Preventive ventilation In high risk patients for ARDS

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Hammamet – 28 mai 2016

Déclaration de liens

Déclare les liens suivants (consultants) :

- Drager France
- Maquet France
- Fisher Paykel
- Hamilton
- Baxter
- Medtronic

Objectifs

1. Qui sont les patients à risque?

2. Qu'est ce que la ventilation protectrice et préventive ?

3. Quelles sont les évidences ?

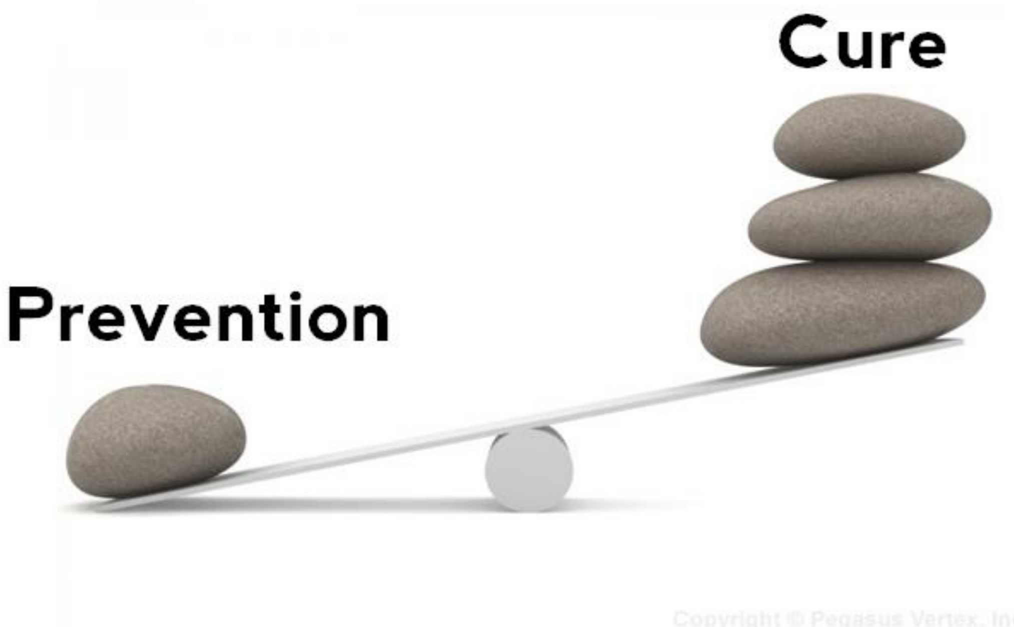
4. Take Home Messages

Background

Benjamin Franklin

Born in Boston, Massachusetts,
The United States 1706-1790

"An ounce of prevention is worth a pound of cure."



"Prevention is better than cure"

The golden hours

“The most sophisticated intensive care becomes unnecessarily expensive terminal care…”
when the pre ICU systems fail

Peter Safar

Safar P. Critical care medicine – Quo Vadis? Crit Care Med 1974; 2:1–5

Quel “patient est à risque” ?

Medical history
(COPD, Cachexia, Cancer, immunosuppresion, Muscle deconditioning...)

Supine Position

Renal f e

n

Mechanical

Transfusion

All ICU patients could be considered at patients at risk to develop lung injury (i.e, ARDS)

SEDATION
- Propofol, Morphinic, NMBA

Antibiotic

Surgery

Pancreatitis

Abdo Cpt Synd

Inflammation

Shock

Sepsis

Electrolytes abnormalities
(Ca, Ph, Mg, K)
Hyperglycemia
Hypertriglyceridemia

Am J Respir Crit Care Med. 2010 Aug 27. [Epub ahead of print]

Early Identification of Patients at Risk of Acute Lung Injury: Evaluation of Lung Injury Prediction Score in a Multicenter Cohort Study.

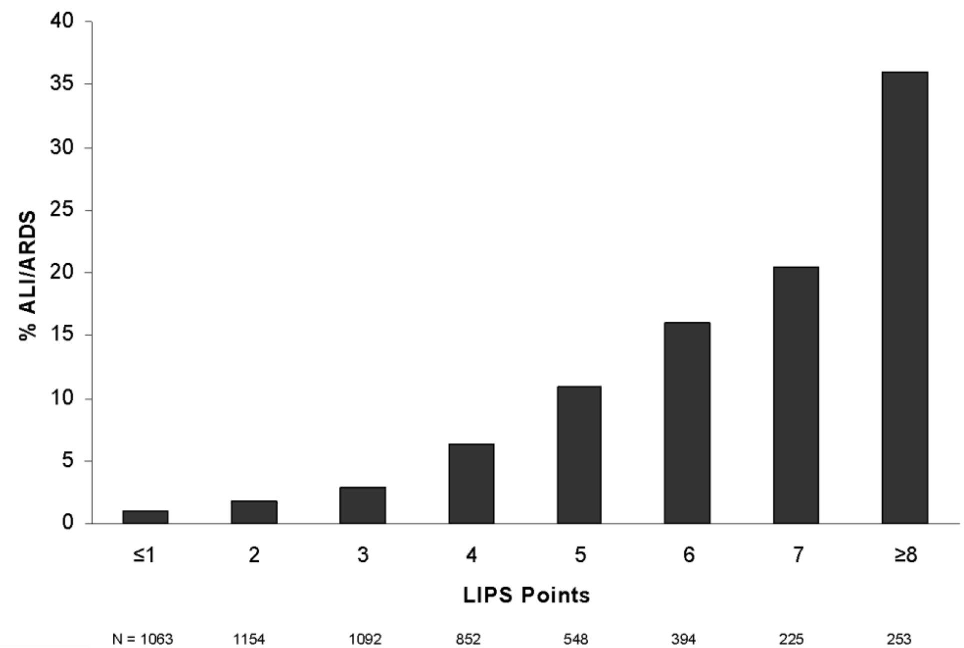
Gajic O, Dabbagh O, Park PK, Adesanya A, Chang SY, Hou P, Anderson Iii H, Hoth JJ, Mikkelsen ME, Gentile NT, Gong MN, Talmor D, Bajwa E, Watkins TR, Festic E, Yilmaz M, Iscimen R, Kaufman DA, Esper AM, Sadikot R, Douglas I, Sevransky J, Malinchoc M; on behalf of the US Critical Illness and Injury Trials Group: Lung Injury Prevention Study Investigators (USCIITG-LIPS).

Department of Internal Medicine, Division of Pulmonary and Critical Care Medicine, Mayo Clinic College of Medicine, 200 First Street SW, Rochester, Minnesota, 55905, United States.

Lung Injury Prediction Score (LIPS)

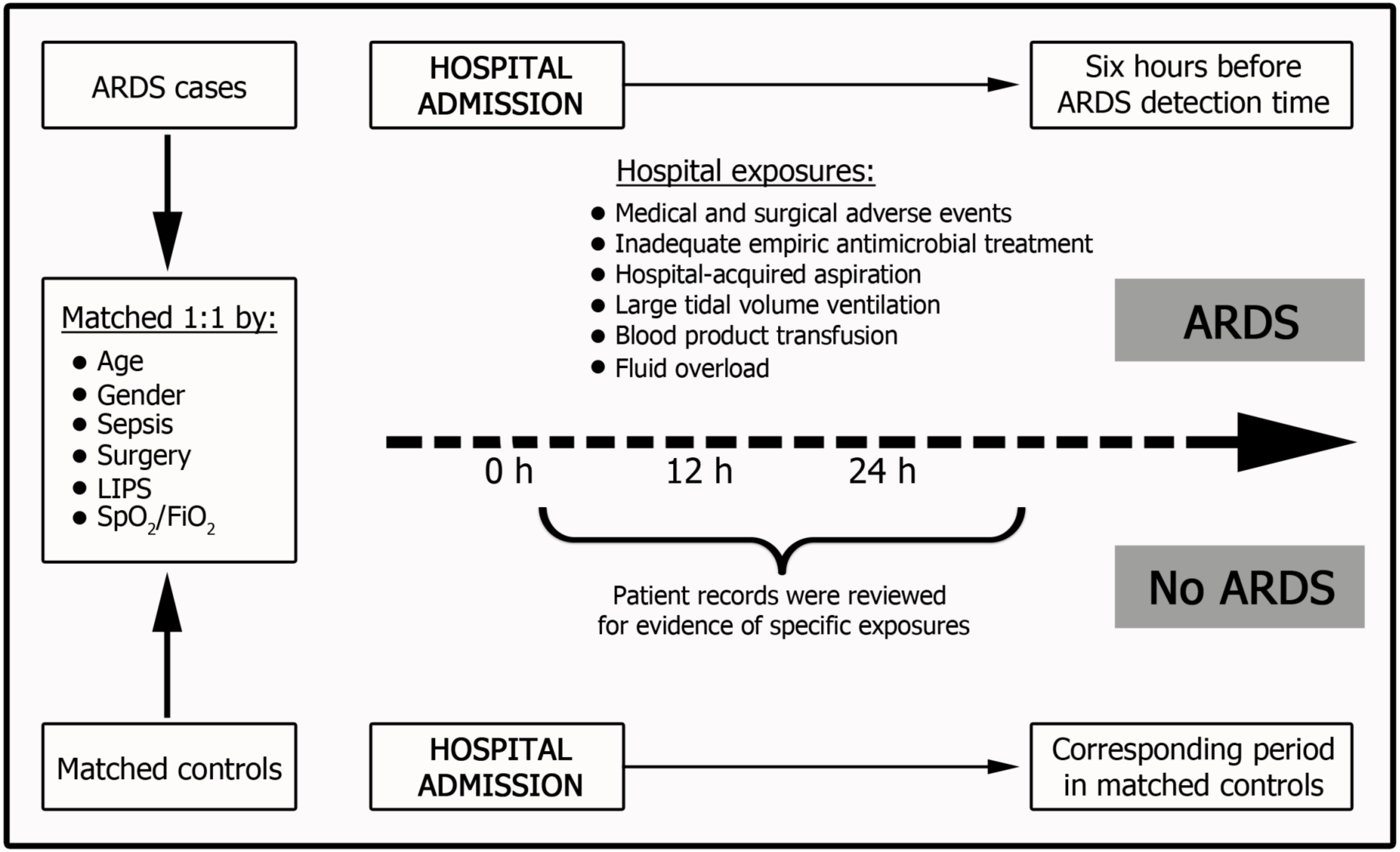
	Estimate	(95% CI)		p-value	LIPS points
Predisposing conditions					
Shock	0.77	0.19	1.32	0.008	2
Aspiration	0.79	0.07	1.45	0.024	2
Sepsis	0.37	-0.13	0.87	0.139	1
Pancreatitis	-1.07	-3.96	0.51	0.299	0
Pneumonia	0.83	0.33	1.34	0.001	1.5
High risk surgery*					
Thoracic (noncardiac)	-0.14	-2.00	1.15	0.896	-
Orthopedic spine	0.75	-0.11	1.53	0.071	1
Acute abdomen	0.93	0.06	1.72	0.028	2
Cardiac	1.32	0.67	1.96	<.001	2.5
Aortic vascular	1.78	0.93	2.56	<.001	3.5
High risk trauma					
Traumatic brain injury	1.29	0.67	1.91	<.001	2
Smoke inhalation	0.93	-0.21	1.41	0.438	2
Near drowning	1.68	-2.74	6.00	0.498	2
Lung contusion	0.40	-0.48	1.21	0.355	1.5
Multiple fractures	0.64	-0.21	1.41	0.117	1.5
Risk modifiers					
Male gender	0.02	-0.34	0.39	0.905	-
Alcohol abuse	0.51	-0.08	1.07	0.080	1
Obesity (BMI>30)	0.56	0.18	0.93	0.004	1
Hypoalbuminemia	0.46	0.04	0.87	0.029	1
Chemotherapy	0.46	-0.54	1.29	0.314	1
FiO_2 >0.35 (>4L/min)	1.02	0.62	1.41	<.001	2
Tachypnea (RR>30)	0.69	0.11	1.25	0.017	1.5
SpO_2<95%	0.35	-0.04	0.73	0.078	1
Acidosis (pH<7.35)	0.55	0.09	1.00	0.017	1.5
Diabetes mellitus**	-0.59	-1.40	0.15	0.135	-1

