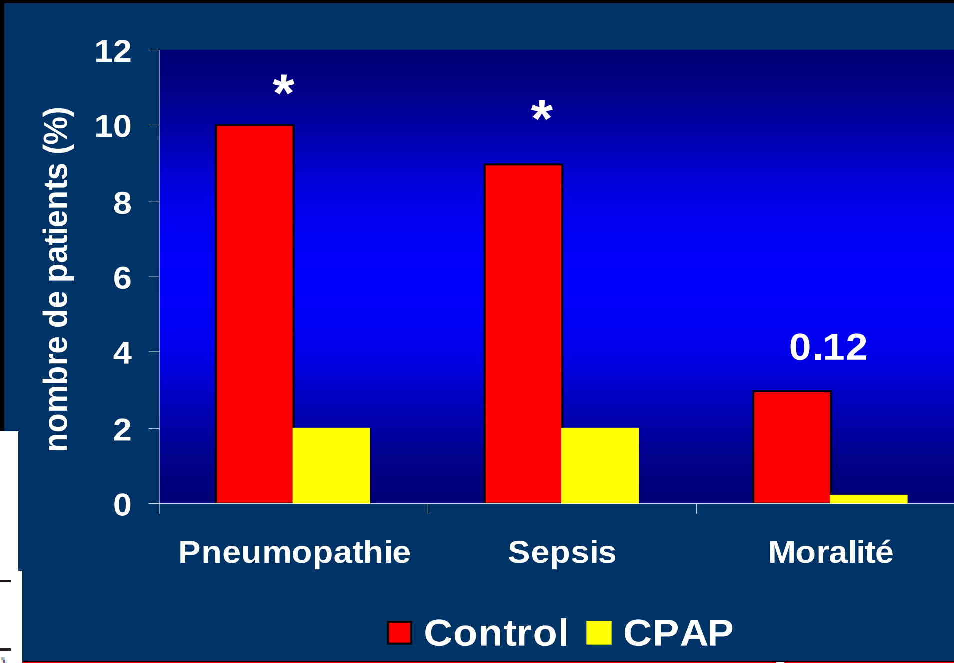


Patients scheduled for elective major abdominal surgery and general anesthesia who met a $PaO_2/FiO_2 < 300$ after 1 h at 30% (Venturi mask) in the recovery room.

Helmet CPAP
10 cmH_2O vs Venturi mask

Table 1. Baseline Characteristics of the Patients at Study Inclusion Before Randomization

	Control (n = 104)	CPAP (n = 105)
Postoperative gases, mean (SD)		
PaO_2/FiO_2	255 (31)	247 (33)
Arterial, pH	7.39 (0.05)	7.38 (0.04)
$PaCO_2$, mm Hg	39 (5)	39 (7)



Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Noninvasive Ventilation on Tracheal Reintubation Among Patients With Hypoxemic Respiratory Failure Following Abdominal Surgery
A Randomized Clinical Trial

Samir Jaber, MD, PhD; Thomas Lescot, MD, PhD; Emmanuel Futier, MD, PhD; Catherine Paugam-Burtz, MD, PhD; Philippe Seguin, MD, PhD; Martine Ferrandiere, MD; Sigismond Lasocki, MD, PhD; Olivier Mimoz, MD, PhD; Baptiste Hengy, MD; Antoine Sannini, MD; Julien Pottecher, MD; Paër-Sélim Abback, MD; Beatrice Riu, MD; Fouad Belafia, MD; Jean-Michel Constantin, MD, PhD; Elodie Masseret, MD; Marc Beaussier, MD, PhD; Daniel Verzilli, MD; Audrey De Jong, MD; Gerald Chanques, MD, PhD; Laurent Brochard, MD, PhD; Nicolas Molinari, PhD; for the NIVAS Study Group

Arterial blood gas at randomization, mean (SD)		
pH	7.41 (0.07)	7.42 (0.07)
Pao_2:Fio_2 ratio, mm Hg	188 (71)	201 (69)
$Paco_2$, mm Hg	37 (7)	39 (7)
HCO_3, mmol/L	24 (4)	25 (4)

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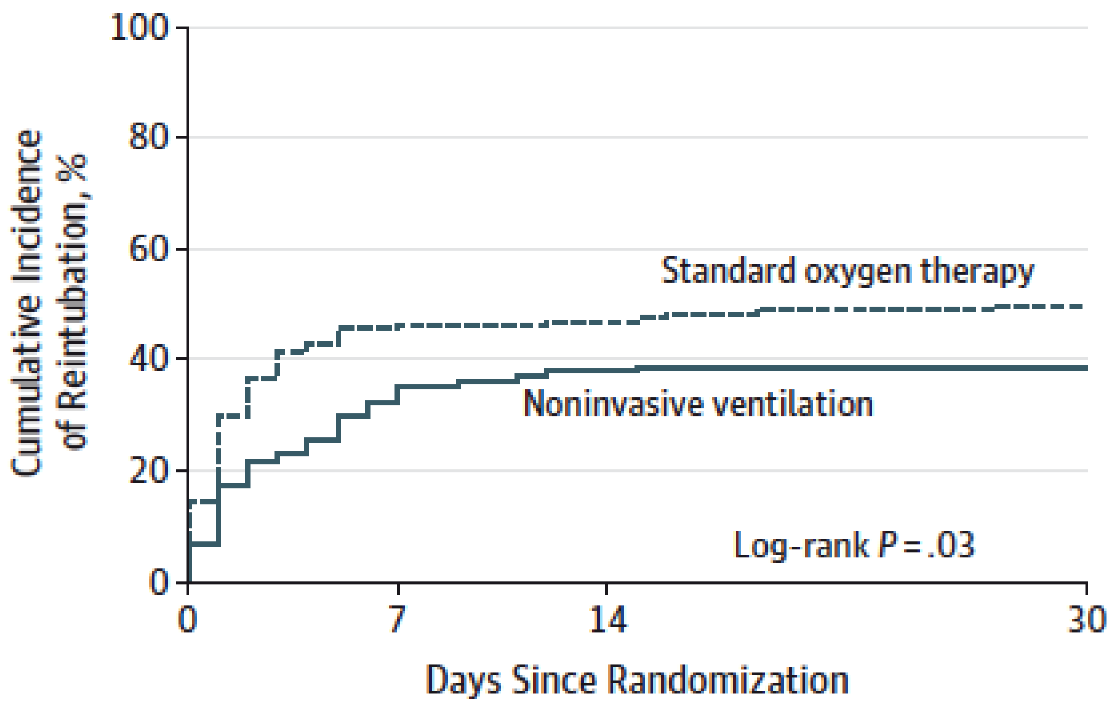
Figure 2. Cumulative Incidence of Reintubation Between Randomization and Day 30 According to Study Group



RCT Post Cardiac Surgery

Stephan F et al, JAMA 2015

- Hi Flow 50 l/min vs NIV 8 cm H20 IPAP, 4 EPAP at least 4 hrs daily

- 414 v 416 pts with failed SBT (P/F < 150) or failed extubation (P/F < 300, RR > 25, Access muscle use)
- Treatment failure 1st outcome (reintubation or early discontinuation)
- RR 33, P/F 200, pH 7.39, PaCO2 39 mm Hg

RCT Post Cardiac Surgery

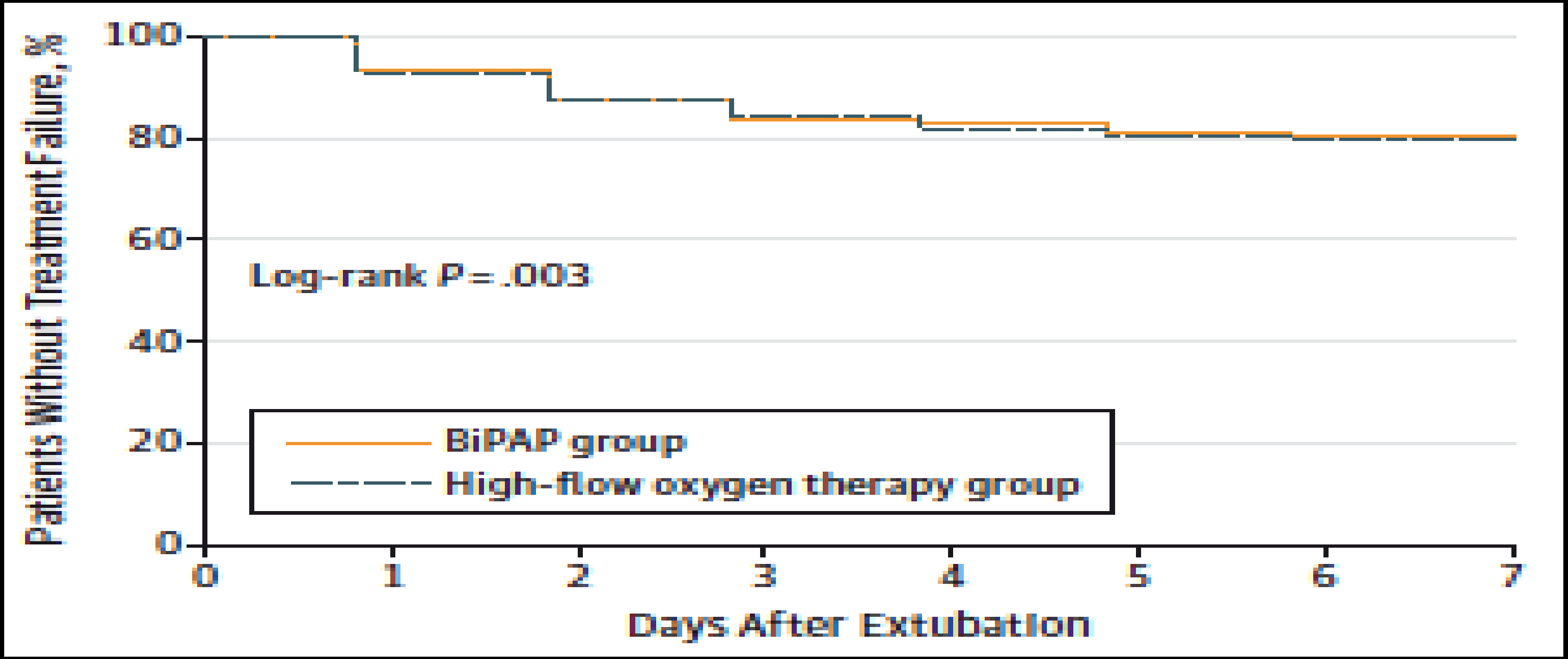
Stephan F et al, JAMA 2015

	HOF	NIV
Treatment failure (%)	21.0	21.9
Reintub (%)	14.0	13.7
Failure P/F < 200 (%)	27.5	24.8
Crossovers (%)	10.8	7.9
PaO2/FIO2	157	187*
Hrs /day	20	6.5*
Settings (cm H2O,l/min)	46.7	9.3/4.2

RCT Post Cardiac Surgery

Pts without Treatment Failure

Stephan JAMA 2015



No diff Comfort or Dyspnea, Mortality (6.8 v 4.8%), Focal erythema (9.4 v 2.5%)

Biases:

- different duration of treatment

- low levels of pressures during NIV

- statistical better oxygenation with NIV

ARDS

The JAMA Network

SPECIAL COMMUNICATION

ONLINE FIRST

Acute Respiratory Distress Syndrome

The Berlin Definition

JAMA. 2012;():1-8. doi:10.1001/jama.2012.5669

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

	Acute Respiratory Distress Syndrome
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging[a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation[b]	
Mild	200 mm Hg $<$ PaO_2/FIO_2 $\leq$ 300 mm Hg with PEEP or CPAP $\geq$5 cm H_2O[c]
Moderate	100 mm Hg $<$ PaO_2/FIO_2 $\leq$ 200 mm Hg with PEEP $\geq$5 cm H_2O
Severe	PaO_2/FIO_2 $\leq$ 100 mm Hg with PEEP $\geq$5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; FIO_2, fraction of inspired oxygen; PaO_2, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.
[a] Chest radiograph or computed tomography scan.
[b] If altitude is higher than 1000 m, the correction factor should be calculated as follows: [PaO_2/FIO_2 × (barometric pressure/760)].
[c] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