*Add 1.5 point if emergency surgery **Only if sepsis



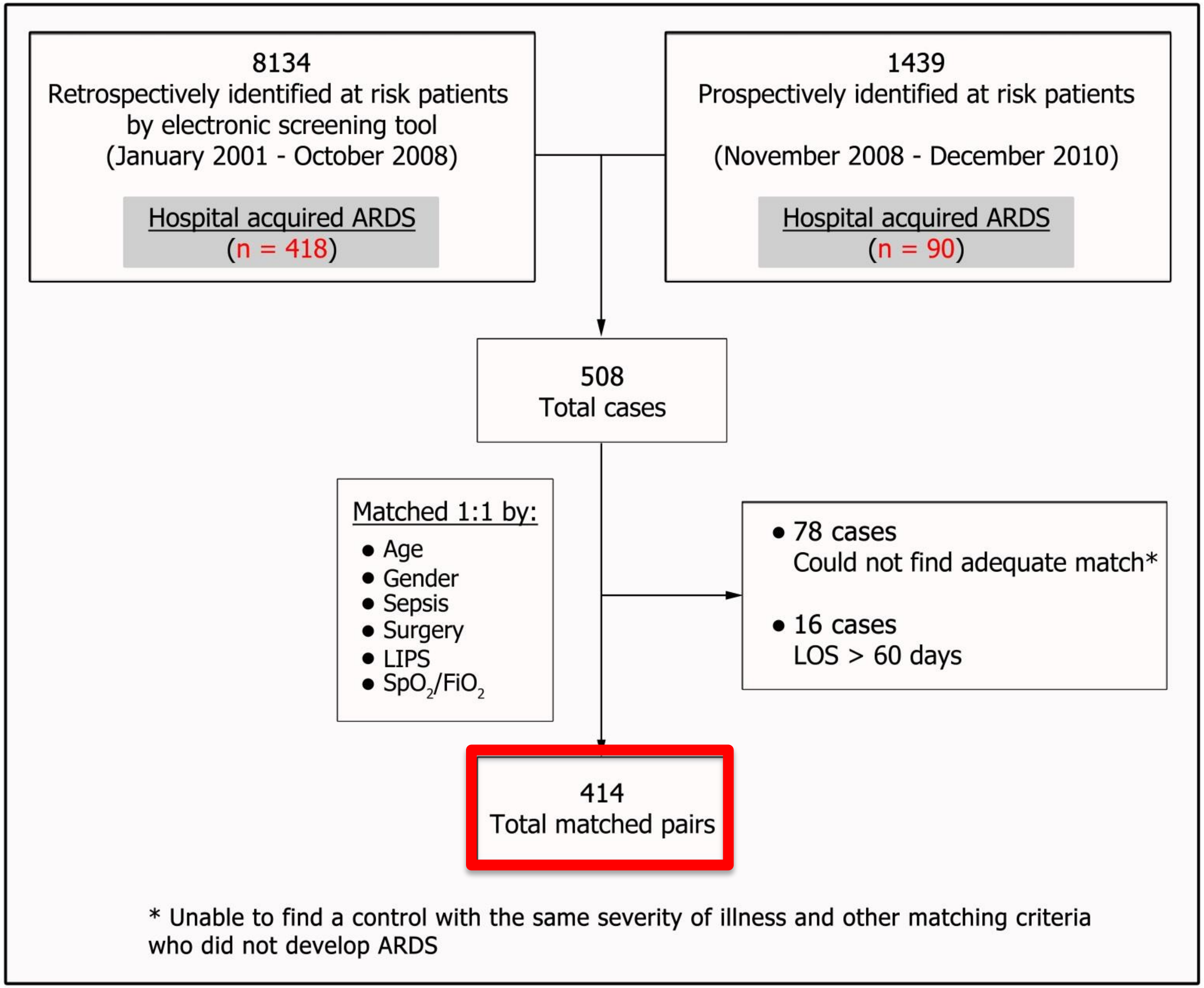
The Role of Potentially Preventable Hospital Exposures in the Development of Acute Respiratory Distress Syndrome: A Population -Based Study

Ahmed, Adil H. MBBS; Litell, John M. DO; Malinchoc, Michael MS; Kashyap, Rahul MBBS; Schiller, Henry J. MD; Pannu, Sonal R. MBBS; Singh, Balwinder MBBS; Li, Guangxi MD; Gajic, Ognjen MD, MSc



Ahmed A et al Crit Care Med 2014

Study Flow chart



Ahmed A et al Crit Care Med 2014

RESULTS

Exposures	ARDS Cases	Controls	OR(95% CI)	P value
Infection control (among those with suspected infection N=151 pairs)				
Inadequate antimicrobial, N (%)	61(40.4)	30 (19.9)	2.9(1.7-5.2)	<0.001
Time to adequate antimicrobial in hours M(IQR)	**7.6(3.0-25.4)**	**3.9 (2.4-8.4)**	**1.3 (1.1-1.5)**	**<0.001**
Hospital acquired aspiration and aspiration surrogates N (%)				
Hospital acquired aspiration	**51 (12.3)**	**1 (0.2)**	**51 (7.1-369)**	**<0.001**
Nasogastric tube	190 (45.9)	60 (14.5)	6.4(4.2-9.9)	<0.001
Head of bed elevation *(≥30°)	16 (61.5)	17 (65.4)	0.8 (0.4-2.4)	0.81
Documented intubation difficulty	32 (7.7)	10 (2.4)	3.2(1.5-6.5)	<0.001
IV Fluids -for one or more liter infused , median (IQR)				
Crystalloid first 24 hours- M (IQR)	1 (0.2,3.0)	1.4 (0.4,3.4)	0.9 (0.9-1.0)	0.26
Mechanical ventilation parameters (n=29 pairs)				
TV by PBW, median (IQR)	**9 (7.3-10.8)**	**7.7 (6.9-8.5)**	**1.7 (1.1-2.6)**	**.025**
FIO_2 %, median (IQR)	54 (43-62)	55 (50-63)	0.9 (0.9-1.0)	.92
Blood product transfusion N (%)				
Red blood cells	**163(39.4)**	**49 (11.8)**	**1.4 (1.3-1.6)**	**<0.001**
Platelet	**51 (12.3)**	**11 (2.7)**	**2.0 (1.4-2.9)**	**<0.001**
Fresh frozen plasma	**85 (20.5)**	**15 (3.6)**	**1.4 (1.2-1.6)**	**<0.001**

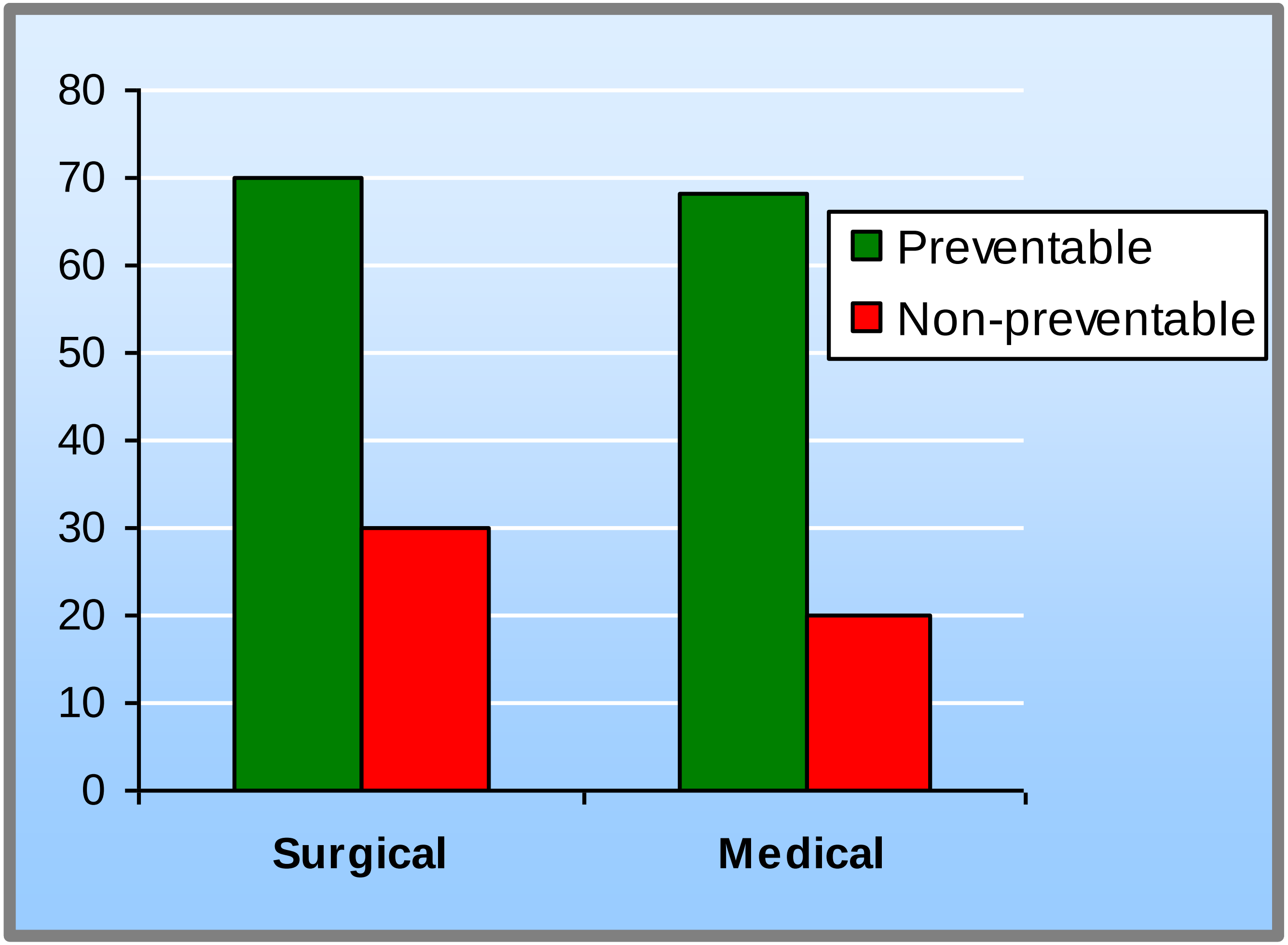
Ahmed A et al Crit Care Med 2014

RESULTS

Exposures	ARDS	Controls	OR(95% CI)	P value
Adverse events (surgical and medical adverse events) N=828 **				
Accidental cut, puncture, perforation, or hemorrhage, N (%)	27 (6.5)	4(1.0)	12.5(3.0-52.8)	<0.001
Failure of sterile precautions, N (%)	4 (1.0)	0 (0.0)	---------	------
Dosage failure, N (%)	113(27.3)	35 (8.5)	3.5(0.7-16.8)	0.118
Contaminated or infected blood, fluid, drug, or biological substance, N (%)	0 (0.0)	1 (0.2)	----------	--------
Other and unspecified N (%)	57 (13.8)	8 (1.9)	8 (3.6-17.6)	<0.001
Any adverse event N (%)	**131 (31.6)**	**47 (11.4)**	**6.2(4.0-9.7)**	**<0.001**