Intensive Care Med (2008) 34:17–60
DOI 10.1007/s00134-007-0934-2

SPECIAL ARTICLE

R. Phillip Dellinger
Mitchell M. Levy
Jean M. Carlet
Julian Bion
Margaret M. Parker

Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: 2008

Mechanical ventilation of sepsis-induced acute lung injury (ALI)/ARDS

- Target a tidal volume of 6 ml/kg (predicted) body weight in patients with ALI/ARDS. *(1B)*
- Target an initial upper limit plateau pressure $\leq$ 30 cm H_2O. Consider chest wall compliance when assessing plateau pressure. *(1C)*
- Allow $PaCO_2$ to increase above normal, if needed to minimize plateau pressures and tidal volumes. *(1C)*
- Positive end expiratory pressure (PEEP) should be set to avoid extensive lung collapse at end expiration. *(1C)*
- ○ Consider using the prone position for ARDS patients requiring potentially injurious levels of FiO_2 or plateau pressure, provided they are not put at risk from positional changes. *(2C)*
- Maintain mechanically ventilated patients in a semi-recumbent position (head of the bed raised to 45°) unless contraindicated *(1B)*, between 30°–45° *(2C)*.
- ○ Non invasive ventilation may be considered in the minority of ALI/ARDS patients with mild-moderate hypoxemic respiratory failure. The patients need to be hemodynamically stable, comfortable, easily arousable, able to protect/clear their airway and expected to recover rapidly. *(2B)*
- Use a weaning protocol and a spontaneous breathing trial (SBT) regularly to evaluate the potential for discontinuing mechanical ventilation. *(1A)*
  - SBT options include a low level of pressure support with continuous positive airway pressure 5 cm H_2O or a T-piece.
  - Before the SBT, patients should:
    - be arousable
    - be haemodynamically stable without vasopressors
    - have no new potentially serious conditions
    - have low ventilatory and end-expiratory pressure requirement
    - require FiO_2 levels that can be safely delivered with a face mask or nasal cannula

A multiple-center survey on the use in clinical practice of noninvasive ventilation as a first-line intervention for acute respiratory distress syndrome*

Massimo Antonelli, MD; Giorgio Conti, MD; Antonio Esquinas, MD; Luca Montini, MD; Salvatore Maurizio Maggiore, MD, PhD; Giuseppe Bello, MD; Monica Rocco, MD; Riccardo Maviglia, MD; Mariano Alberto Pennisi, MD; Gumersindo Gonzalez-Diaz, MD; Gianfranco Umberto Meduri, MD

Observational multicenter study.

It is important to note the NIV exclusion criteria

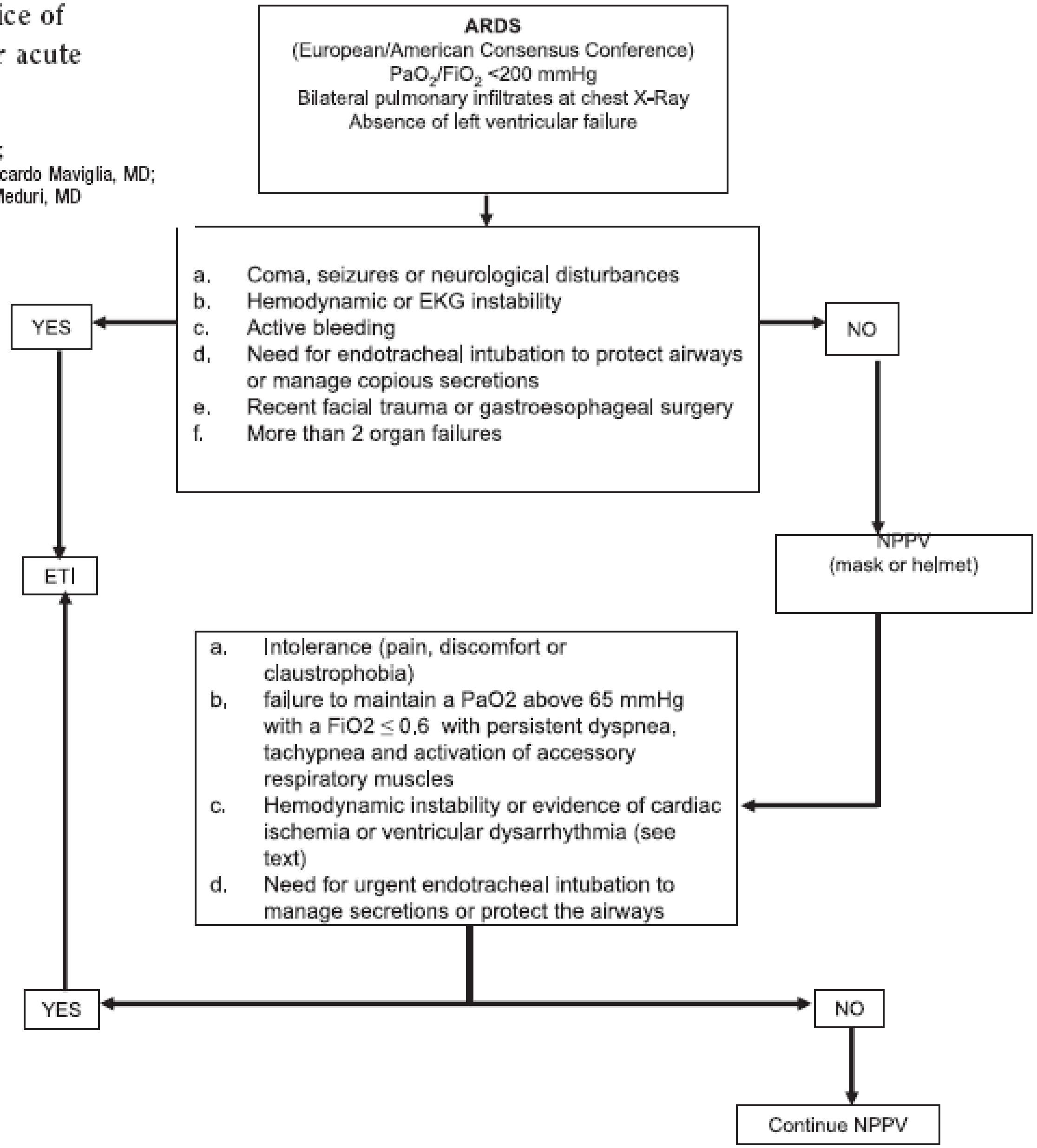


Figure 1. Study design. *ARDS*, acute respiratory distress syndrome; *EKG*, electrocardiograph; *NPPV*, noninvasive positive pressure ventilation.

Table 1. Baseline characteristics in patients who avoided and required intubation

Variable	Avoided Intubation (n = 79)	Required Intubation (n = 68)	*p* Value
Age, yrs, median (25th–75th)	53 (35–64)	60 (51–68)	.02
Male gender, n (%)	43 (54)	50 (73)	.02
SAPS II on admission, median (25th–75th)	32 (28–36)	38 (34–41)	<.001
GCS, mean (SD)	14 (1)	14 (1)	.9
PEEP[a] basal, mean (SD)	7 (2)	8 (2)	.03
PSV, cm H_2O, mean (SD)	14 (3)	16 (4)	.02
NPPV started in the ER, n (%)	17 (21)	13 (19)	.43
Patients treated with the helmet, n (%)	25 (32)	19 (28)	.37
Pao_2/Fio_2 at baseline, mean (SD)	116 (38)	105 (33)	.06
pH at baseline, mean (SD)	7.41 (0.08)	7.39 (0.07)	.12
$Paco_2$ at baseline, mm Hg, mean (SD)	40 (13)	40 (13)	.94
RR at baseline, mean (SD)	35 (5)	36 (5)	.27
HR at baseline, mean (SD)	105 (21)	106 (24)	.9
Comorbid conditions, n (%)			
None	45 (57)	37 (54)	.8
Systemic hypertension	9 (11)	9 (13)	.9
Diabetes	3 (4)	9 (13)	.09
Immunosuppression[b]	16 (20)	6 (9)	.1
Cardiac ischemia	6 (8)	7 (10)	.72
Etiology of ARDS, n (%)			
Pulmonary	36 (45)	33 (48)	.84
Extrapulmonary	43 (54)	35 (51)	.84

NIV failure were characterized by an high degree of severity (SAPS), older age, male sex, and more severe hypoxia (PaO2/FiO2)

A multiple-center survey on the use in clinical practice of noninvasive ventilation as a first-line intervention for acute respiratory distress syndrome*

Massimo Antonelli, MD; Giorgio Conti, MD; Antonio Esquinas, MD; Luca Montini, MD; Salvatore Maurizio Maggiore, MD, PhD; Giuseppe Bello, MD; Monica Rocco, MD; Riccardo Maviglia, MD; Mariano Alberto Pennisi, MD; Gumersindo Gonzalez-Diaz, MD; Gianfranco Umberto Meduri, MD

Conclusions: In expert centers, NPPV applied as first-line intervention in ARDS avoided intubation in 54% of treated patients. A SAPS II >34 and the inability to improve PaO_2/FIO_2 after 1 hr of NPPV were predictors of failure. (Crit Care Med 2007; 35:18–25)

479 patients with ARDS
332 need immediate intubation
147 treated with NIV
79 success
THEREFORE OVERALL NIV SUCCESS IN REAL LIFE IS:
16.4%

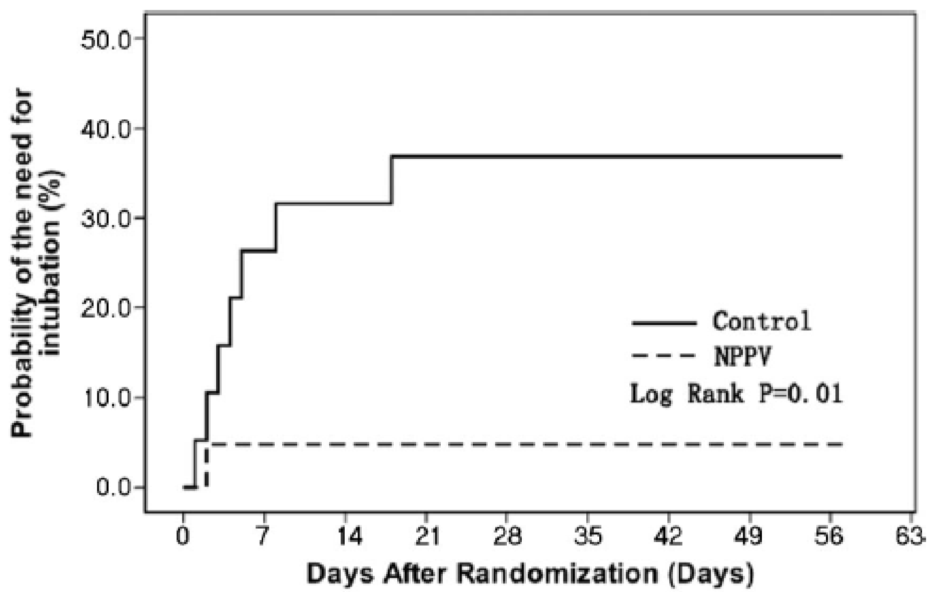
THE TIMING of APPLIOCATION IS HOWEVER CRITICAL