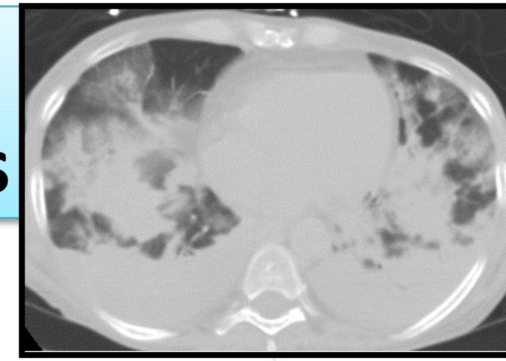
Ahmed A et al Crit Care Med 2014

Medical and Surgical Adverse events



Ahmed A et al Crit Care Med 2014

ARDS Pathogenesis: “Multiple hit” Hypothesis



Patient at risk (1st hit)

- Pneumonia
- Toxic inhalation
- Pancreatitis
- Aspiration
- Trauma
- Sepsis
- Shock
- Age
- SNPs
- Alcohol
- Tobacco
- Thoracic and vascular surgery
- Preexisting lung disease
- Vasculitis
- Radiation
- Chemotherapy

HOSPITAL ADMISSION

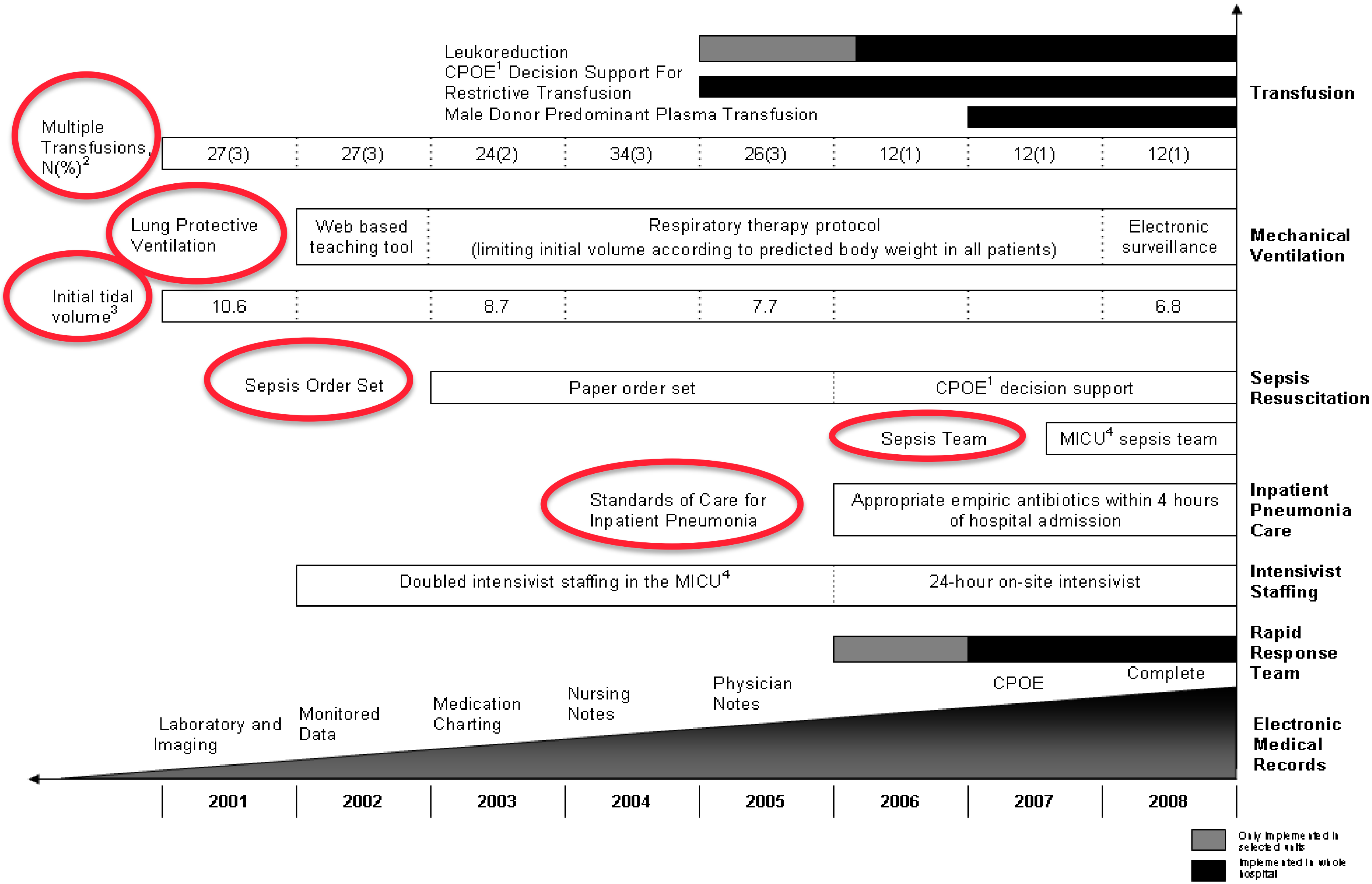
ICU ADMISSION

Eight-Year Trend of Acute Respiratory Distress Syndrome - AJRCCM 2011

Systematic Changes in Acute Care Delivery

A Population-based Study in Olmsted County, Minnesota

Guangxi Li[1,2], Michael Malinchoc[1,3], Rodrigo Cartin-Ceba[1], Chakradhar V. Venkata[1], Daryl J. Kor[1,4], Steve G. Peters[1], Rolf D. Hubmayr[1], and Ognjen Gajic[1]



Eight-Year Trend of Acute Respiratory Distress Syndrome - AJRCCM 2011

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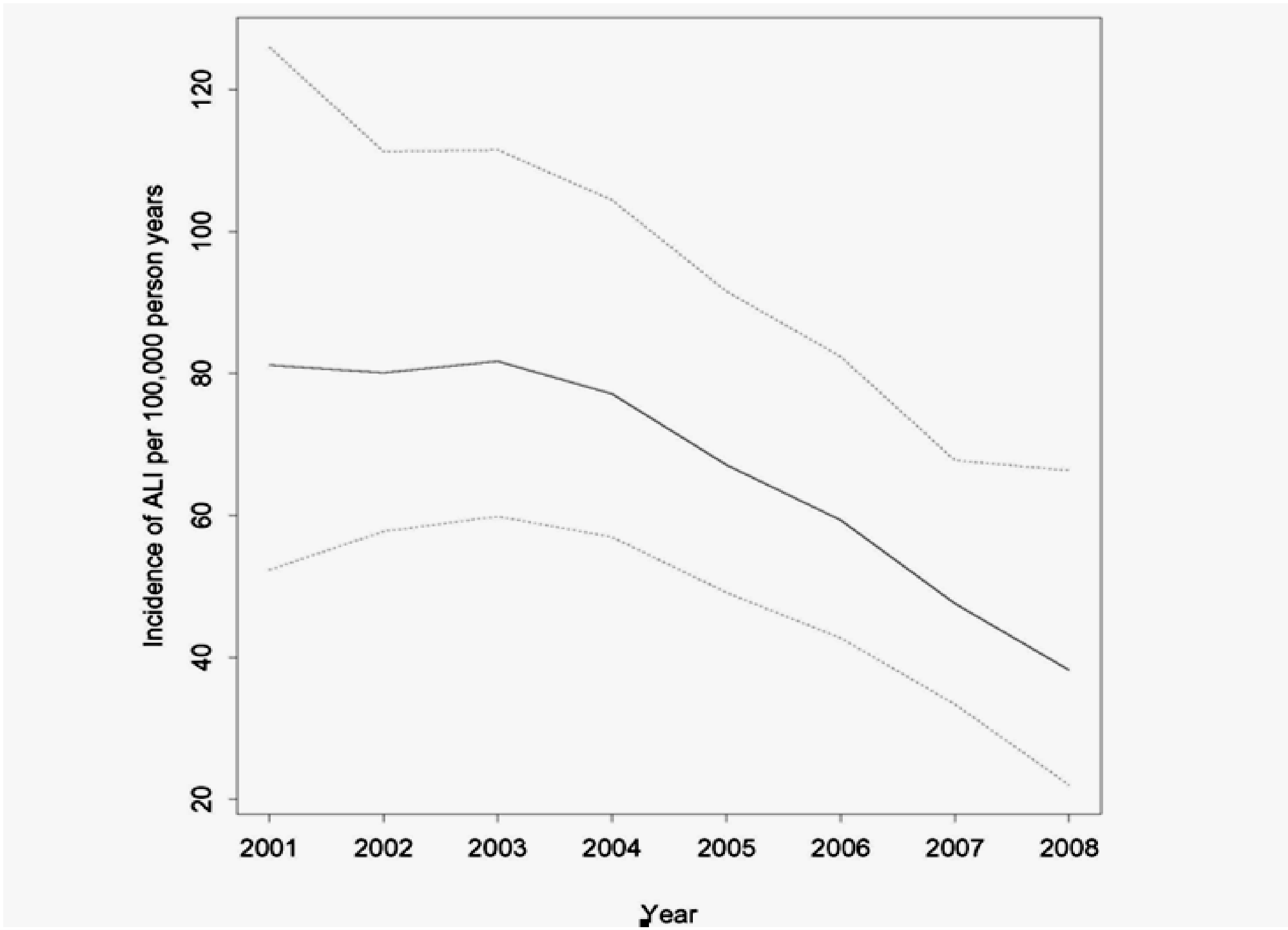
Guangxi Li[1,2], Michael Malinchoc[1,3], Rodrigo Cartin-Ceba[1], Chakradhar V. Venkata[1], Daryl J. Kor[1,4], Steve G. Peters[1], Rolf D. Hubmayr[1], and Ognjen Gajic[1]



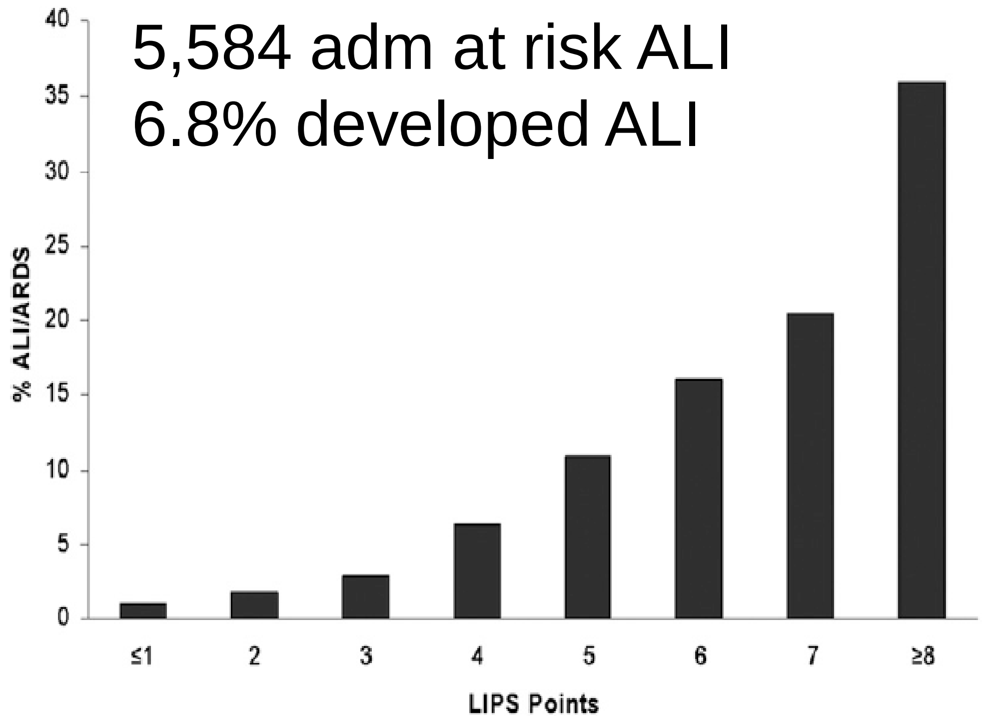
Incidence of ARDS in Olmsted County, Minnesota: Combined Effect?

Checklist for Lung Injury Prevention (CLIP)

Clip Elements	Definition
Lung protective mechanical ventilation	Tidal volume between 6-8 mL / kg predicted body weight and plateau pressure <30 cm H_2O; PEEP≥5 cm H_2O, minimize FIO_2 (target O_2sat 88-92% after early shock)

Early Identification of Patients at Risk of Acute Lung Injury

22 centres
5,584 adm at risk ALI
6.8% developed ALI

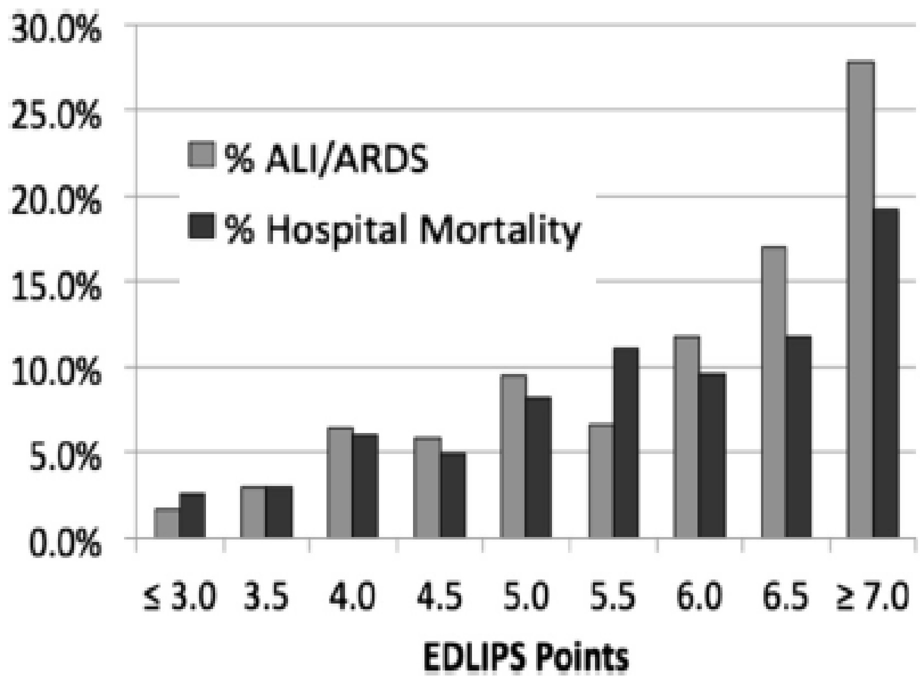


Predisposing Conditions	
Shock	2
Aspiration	2
Sepsis	1
Pneumonia	1.5
High-risk surgery*	
Orthopedic spine	1
Acute abdomen	2
Cardiac	2.5
Aortic vascular	3.5
High-risk trauma	
Traumatic brain injury	2
Smoke inhalation	2
Near drowning	2
Lung contusion	1.5
Multiple fractures	1.5
Risk modifiers	
Alcohol abuse	1
Obesity (BMI > 30)	1
Hypoalbuminemia	1
Chemotherapy	1
F_{IO_2} > 0.35 (> 4 L/min)	2
Tachypnea (RR > 30)	1.5
Sp_{O_2} < 95%	1
Acidosis (pH < 7.35)	1.5
Diabetes mellitus†	−1

Gajic et al AmJRCCM 2011

ORIGINAL RESEARCH Open Access

Lung injury prediction score for the emergency department: first step towards prevention in patients at risk



Pre-disposing conditions

Male 1, Aspiration 2, Pneumonia 1, Sepsis 1, Shock 2, Lung contusion 1, Smoke inhalation 1.5 Long bone fractures 2, Brain injury 2, Cardiac surgery 5, Aortic surgery 5, Spine surgery 5, Acute abdomen 2.5

Risk modifiers

Diabetes −0.5, Cirrhosis 1, Chemo 2, Obesity 1.5, Acidosis 2, $FiO_2 > 0.35$ 2, Albumin 1.5, $SpO_2 < 95\%$ 1.5

Elie-Turenne et al. International Journal of Emergency Medicine 2012

Predicting Risk of Postoperative Lung Injury in High-risk Surgical Patients

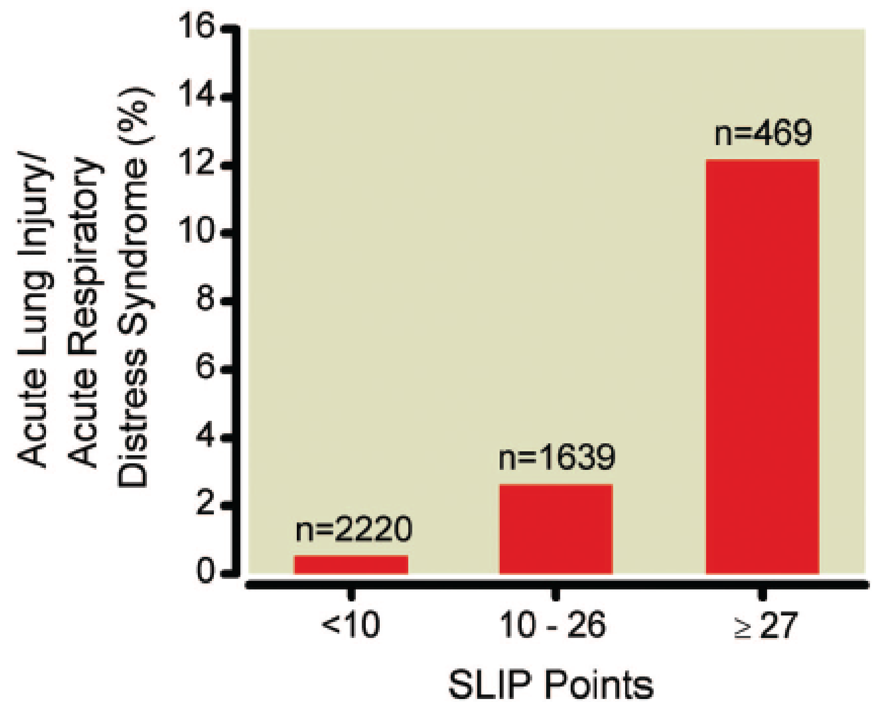
A Multicenter Cohort Study ANESTHESIOLOGY 2014; 120:1168-81

Daryl J. Kor, M.D., Ravi K. Lingineni, M.P.H., Ognjen Gajic, M.D., M.Sc., Pauline K. Park, M.D., James M. Blum, M.D., Peter C. Hou, M.D., J. Jason Hoth, M.D., Harry L. Anderson III, M.D., Ednan K. Bajwa, M.D., M.P.H., Raquel R. Bartz, M.D., Adebola Adesanya, M.D., Emir Festic, M.D., Michelle N. Gong, M.D., M.S., Rickey E. Carter, Ph.D., Daniel S. Talmor, M.D., M.P.H.

surgical lung injury prediction

Predictor Variables	SLIP Points
High-risk surgical procedure	
Cardiac	19
Vascular	32
Thoracic	16
Comorbidities	
Diabetes mellitus	6
COPD	10
GERD	7
Modifying conditions	
Alcohol abuse	11

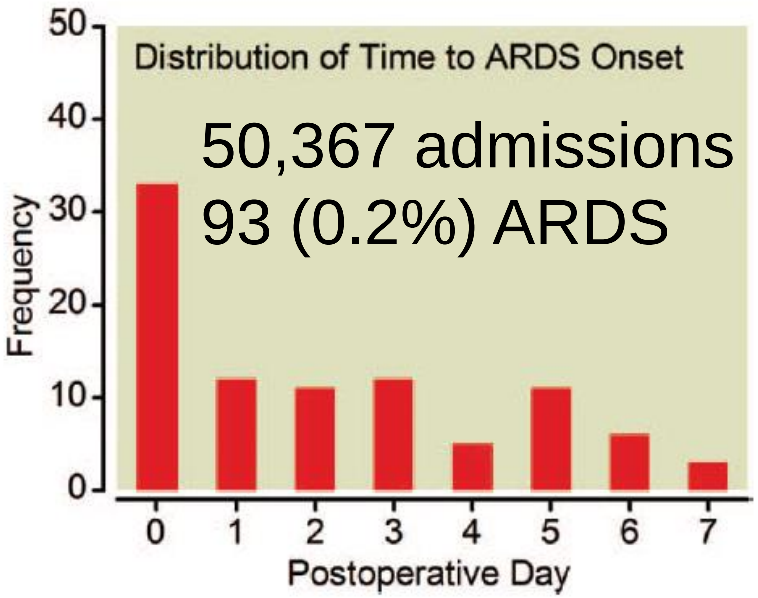
n= 4366
2.6% ALI



PERIOPERATIVE MEDICINE

Preoperative and Intraoperative Predictors of Postoperative Acute Respiratory Distress Syndrome in a General Surgical Population

Blum et al Anesthesiology 2013



Intra-operative predictors ARDS

RBC transfusion	OR 5.4 (1.4-11.1)
Median drive pressure	OR 1.2(1.1 – 1.3)
Median FiO_2	OR 1.02(1-1.05)
Crystalloid	OR 1.4(1.2-1.9)

A RETENIR : Principaux facteurs associés à un risque de développer un SDRA

1. **Traitement de la cause du SDRA insuffisant** (ex: ATB inadapté, chirurgie non faite…)

2. **Mauvais réglage du ventilateur :** haut VT (>8-10 ml/kg); Pression motrice élevée…

3. **Transfusion;** surcharge volémique

4. **Post-opératoire** de chirurgie « lourde »

5. **Co-morbidité(s)** (immunodépression, cirrhose, cancer…)