Early use of noninvasive positive pressure ventilation for acute lung injury: A multicenter randomized controlled trial*

Qingyuan Zhan, MD; Bing Sun, MD; Lirong Liang, MD; Xixin Yan, MD; Lutao Zhang, MD; Jingping Yang, MD; Ling Wang, MD; Zhuang Ma, MD; Liang Shi, MD; Luqing Wei, MD; Guoqiang Li, MD; Lan Yang, MD; Zhihong Shi, MD; Yuqing Chen, MD; Qixia Xu, MD; Wei Li, MD; Xi Zhu, MD; Zongyu Wang, MD; Yongchang Sun, MD; Jie Zhuo, MD; Yang Liu, MD; Xuesong Li, MD; Chen Wang, MD

Crit Care Med 2012 Vol. 40, No. 2

P/F ratio <300>200



Number at risk										
Control:	19	14	13	12	12	12	12	12	12	12
NPPV:	21	20	20	20	20	20	20	20	20	20

Early use of noninvasive positive pressure ventilation for acute lung injury: A multicenter randomized controlled trial*

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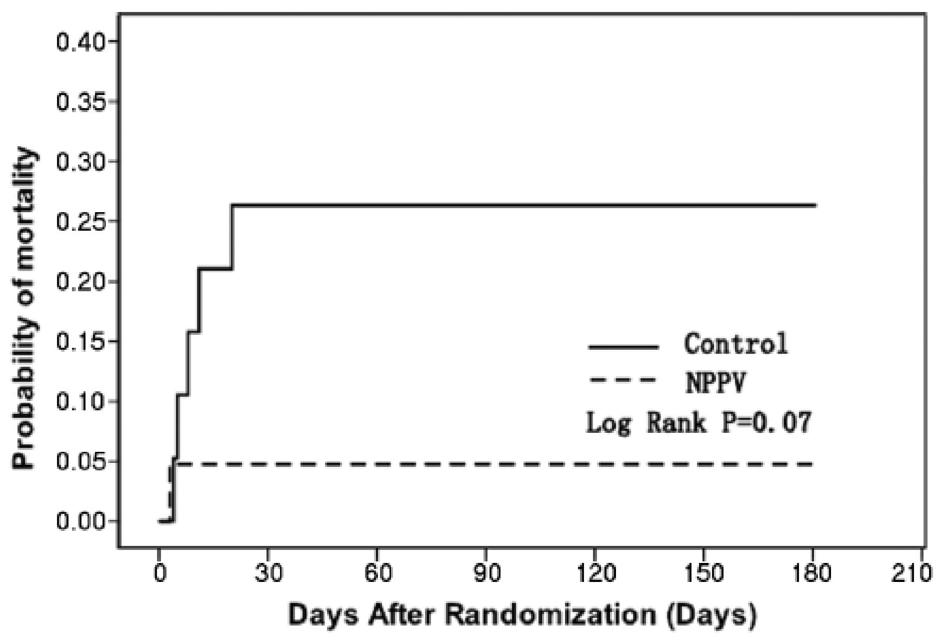
Crit Care Med 2012 Vol. 40, No. 2



Number at risk								
Control:	19	14	14	14	14	14	14	14
NPPV:	21	20	20	20	20	20	20	20

Where do HOF, NIV and ECCO²R fit in for Rx of ARF?

Hypercapnic Respiratory Failure

O_2 HOF? NIV ECCO²R Intubation

Hypoxemic Respiratory Failure

O_2 HOF/NIV? Intubation ECMO

Mild Severe

Courtesy of N. Hill

Summary:

•Probably HFO as effective as NIV in Hypoxemic RF c/w NIV, but in milder patient group

•HFO May be helpful postop for humidIfication, secretion mobilization, not inferior to NIV in post-cardiac surg pts, not demonstrated in other types of surgical procedures

• ? Other applications; cardiogenic pulm edema, trauma – results fom RCTs are awaited – COPD not yet tested

Be aggressive when you need= INTENSIVISTS

Be non invasive when the patient’s conditions allow= PULMONOLOGISTS

Eur Respir J 2010; 35: 463–466
DOI: 10.1183/09031936.00002410

EDITORIAL: RESPIRATORY INTENSIVE CARE ASSEMBLY

Pulmonologists and intensivists: ''two hearts are better than one''

Respiratory Intensive Care Assembly contribution to the celebration of 20 years of the ERS

S. Nava* and P. Pelosi#

Definition of COPD

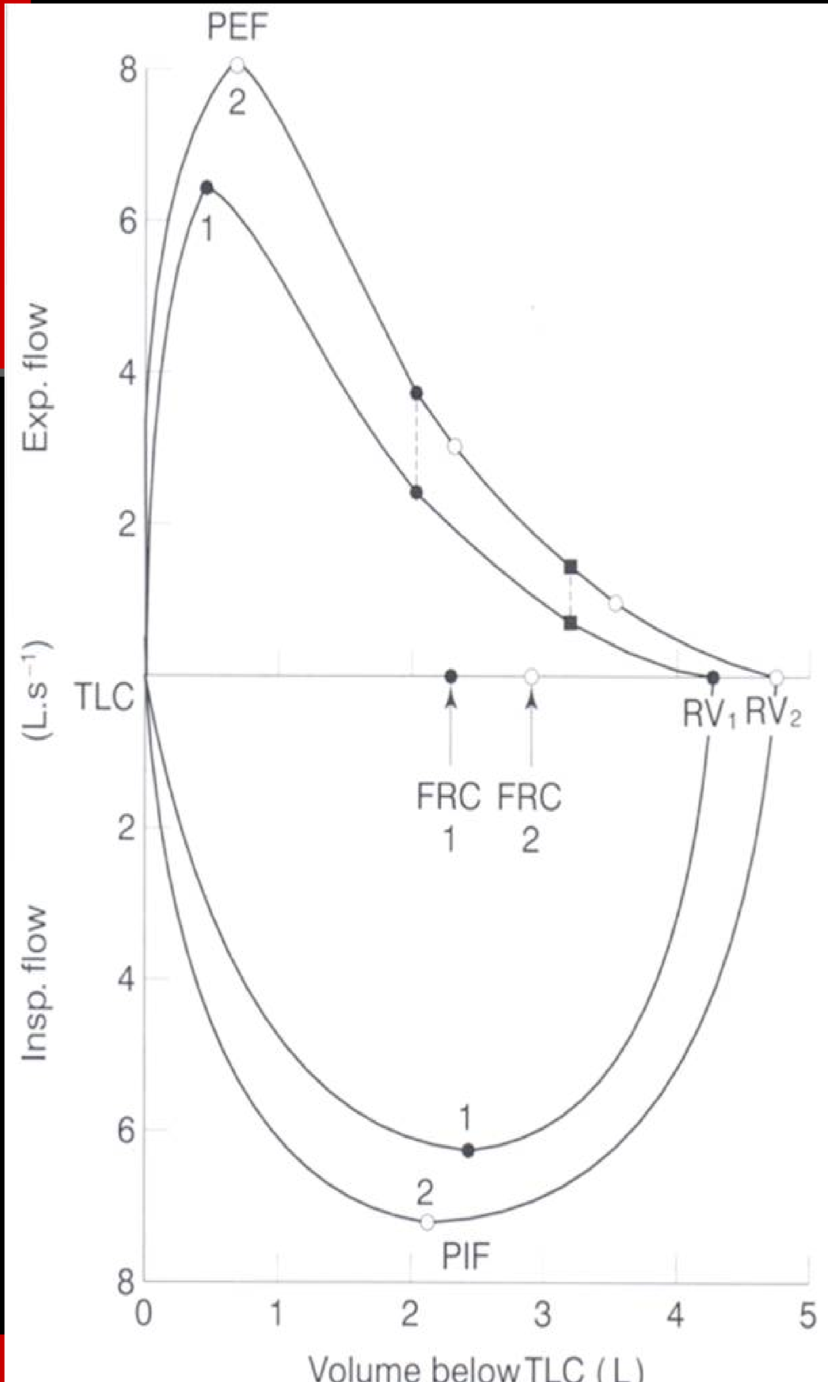
Chronic obstructive pulmonary disease (COPD) is a disease state characterised by airflow limitation that is not fully reversible.

The airflow limitation is usually progressive and is associated with an abnormal inflammatory response

ASTHMA DEFINITION

Asthma is a <u>chronic inflammatory disorder</u> of the airways in which many cells and cellular elements play a role. The chronic inflammation causes an associated increase in airway hyper-responsiveness.

These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment.



Maximum expiratory and inspiratory flow volume curves before (1) and after (2) bronchodilatation

increase in FEV1 and/or FVC ≥ 12% of control and ≥ 200 mL constitutes a positive bronchodilator response

FUNCTIONAL BASIS IN COPD

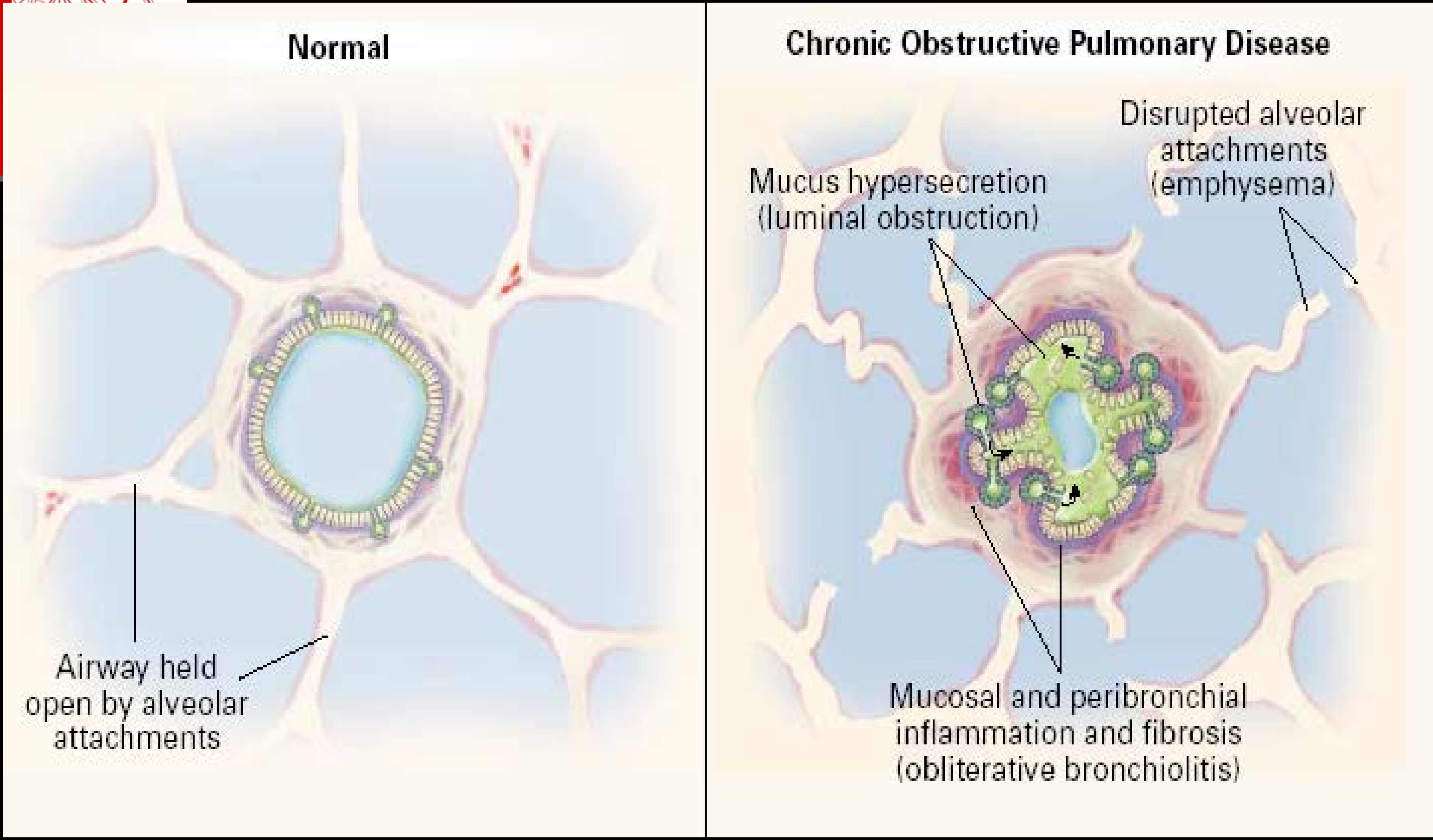
Increased resistances { Bronchoconstriction; Secretion; Wall thickening }

Increased compliance

Dynamic hyperinflation → auto-PEEP

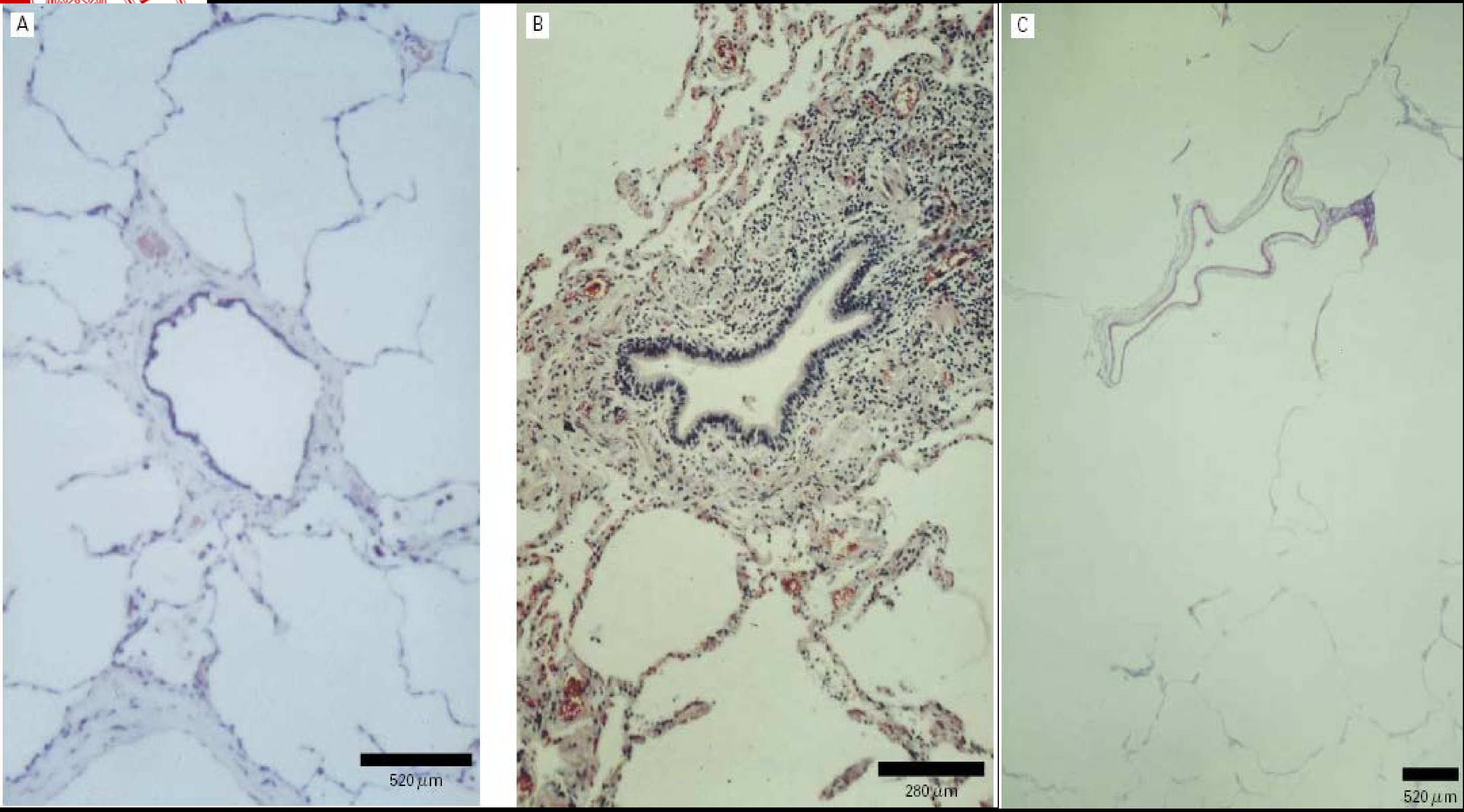
RESPIRATORY RESISTANCE
Broseghini et al. Am Rev Respir Dis 1988; 138: 355

	Rrs,max	Rrs,min	ΔRrs
CPE	12.1	8.3	3.8
ARDS	15.5	8.0	7.5
COPD	26.4	15.6	10.8



Barnes, NEJM 2000

Normal small airway | Small airway disease | Emphysema



Barnes, NEJM 2000

FUNCTIONAL BASIS

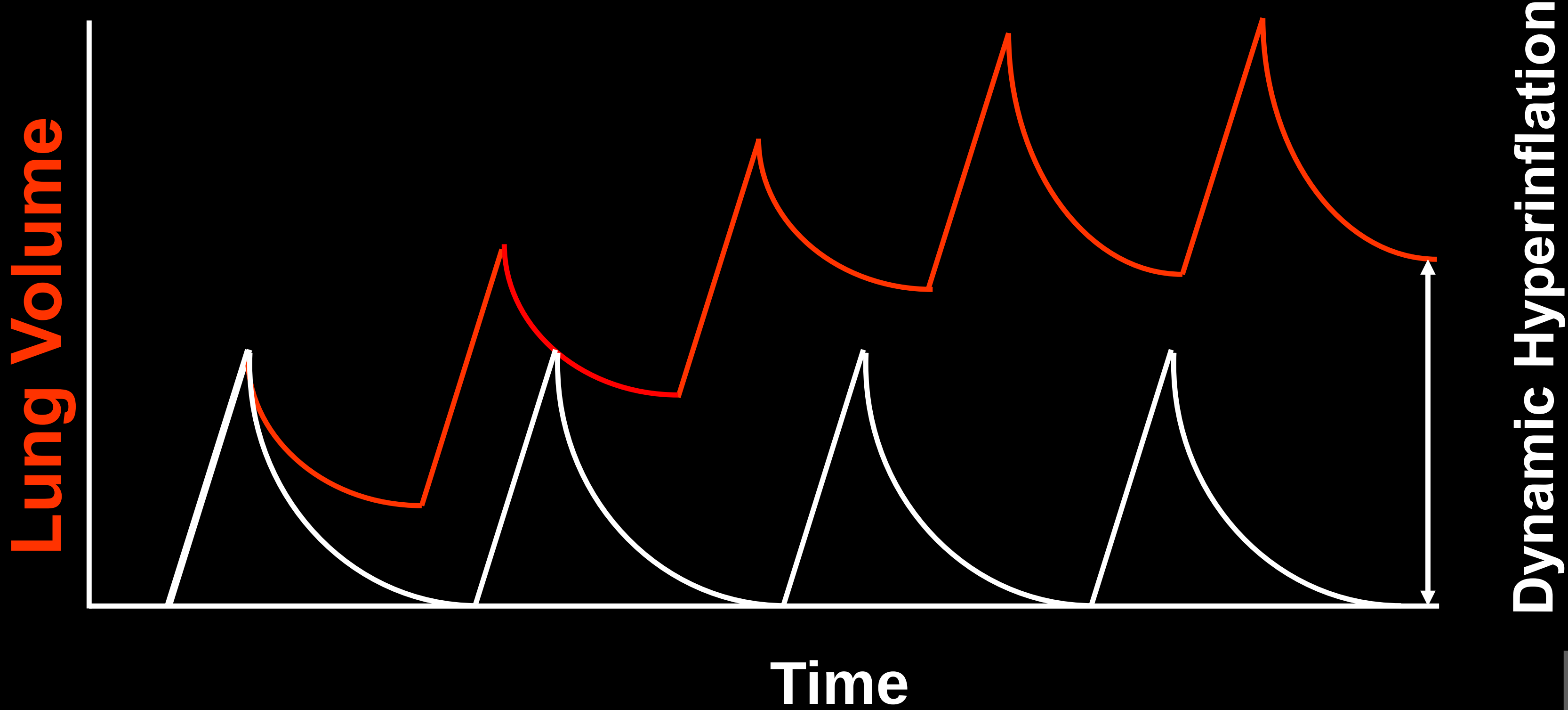
Increased resistances
- Bronchoconstriction
- Secretion
- Wall thickening

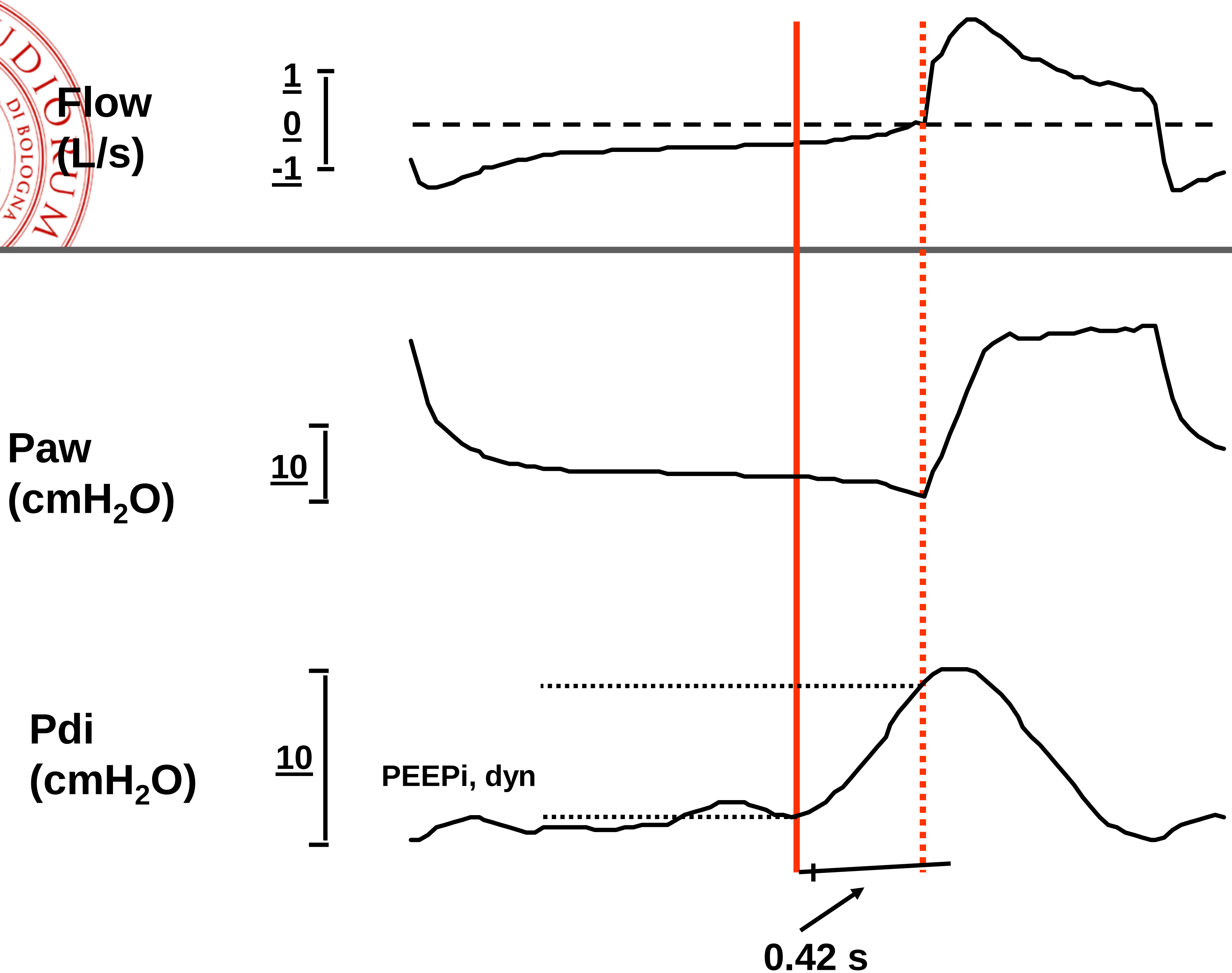
Increased compliance

Dynamic hyperinflation

DYNAMIC HYPERINFLATION

- Duration of expiration is insufficient to allow the lungs to deflate to the relaxation volume of the respiratory system: (airway obstruction, increased breathing frequency, increased tidal volume, tidal expiratory flow limitation)