Objectifs

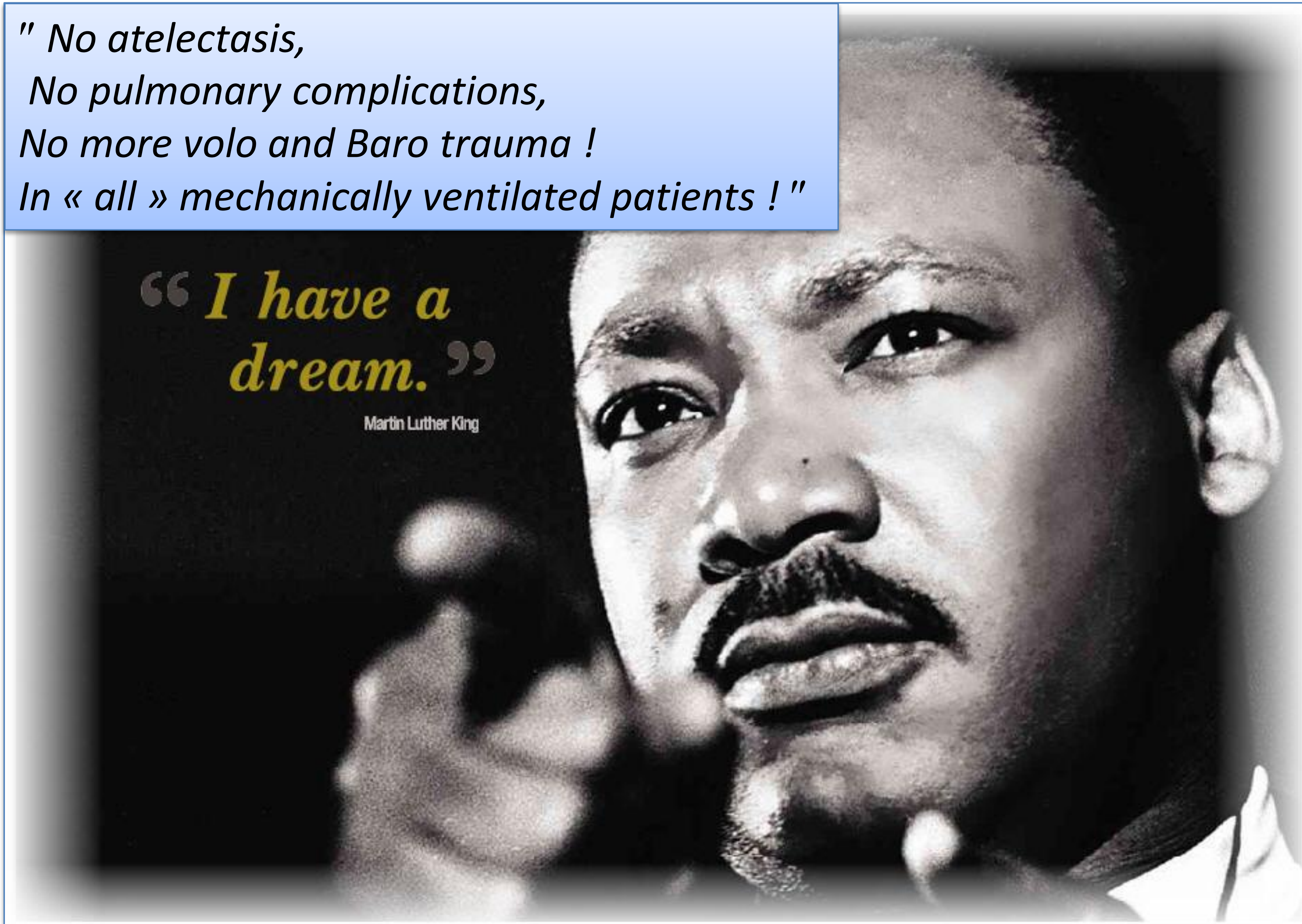
1. Qui sont les patients à risque?

2. Qu'est ce que la ventilation protectrice et préventive ?

3. Quelles sont les évidences ?

4. Take Home Messages

" No atelectasis,
No pulmonary complications,
No more volo and Baro trauma !
In « all » mechanically ventilated patients ! "

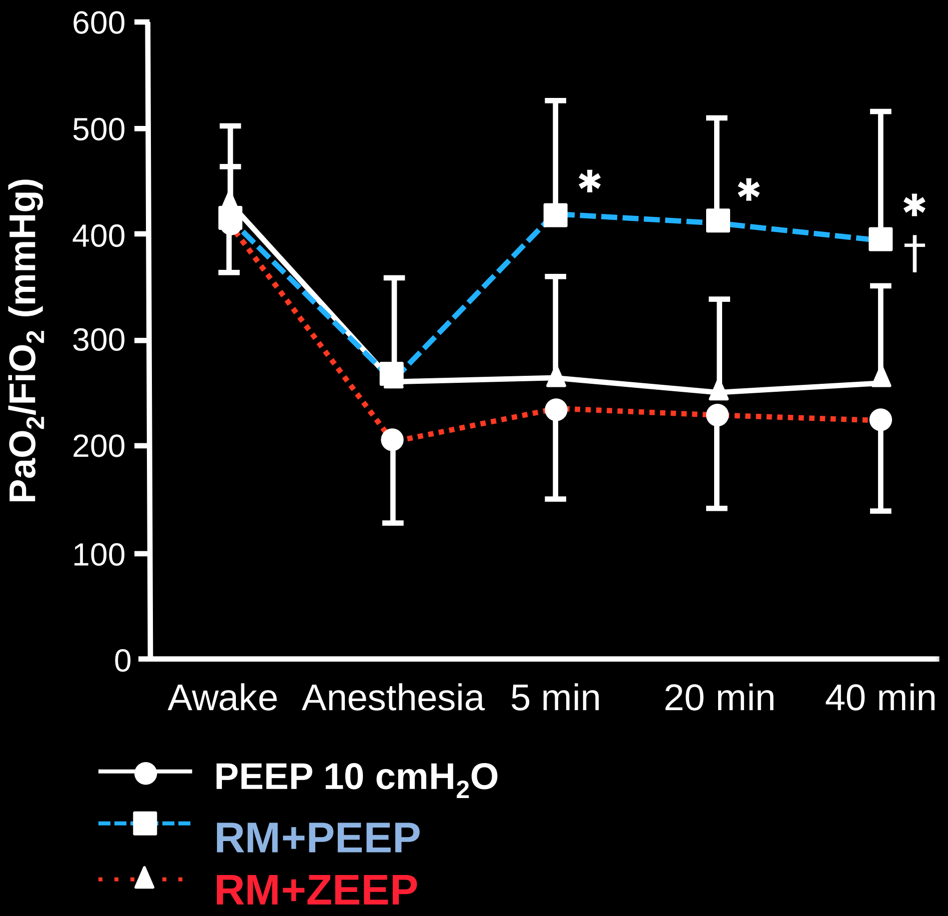


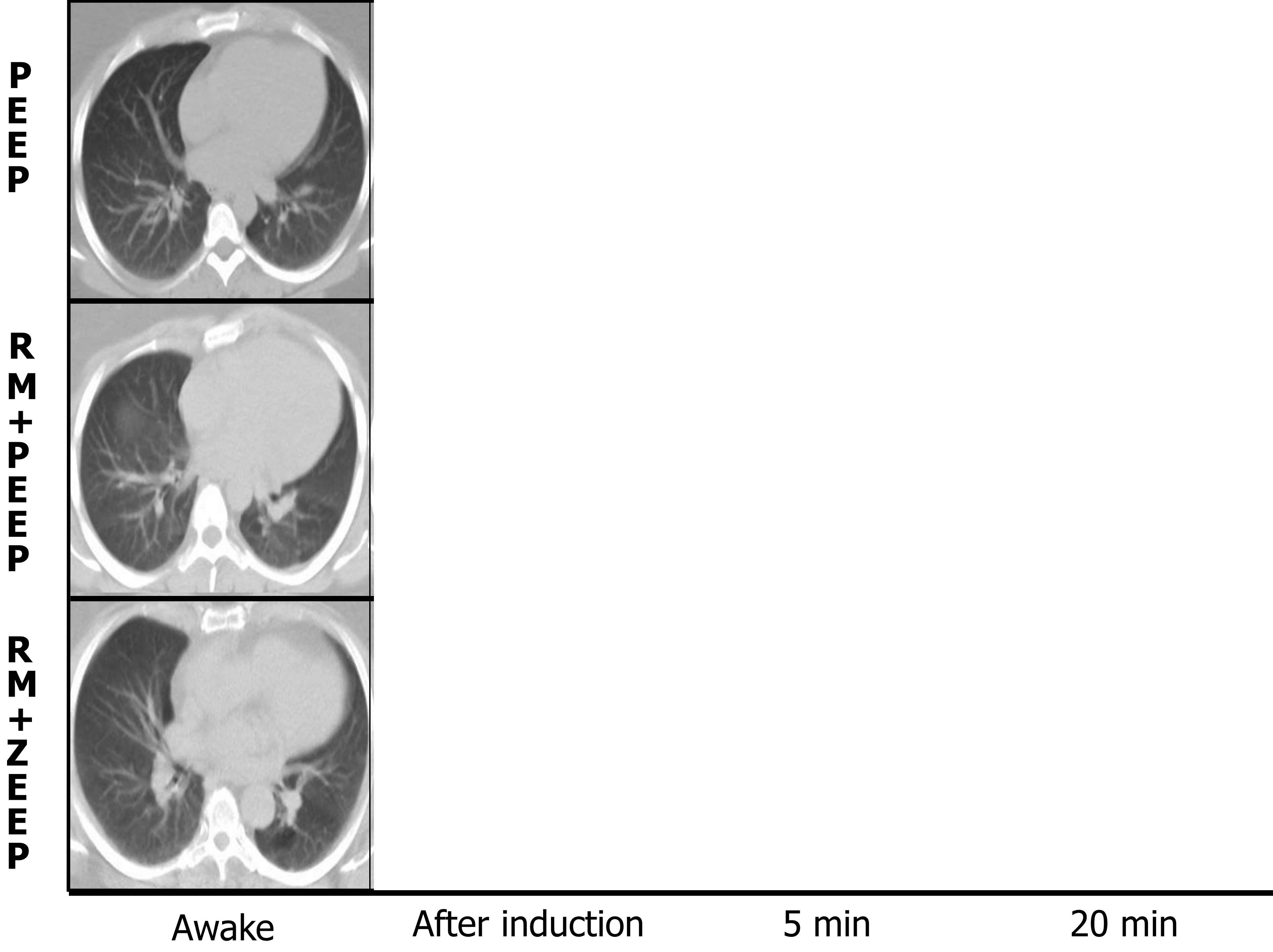
Prevention of Atelectasis in Morbidly Obese Patients during General Anesthesia and Paralysis (= 3 ventilatory strategies)