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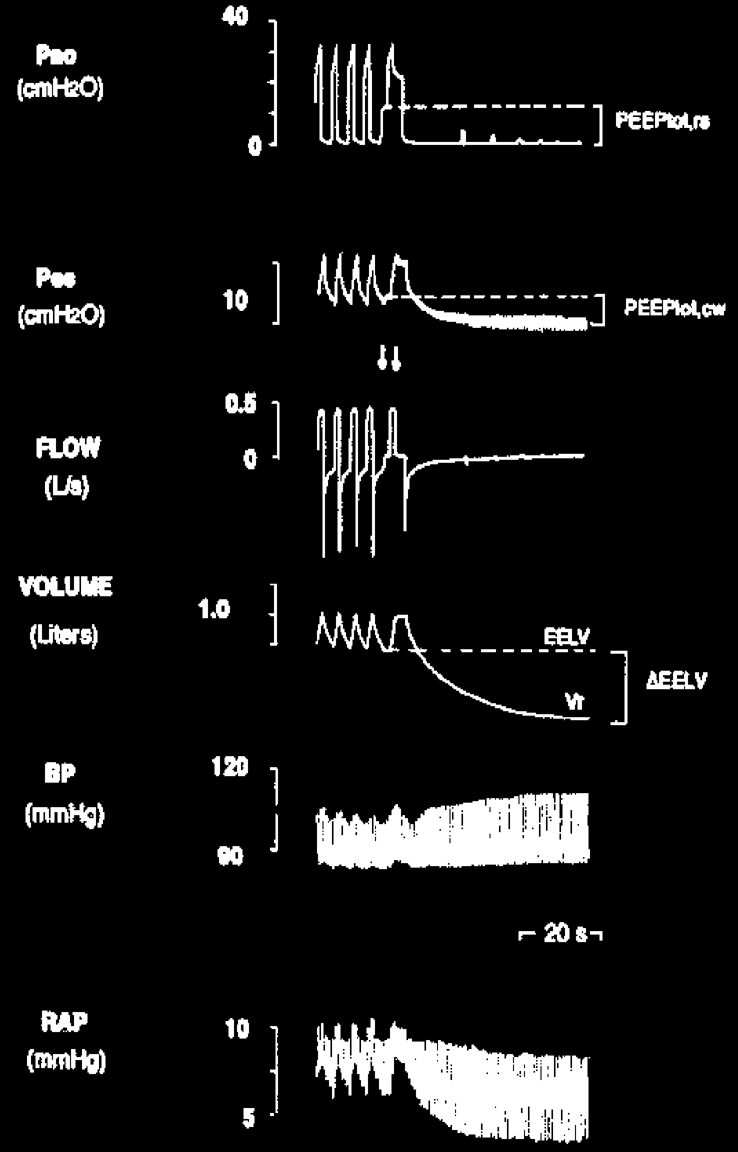
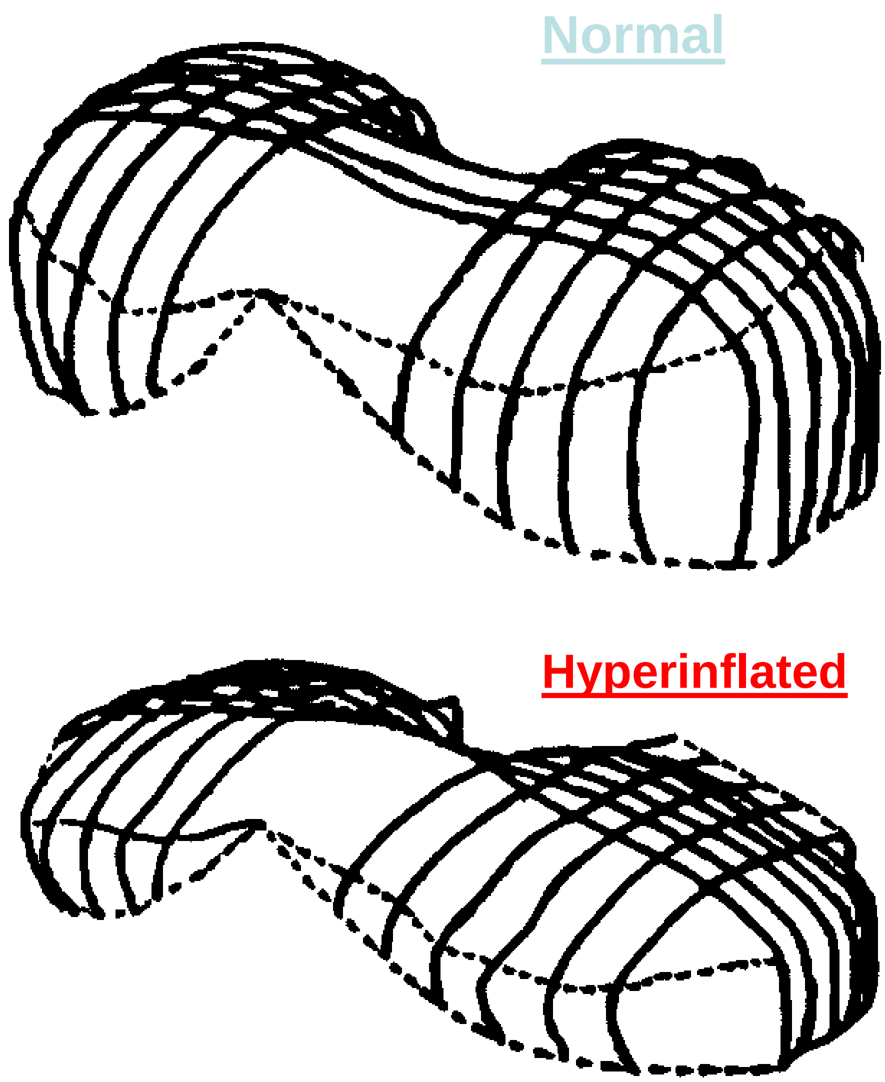
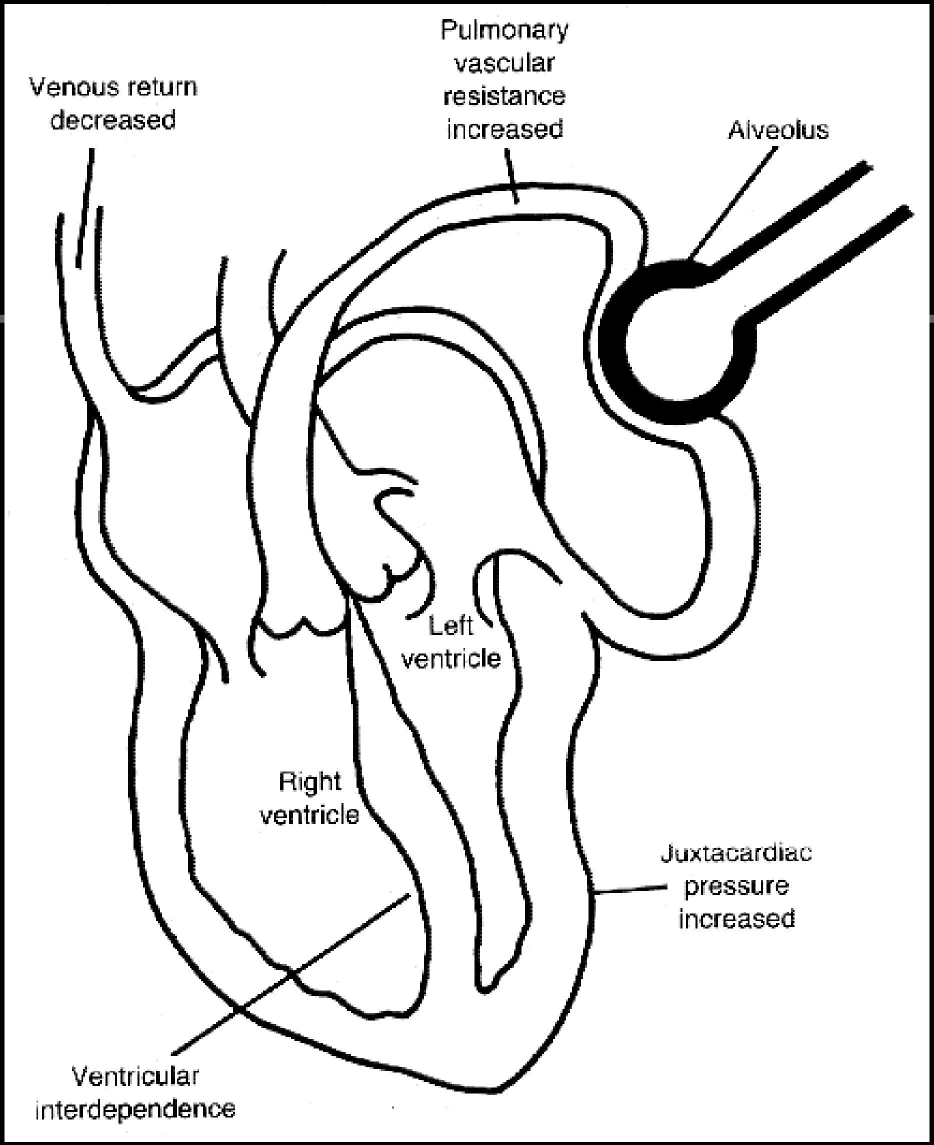


Ranieri V.M. et al.

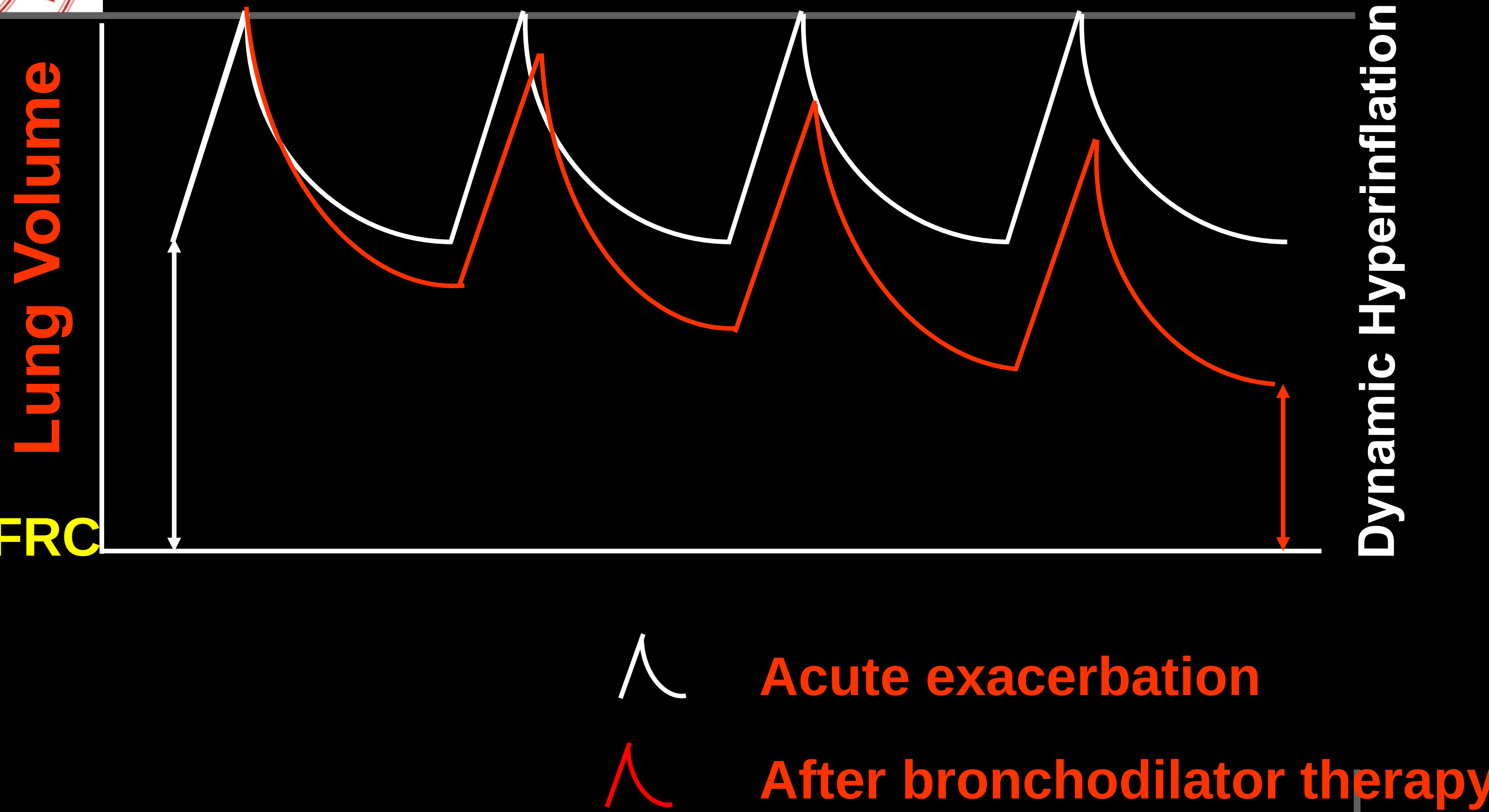
Am Rev Respir Dis 1993; 147: 5-13.


Normal
Hyperinflated


Venous return decreased
Pulmonary vascular resistance increased
Alveolus
Left ventricle
Right ventricle
Juxtacardiac pressure increased
Ventricular interdependence

OBIETTIVI DEL TRATTAMENTO NELL'OSTRUZIONE BRONCHIALE SEVERA

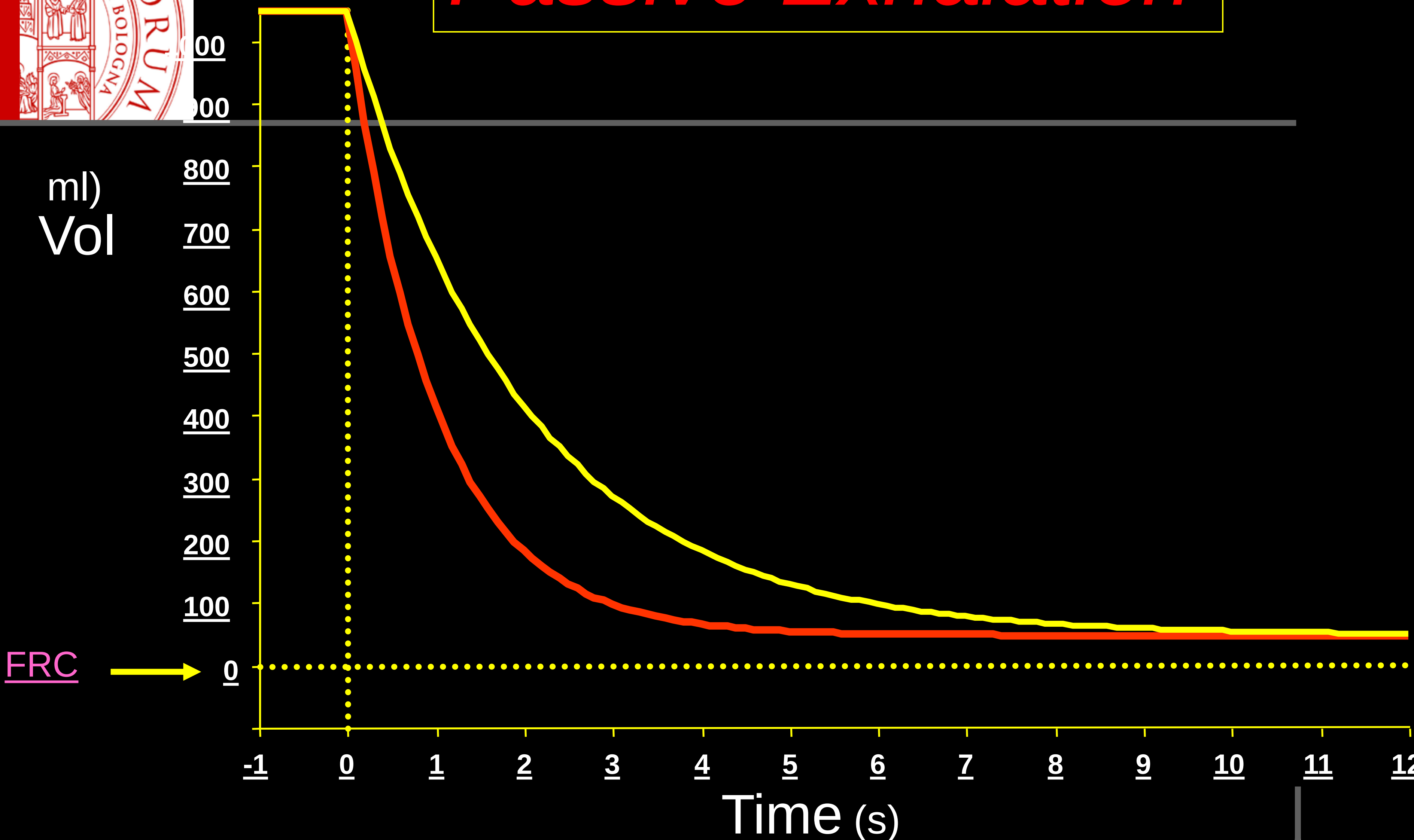
1. **Ossigenazione adeguata**
2. **Riduzione dell'iperinflazione polmonare**
   - **Broncodilatazione aggressiva**
   - **Setting del ventilatore**


Lung Volume
FRC
Dynamic Hyperinflation
Acute exacerbation
After bronchodilator therapy

SETTING DEL VENTILATORE

Minimizzazione iperinflazione polmonare

Passive Exhalation



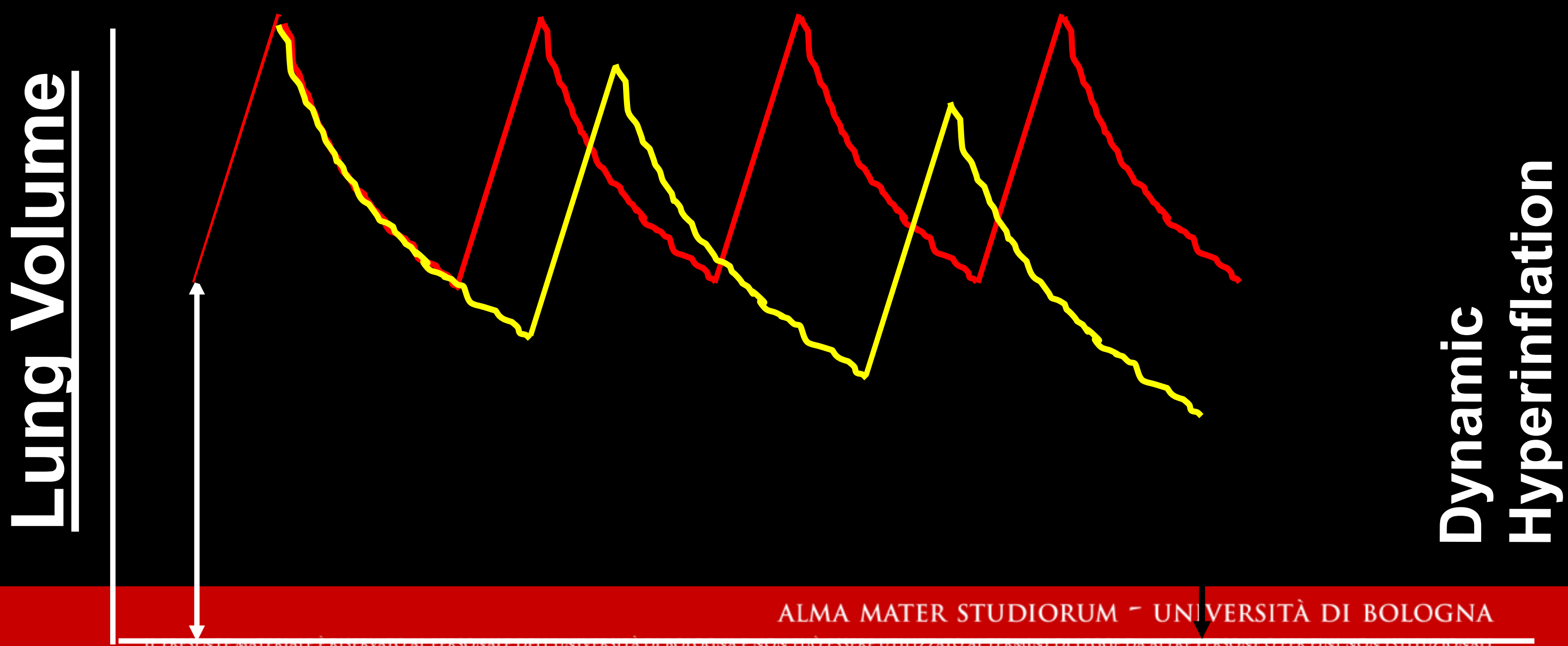
Come possiamo prolungare il Te ?