A Computerized Tomography Study

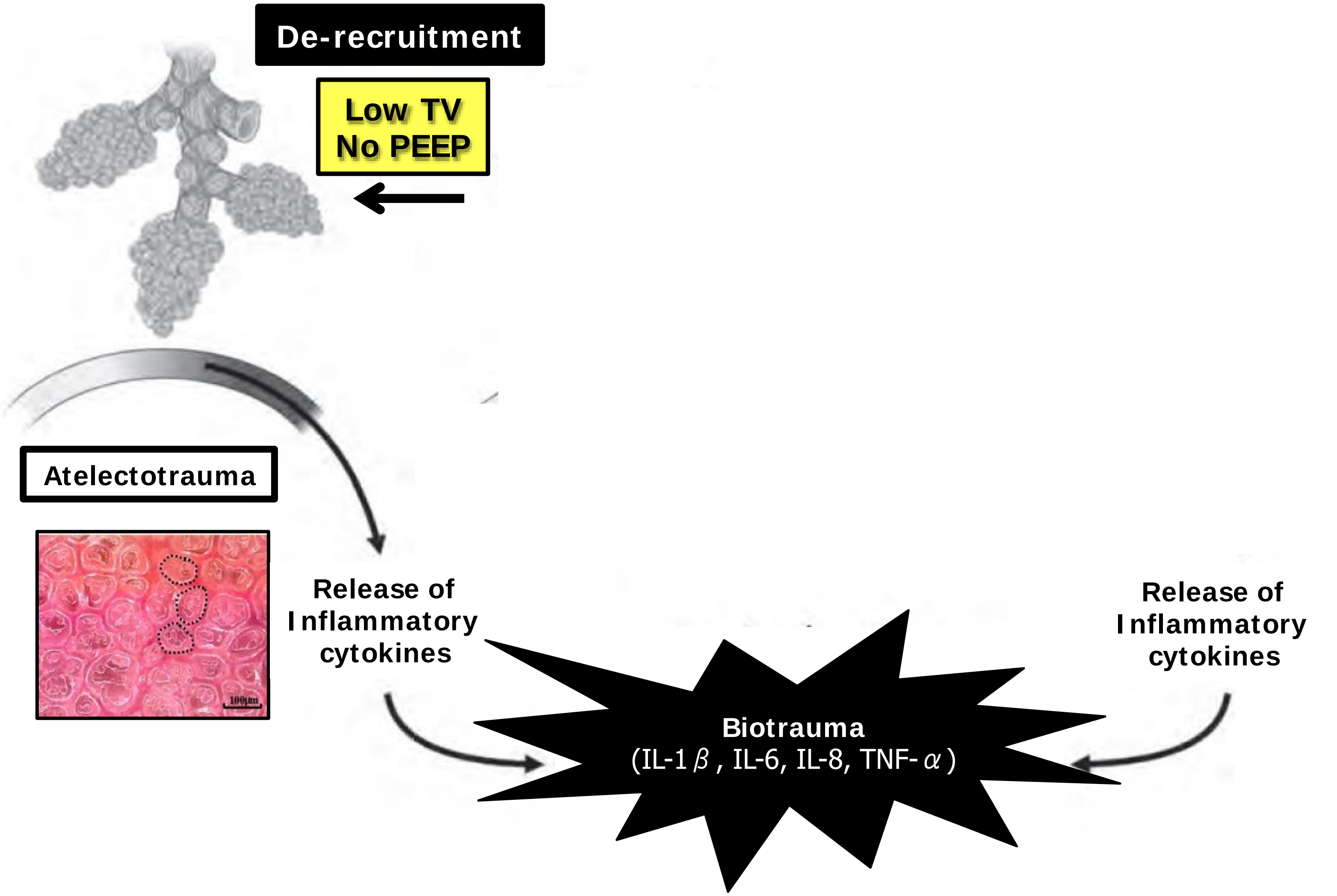
Henrik Reinius, M.D., Lennart Jonsson, M.D., Sven Gustafsson, M.D., Ph.D., Magnus Sundbom, M.D., Ph.D., Olov Duvernoy, M.D., Ph.D.
Paolo Pelosi, M.D., Ph.D., Goran Hedenstierna, M.D., Ph.D., Filip Freden, M.D., Ph.D. **Anesthesiology 2009**

RM = CPAP 55 cmH_2O for 10 sec and/or PEEP=+10 cmH_2O



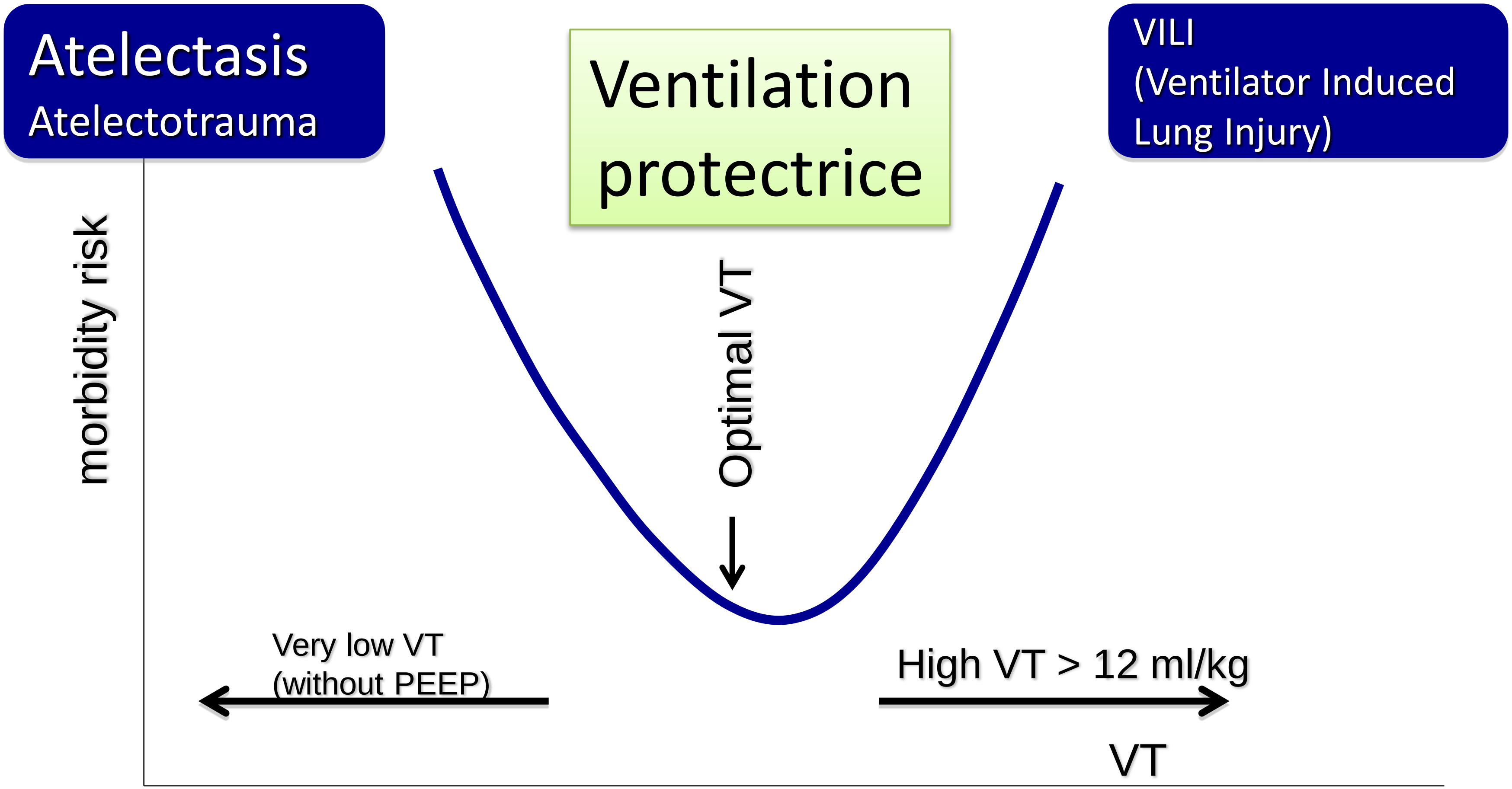

PEEP
RM+PEEP
RM+ZEEP
Awake
After induction
5 min
20 min

Ventilator-associated lung injury (VALI)



Adapted from Tusman G et al. Curr Opin Anesthesiol 2012

Tidal volume (VT) : how much is too much ?



WHAT'S NEW IN INTENSIVE CARE

What's new in mechanical ventilation in patients without ARDS: lessons from the ARDS literature

Ary Serpa Neto[1,2,3] and Samir Jaber[4*]

Intensive Care Med 2016 May

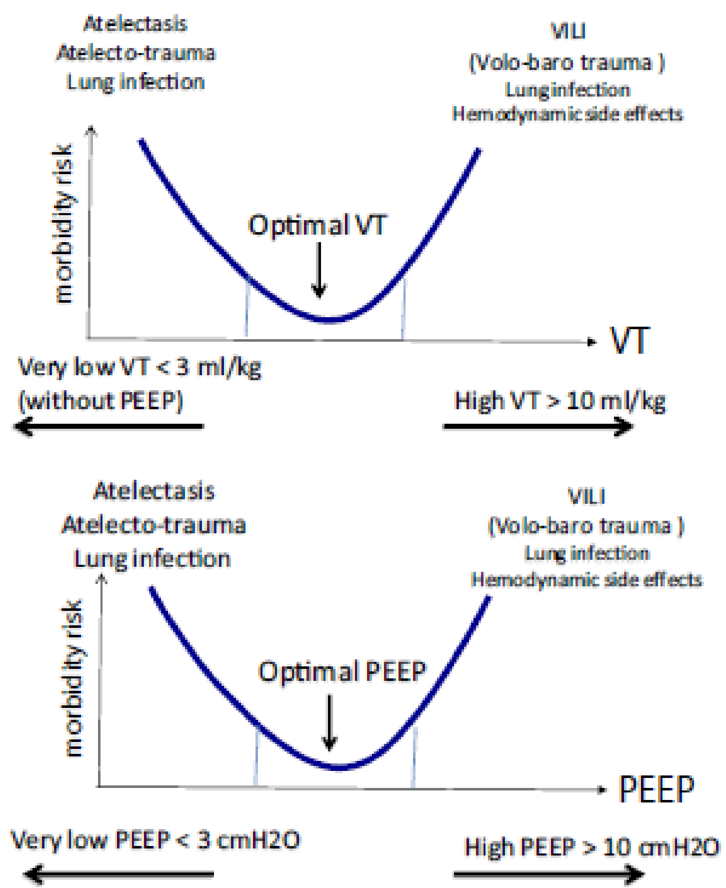
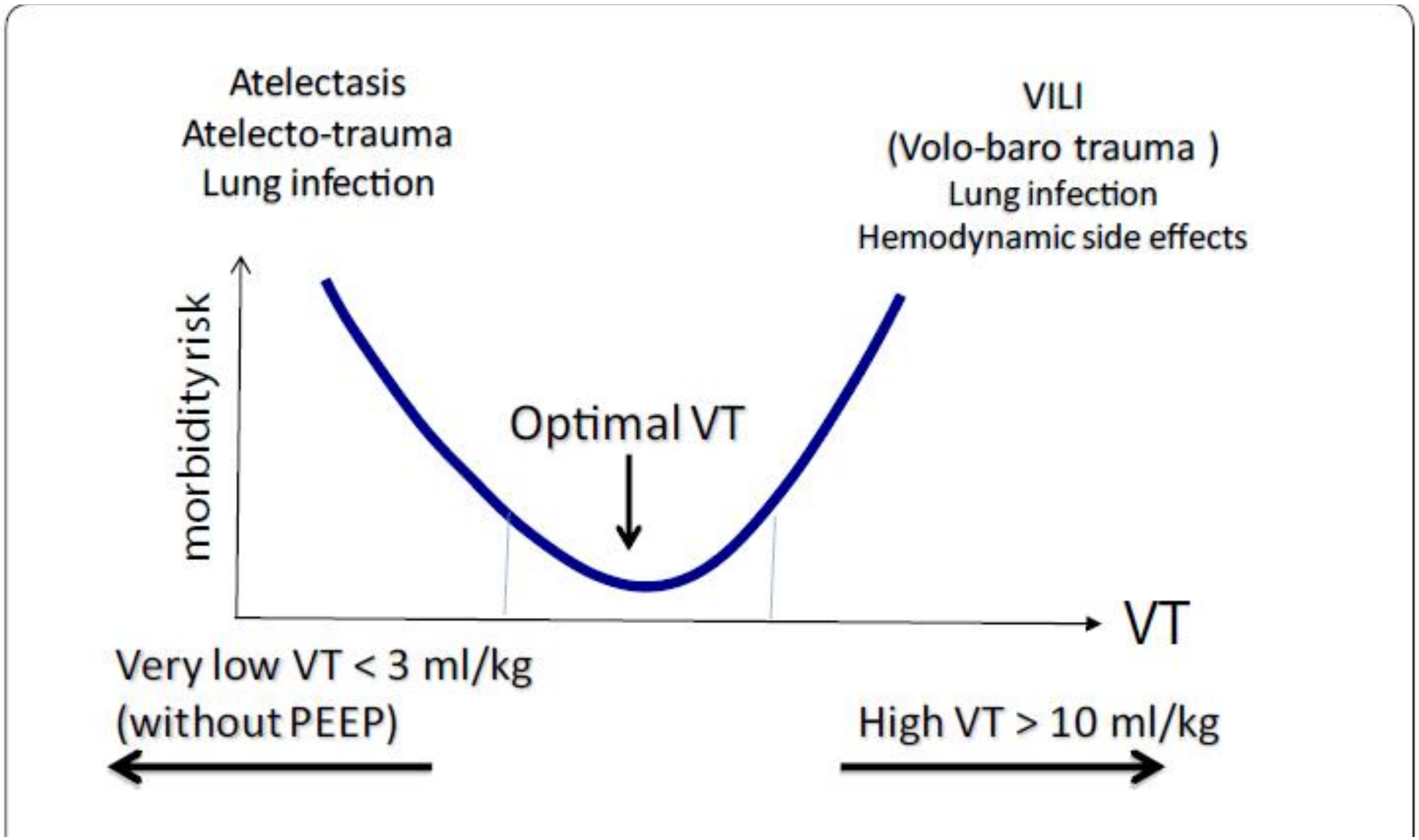


Fig. 1 Optimal tidal volume and PEEP level ranges and its related complications in patients with healthy non-ARDS lungs. V_T tidal volume, *PEEP* positive end expiratory pressure, *VILI* ventilator-induced lung injury

What's new in mechanical ventilation in patients without ARDS: lessons from the ARDS literature

Ary Serpa Neto[1,2,3] and Samir Jaber[4*]

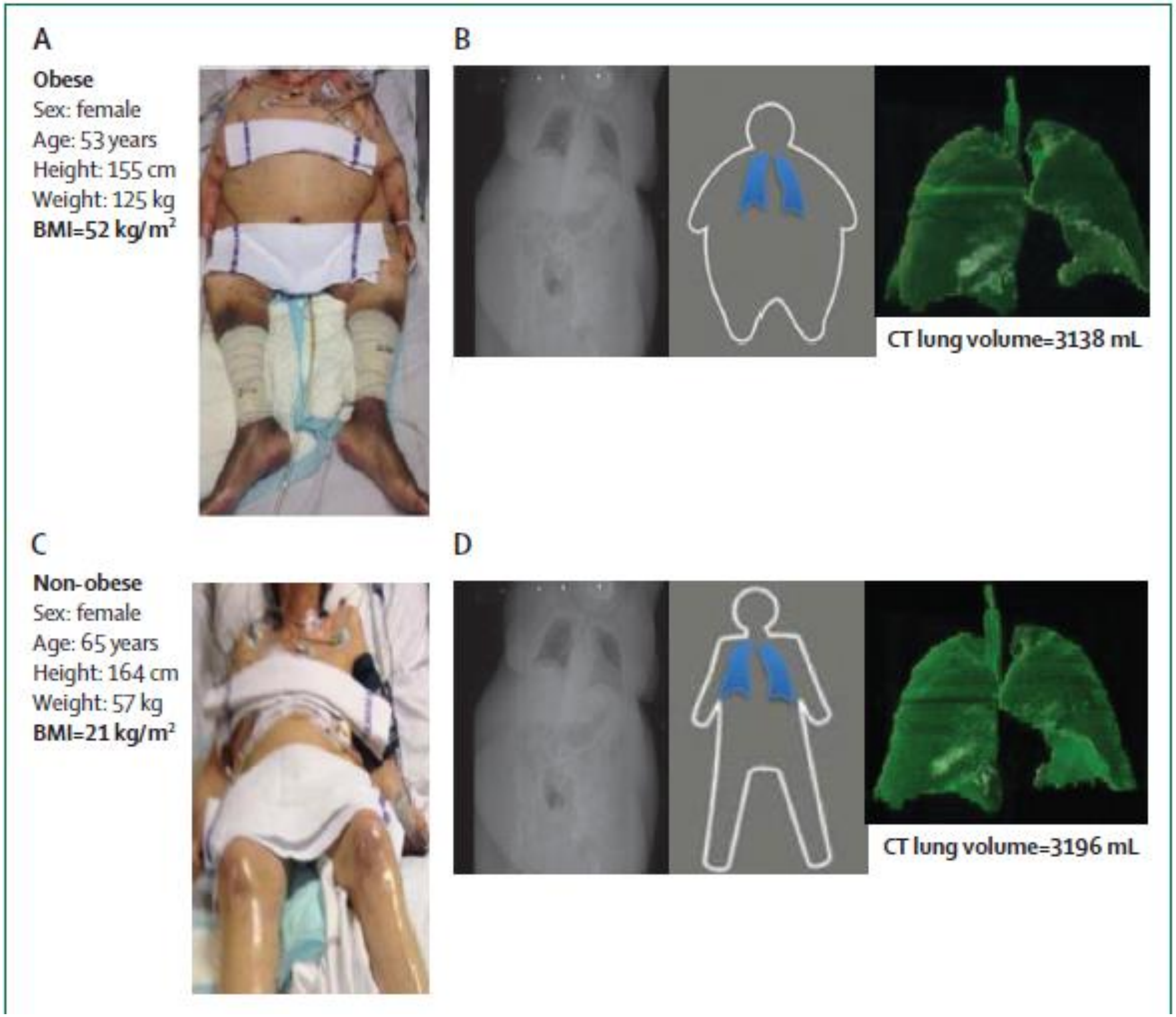
4 < VT < 6 ml/kg



Lancet Respir Med 2016; 4: 407–18

Prevention and care of respiratory failure in obese patients

Jean Louis Pépin, Jean François Timsit, Renaud Tamisier, Jean Christian Borel, Patrick Lévy, Samir Jaber



Réglage du volume courant (VT)

- **Poids Idéal Théorique (P.I.T) :**

PIT = X + 0,91 (taille en cm - 152,4)

Femmes : X = 45, 5

Hommes : X = 50

pour évaluer simplement

PIT (kg) = Taille (cm) -100 chez l'HOMME

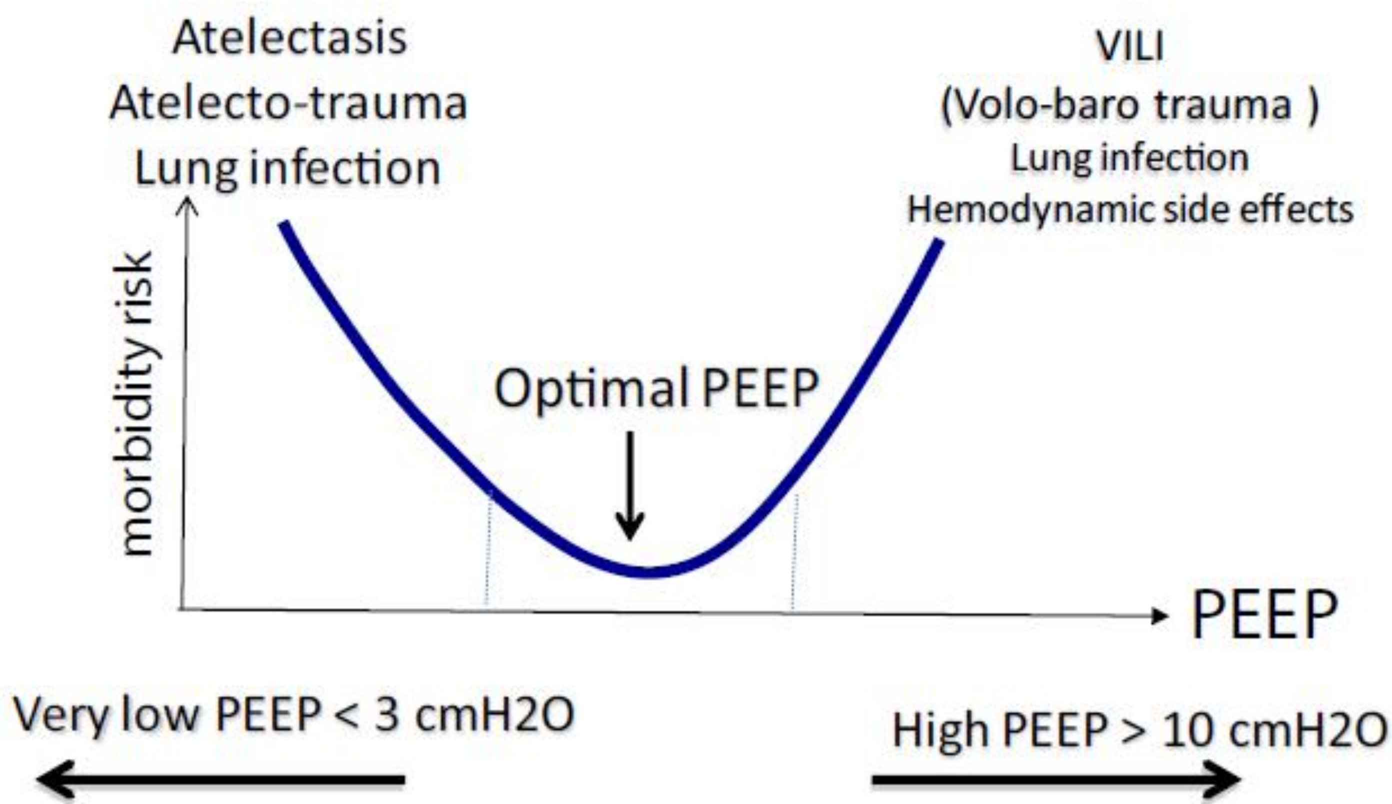
PIT (kg) = Taille (cm) -110 chez la FEMME

WHAT'S NEW IN INTENSIVE CARE

What's new in mechanical ventilation in patients without ARDS: lessons from the ARDS literature

Ary Serpa Neto[1,2,3] and Samir Jaber[4*]

5 < PEEP < 15 cmH2O



Evolution of Mortality over Time in Patients Receiving Mechanical Ventilation

Andrés Esteban[1], Fernando Frutos-Vivar[1], Alfonso Muriel[2], Niall D. Ferguson[3], Oscar Peñuelas[1], Victor Abraira[2], Konstantinos Raymondos[4], Fernando Rios[5], Nicolas Nin[1], Carlos Apezteguía[5], Damian A. Violi[6], Arnaud W. Thille[7], Laurent Brochard[8], Marco González[9], Asisclo J. Villagomez[10], Javier Hurtado[11], Andrew R. Davies[12], Bin Du[13], Salvatore M. Maggiore[14], Paolo Pelosi[15], Luis Soto[16], Vinko Tomicic[17], Gabriel D'Empaire[18], Dimitrios Matamis[19], Fekri Abroug[20], Rui P. Moreno[21], Marco Antonio Soares[22], Yaseen Arabi[23], Freddy Sandi[24], Manuel Jibaja[25], Pravin Amin[26], Younsuck Koh[27], Michael A. Kuiper[28], Hans-Henrik Bülow[29], Amine Ali Zeggwagh[30], and Antonio **Anzueto**[31]