- **Riduzione di Frequenza**
- **Riduzione del tempo inspiratorio (rapporto I:E)**
- **Abolizione di qualsiasi pausa tele-inspiratoria**
- **Sedazione profonda**

RIDUZIONE FREQUENZA RESPIRATORIA

- VT = 800 ml
- VI = 60L/min
- FR = 15
- VE = 12 L/min
- TE = 3.2 s

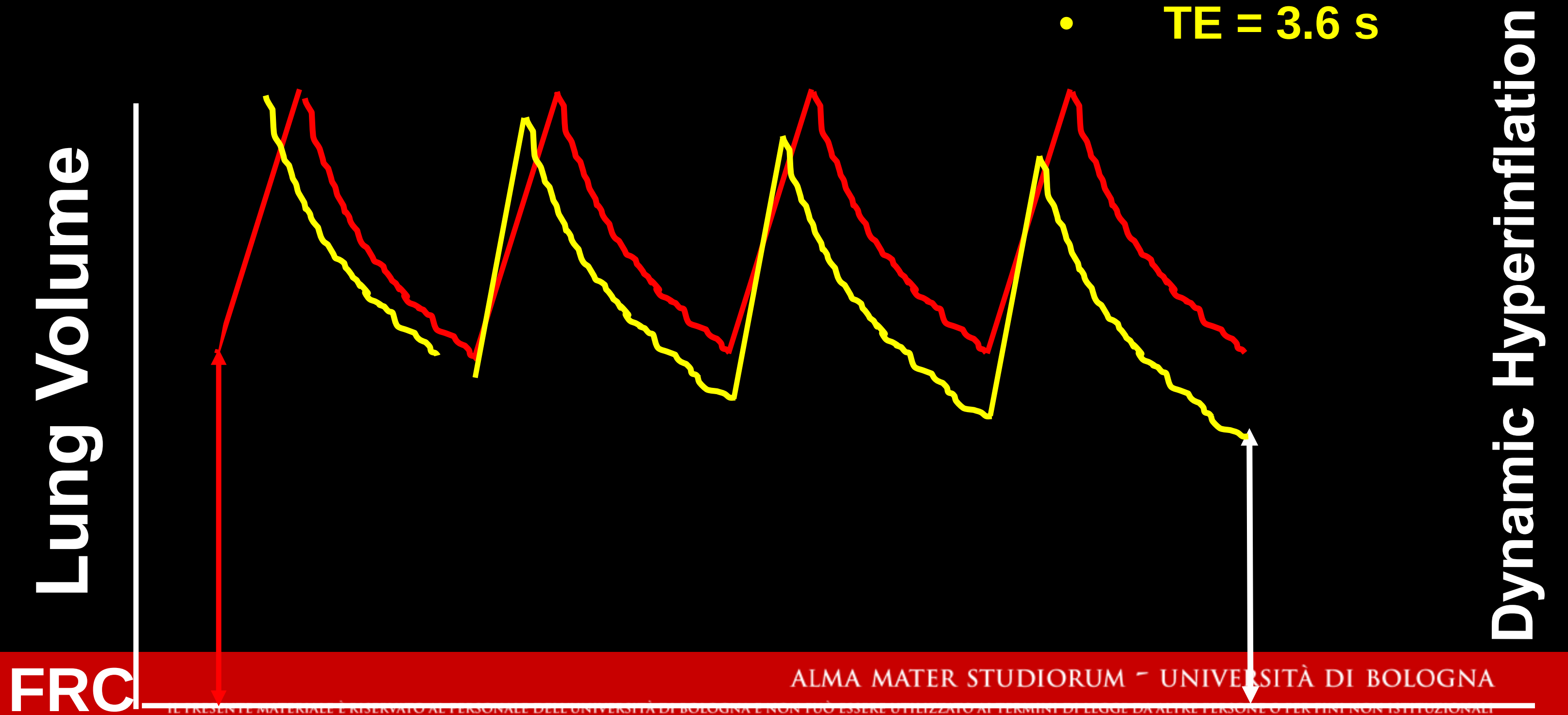
- VT = 800 ml
- VI = 60L/min
- FR = 12
- VE = 9,6 L/min
- TE = 4.2 s

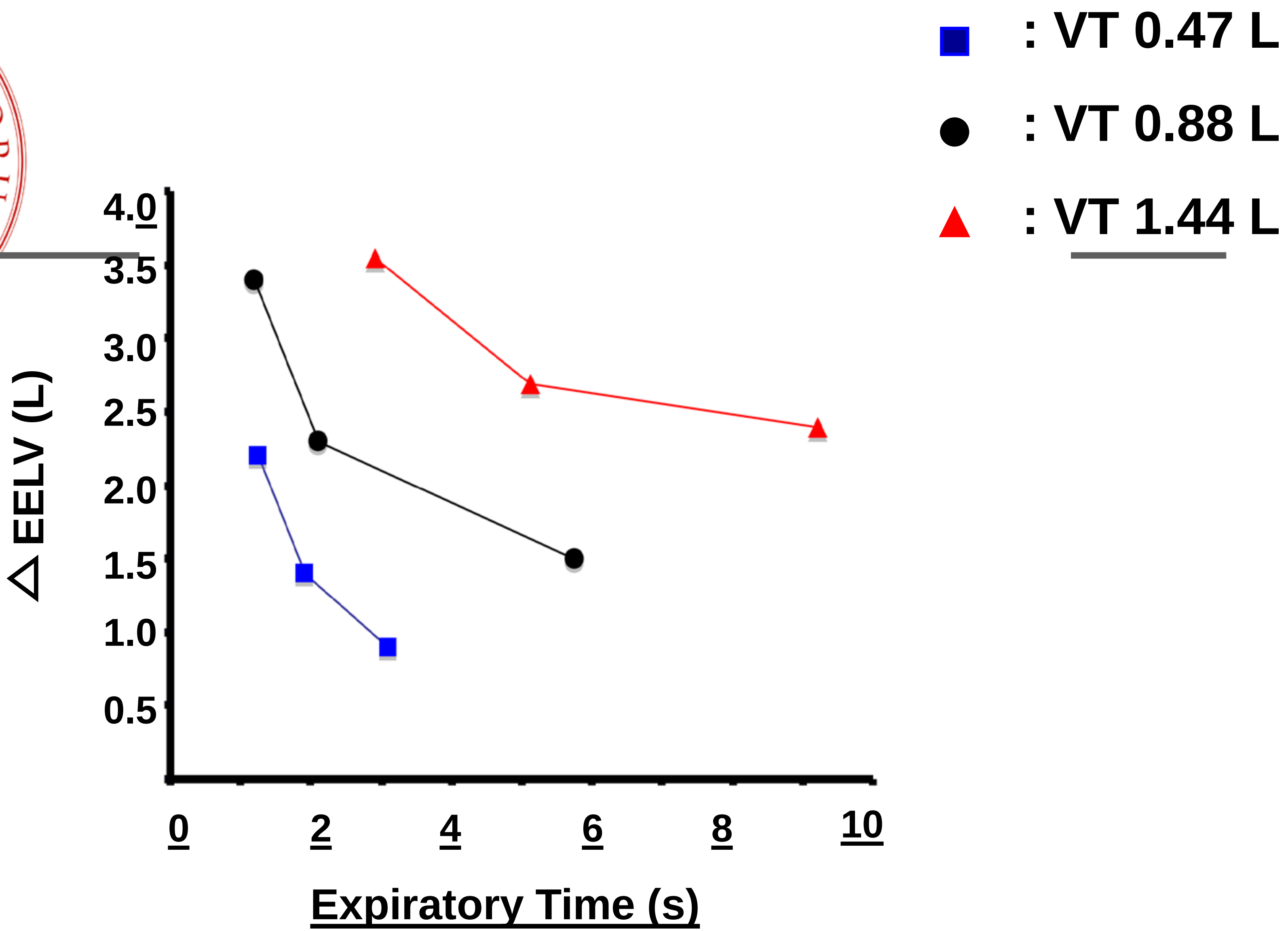


RIDUZIONE TEMPO INSPIRATORIO

- VT = 800 ml
- VI = 60L/min
- FR = 15
- VE = 12 L/min
- TE = 3.2 s

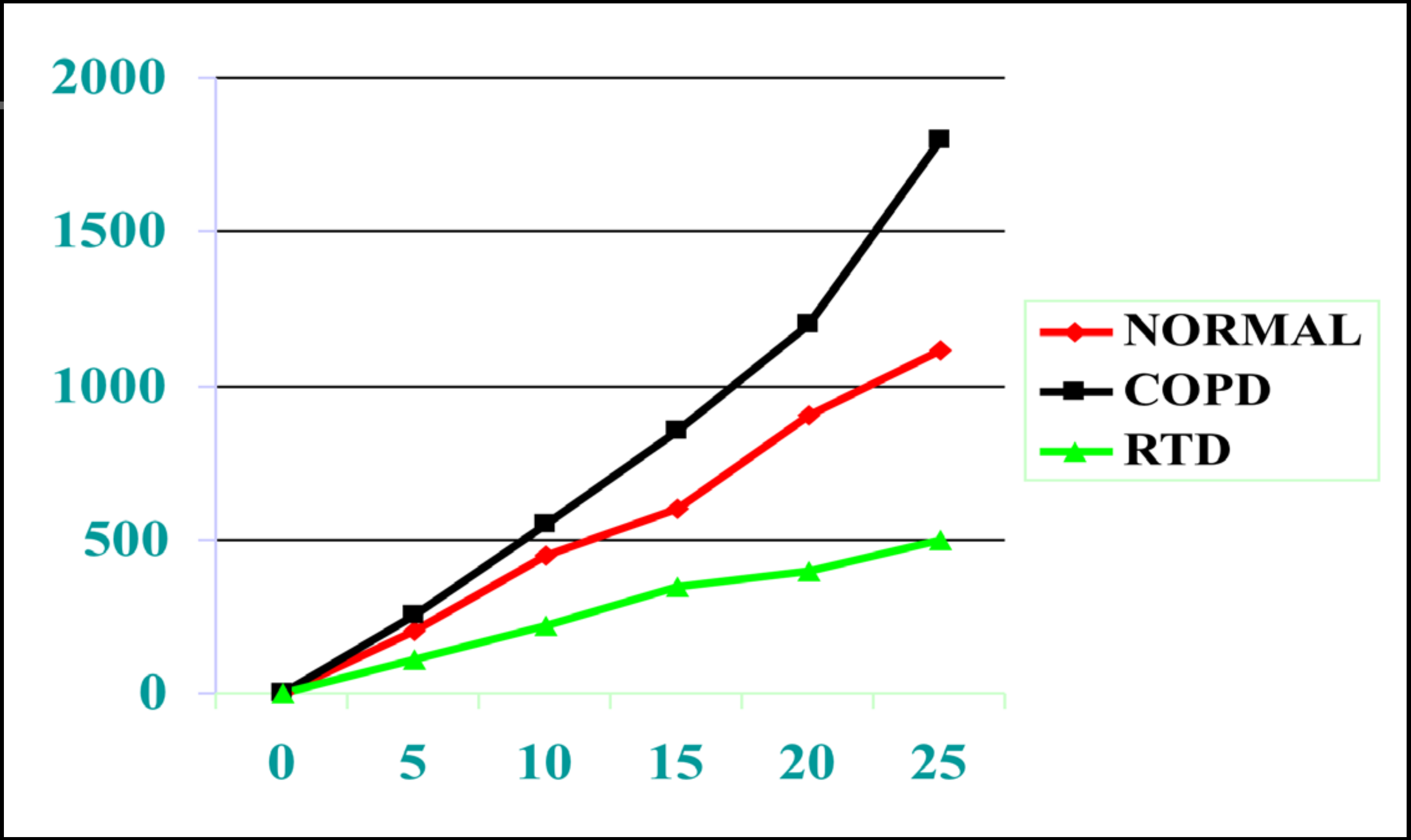
- VT = 800 ml
- VI = 120 L/min
- FR = 15
- VE = 12 L/min
- TE = 3.6 s





Modified from Tuxen D. Am Rev Respir Dis 1989; 140:5-9

VOLUME (ml)



TRANSPULMONARY PRESSURE
(cm$H_2$0)

Tre tipi di auto PEEP

1. Auto-PEEP senza iperinflazione dinamica. Questo perche' in muscoli espiratori si attivano marcatamente

2. Iperinflazione dinamica senza limitazione al flusso. Non viene dato tempo sufficiente ai polmoni di desufflarsi completamente. Il flusso espiratorio continua pero' sino a fine espirazone guidato dall differenza fra la pressione alveolare e quella atmosferica. L'auto-PEEP quindi si genera a vie aeree "aperte"

3. Iperinflazione dinamica con limitazione al flusso. Il collasso delle vie aeree e la limitazione al flusso avvengono alla fine della espirazione tidal. In questi pazienti c'e' un punto di chiusura dinamica e pertanto essi manifestano un vero air-trapping dal momento che un aumentato sforzo espiratorio si traduce in un aumento della pressione alveolare, senza un effetto sul flusso espiratorio.

Why a COPD patient needs ventilation?

- Severe encefalopathy (sedation!!)
- Cardiovascular instability
- Respiratory muscle fatigue

Original Investigation

Outcomes Associated With Invasive and Noninvasive Ventilation Among Patients Hospitalized With Exacerbations of Chronic Obstructive Pulmonary Disease

Peter K. Lindenauer, MD, MSc; Mihaela S. Stefan, MD; Meng-Shiou Shieh, PhD; Penelope S. Pekow, PhD; Michael B. Rothberg, MD, MPH; Nicholas S. Hill, MD

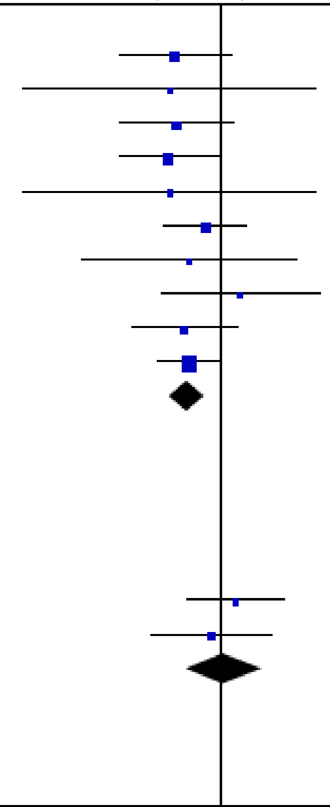
JAMA Intern Med. doi:10.1001/jamainternmed.2014.5430

Table 4. Hospital Characteristics and Outcomes of Patients in the Propensity-Matched Sample

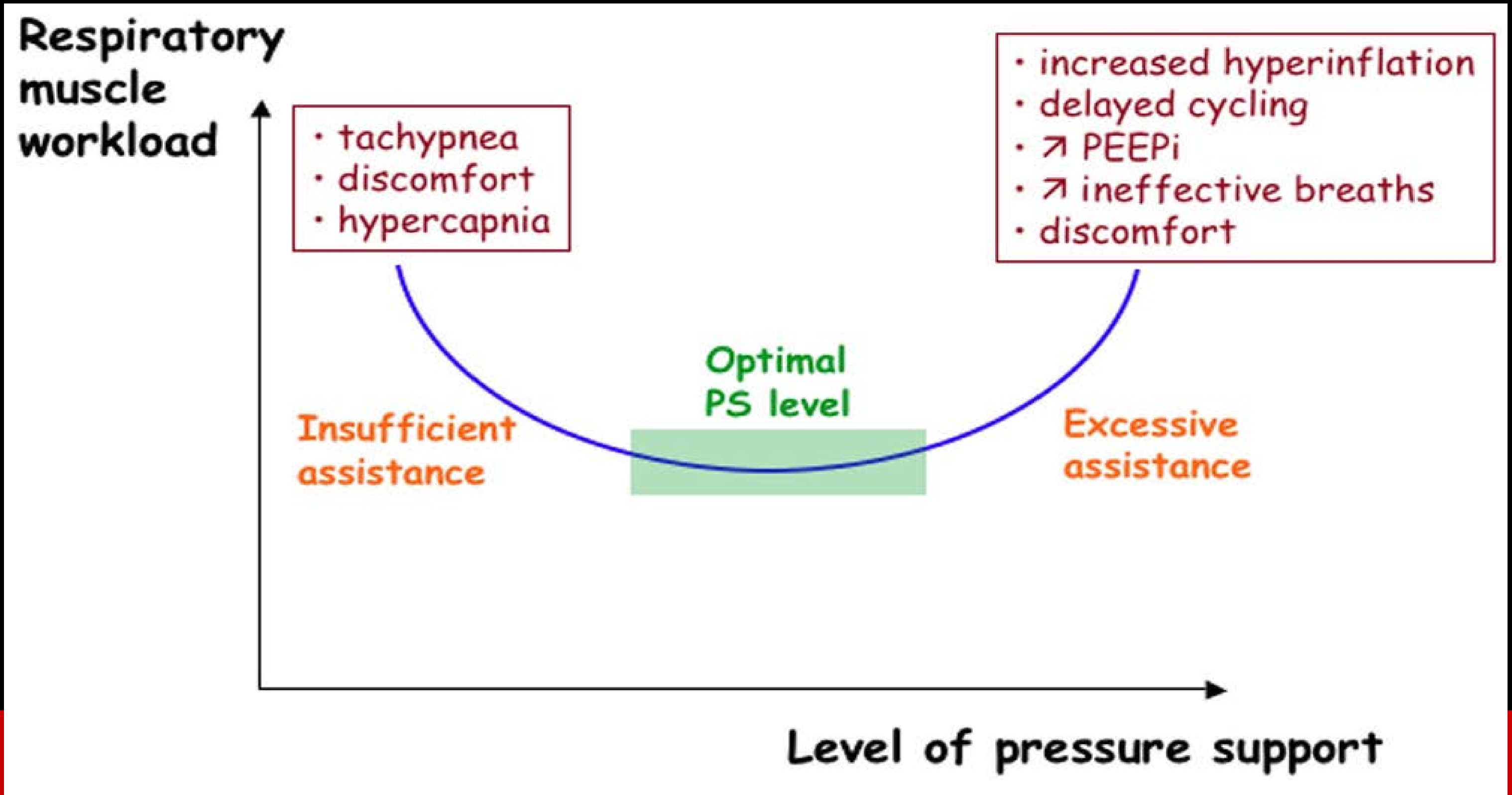
Hospital Characteristic	Ventilation[a] Noninvasive (n = 5225)	Ventilation[a] Invasive (n = 5225)	P Value
Outcomes			
Hospital-acquired pneumonia	139 (2.5)	210 (3.8)	<.001
In-hospital mortality	334 (6.0)	506 (9.2)	<.001
LOS, d	7.2	8.9	<.001
Median (IQR)	6 (4-9)	7 (4-11)	
Costs, US $	14 812	21 202	<.001
Median (IQR)	10 408 (6460-16702)	15 677 (9882-25362)	
Readmission			
COPD-specific	288 (5.5)	272 (5.4)	.78
All-cause	689 (13.3)	635 (12.7)	.35

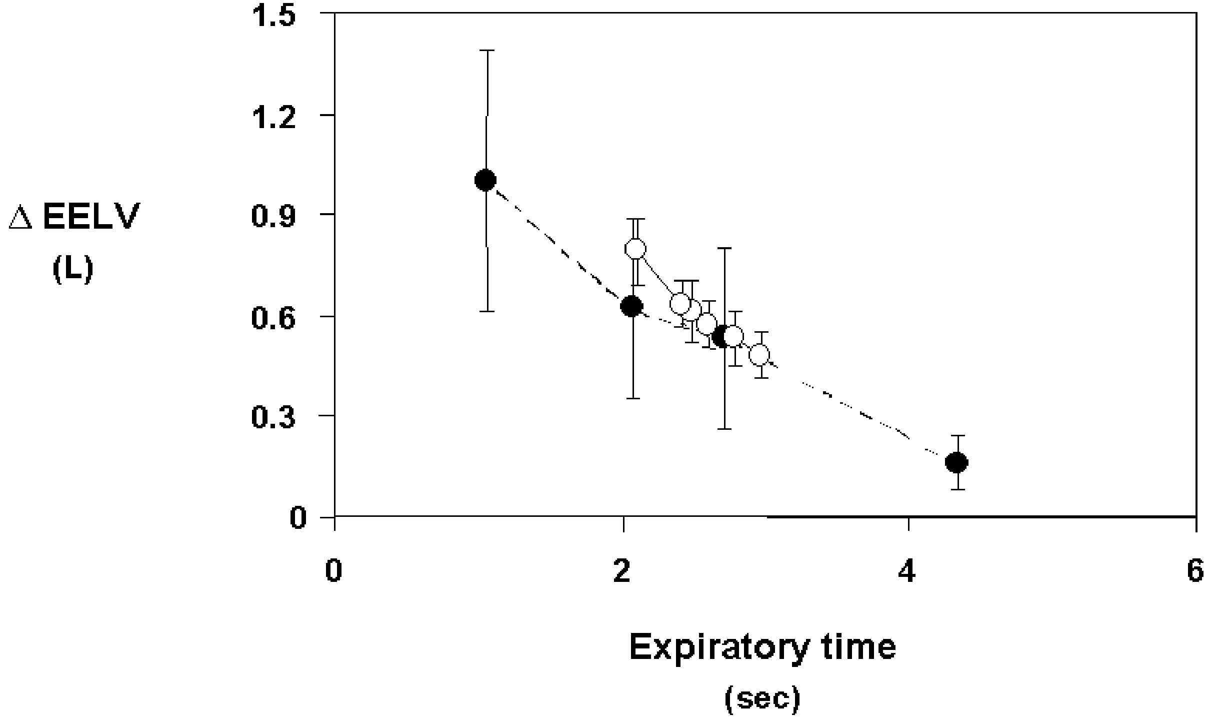
Study or Subgroup	NIV Events	NIV Total	Standard Medical Care Events	Standard Medical Care Total	Weight	Risk Ratio M-H, Fixed, 95% CI
1.1.1 Compared to standard of care						
Avdeev 1998	3	26	9	29	9.7%	0.37 [0.11, 1.23]
Bardi 2000	0	15	1	15	1.7%	0.33 [0.01, 7.58]
Bott 1993	3	26	9	30	9.5%	0.38 [0.12, 1.27]
Brochard 1995	4	43	12	42	13.8%	0.33 [0.11, 0.93]
Celikel 1998	0	15	1	15	1.7%	0.33 [0.01, 7.58]
Chen 2005	12	171	7	71	11.3%	0.71 [0.29, 1.73]
Dikensoy 2002	1	17	2	17	2.3%	0.50 [0.05, 5.01]
Khilnani 2010	3	20	2	20	2.3%	1.50 [0.28, 8.04]
Martin 2000	3	12	6	11	7.1%	0.46 [0.15, 1.40]
Plant 2000	12	118	24	118	27.3%	0.50 [0.26, 0.95]
Subtotal (95% CI)		**463**		**368**	**86.8%**	**0.49 [0.34, 0.70]**
Total events	41		73			
Heterogeneity: $Chi^2 = 3.46$, df = 9 (P = 0.94); $I^2 = 0\%$						
Test for overall effect: Z = 3.89 (P = 0.0001)						
1.1.2 Compared to MV						
Conti 2002	6	23	5	26	5.3%	1.36 [0.48, 3.86]
Jurjevic 2009	4	78	5	78	5.7%	0.80 [0.22, 2.87]
Subtotal (95% CI)		**101**		**104**	**11.0%**	**1.07 [0.48, 2.39]**
Total events	10		10			
Heterogeneity: $Chi^2 = 0.40$, df = 1 (P = 0.53); $I^2 = 0\%$						
Test for overall effect: Z = 0.16 (P = 0.87)						

Risk Ratio
M-H, Fixed, 95% CI



	ADVANTAGES	DISADVANTAGES
PSV	Increases pt comfort	Requires intact drive





Navalesi P & Maggiore SM "PEEP"