AJRCCM Vol. 188, No. 2 **(2013)** pp. 220-230

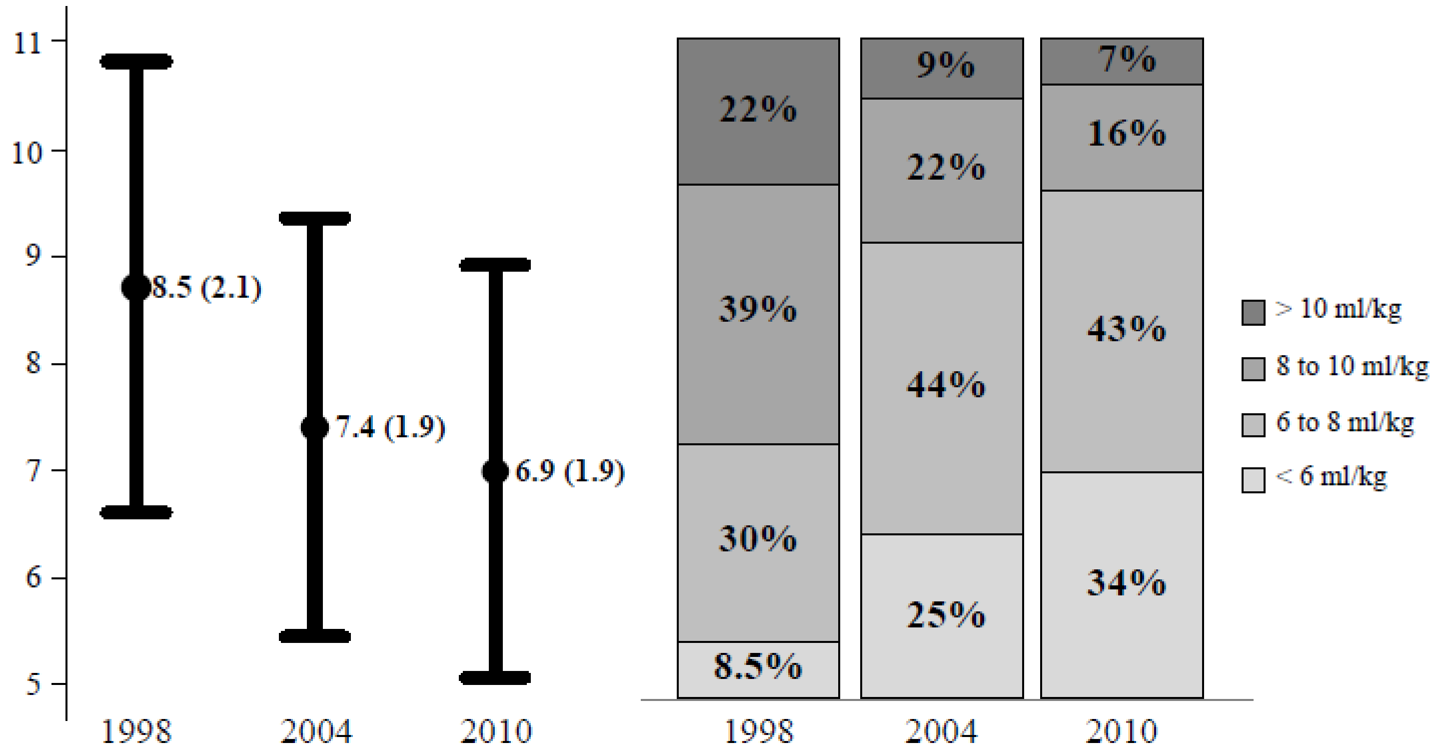
TABLE 2 - COMPARISON OF VARIABLES RELATED TO MANAGEMENT

	1998	2004	2010	e*
	N = 5183	N = 4968	N = 8151	
Non-invasive positive pressure ventilation prior to admission in the intensive care unit, n (%)	n.d.	n.d.	429 (5)	-
Non-invasive positive pressure ventilation at admission in the intensive care unit, n (%)	256(5)	479(10)	1169(14)	< 0.001
Mode of ventilation, days of use per 1000 days of invasive mechanical ventilation (excluding days during weaning from mechanical ventilation process)				
Assist-control	627	412	330	< 0.001
SIMV	66	21	34	< 0.001
SIMV-PS	132	132	94	< 0.001
Pressure support	65	125	237	< 0.001
PCV	75	125	130	< 0.001
APRV/BIPAP	n.d.	66	91	< 0.001
PRVC	n.d.	98	61	< 0.001
Other mode	35	21	23	< 0.001
Tidal volume				
In ml/kg actual body weight, mean (SD)	8.8 (2.1)	7.6 (2.1)	6.9 (1.9)	< 0.001
In ml/kg predicted body weight, mean (SD)	n.d.	9.3 (2.3)	8.2 (2.0)	< 0.001
Total respiratory rate, mean (SD), breaths per minute	18 (11)	18 (6)	19 (6)	< 0.001

Esteban et al. AJRCCM 2013

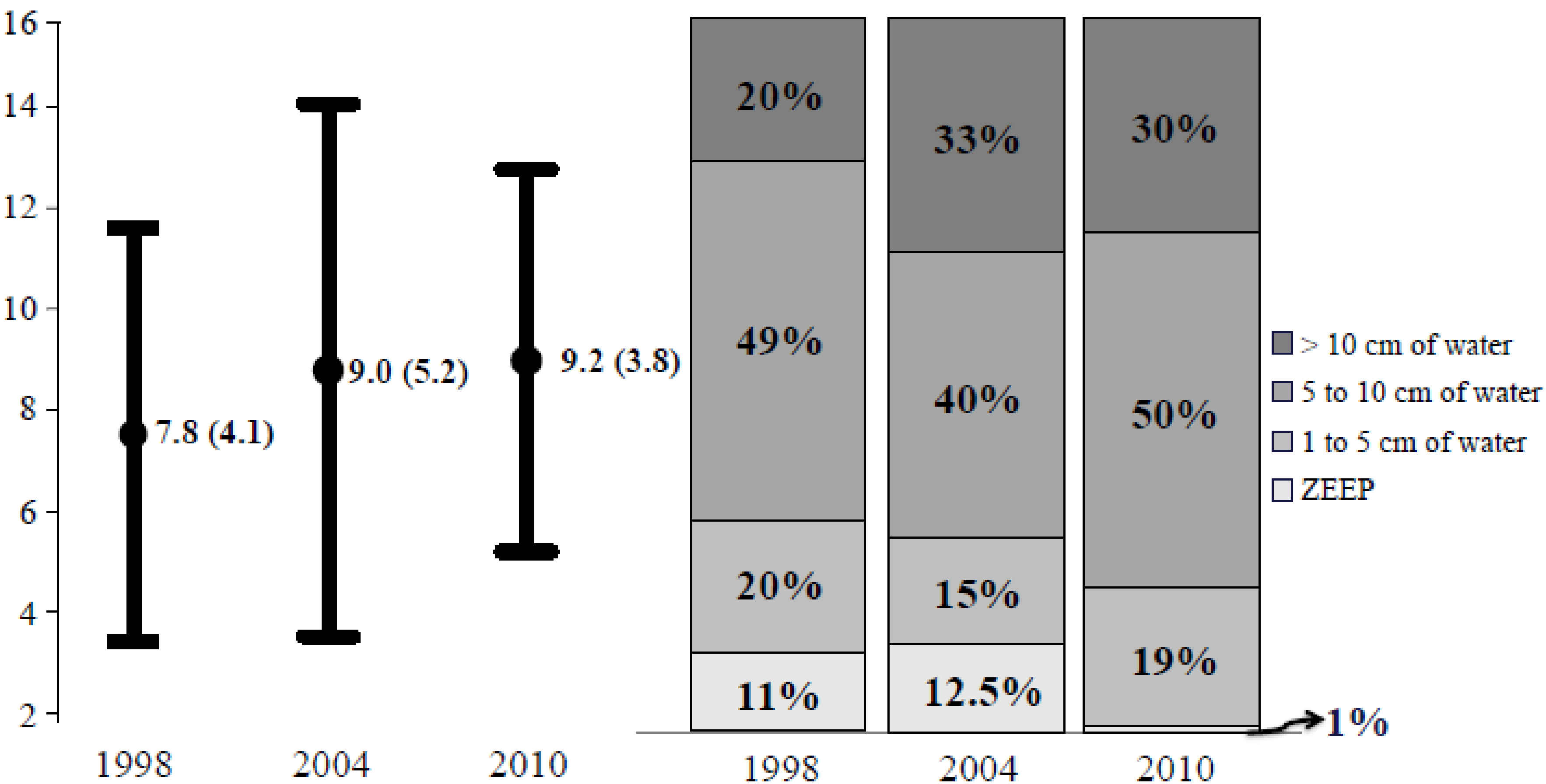
volume courant (VT)

Fig 1



PEEP

Fig 2


16
14
12
10
8
6
4
2
7.8 (4.1)
9.0 (5.2)
9.2 (3.8)
1998
2004
2010
20%
49%
20%
11%
33%
40%
15%
12.5%
30%
50%
19%
1%
> 10 cm of water
5 to 10 cm of water
1 to 5 cm of water
ZEEP
1998
2004
2010

Objectifs

1. Qui sont les patients à risque?

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3. Quelles sont les évidences ?

4. Take Home Messages

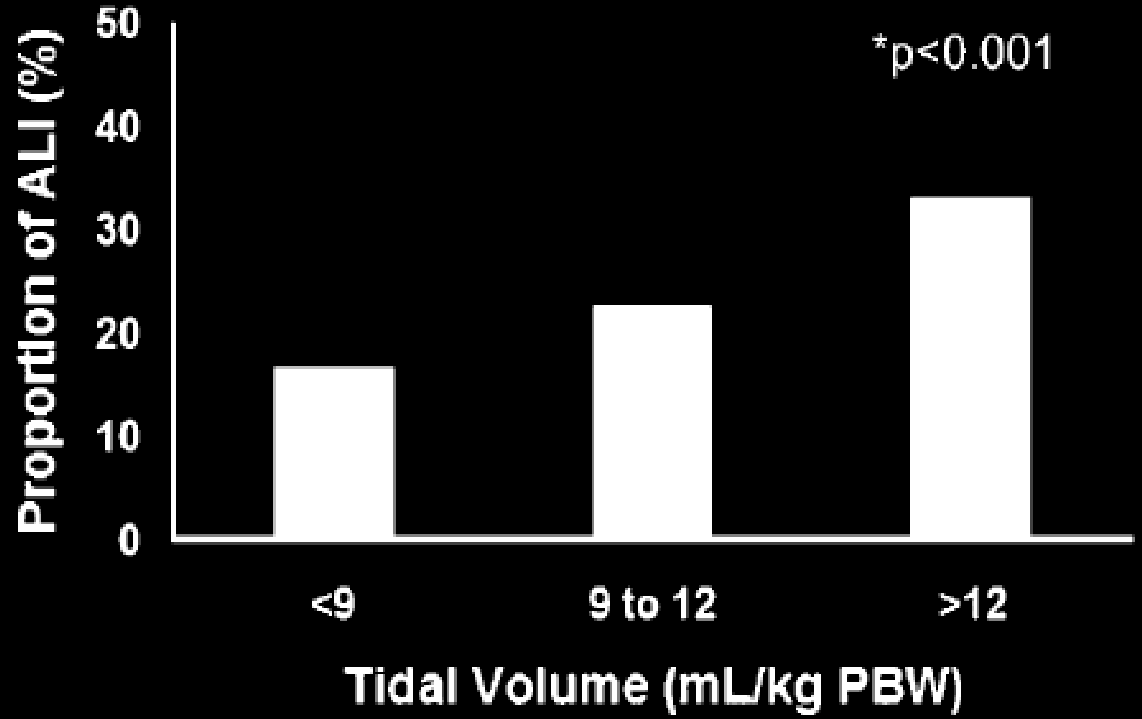
Is there a rationale to use lung protective ventilation in patients with normal lungs ?

Ventilator-associated lung injury in patients without acute lung injury at the onset of mechanical ventilation

Ognjen Gajic, MD; Saqib I. Dara, MD; Jose L. Mendez, MD; Adebola O. Adesanya, MD; Emir Festic, MD; Sean M. Caples, MD; Rimki Rana, MD; Jennifer L. St. Sauver, PhD; James F. Lymp, PhD; Bekele Afessa, MD; Rolf D. Hubmayr, MD

A retrospective cohort study of 332 patients with « normal lungs » at the onset of mechanical ventilation and who received mechanical ventilation for ≥24h
4 ICUs of a tertiary referral center

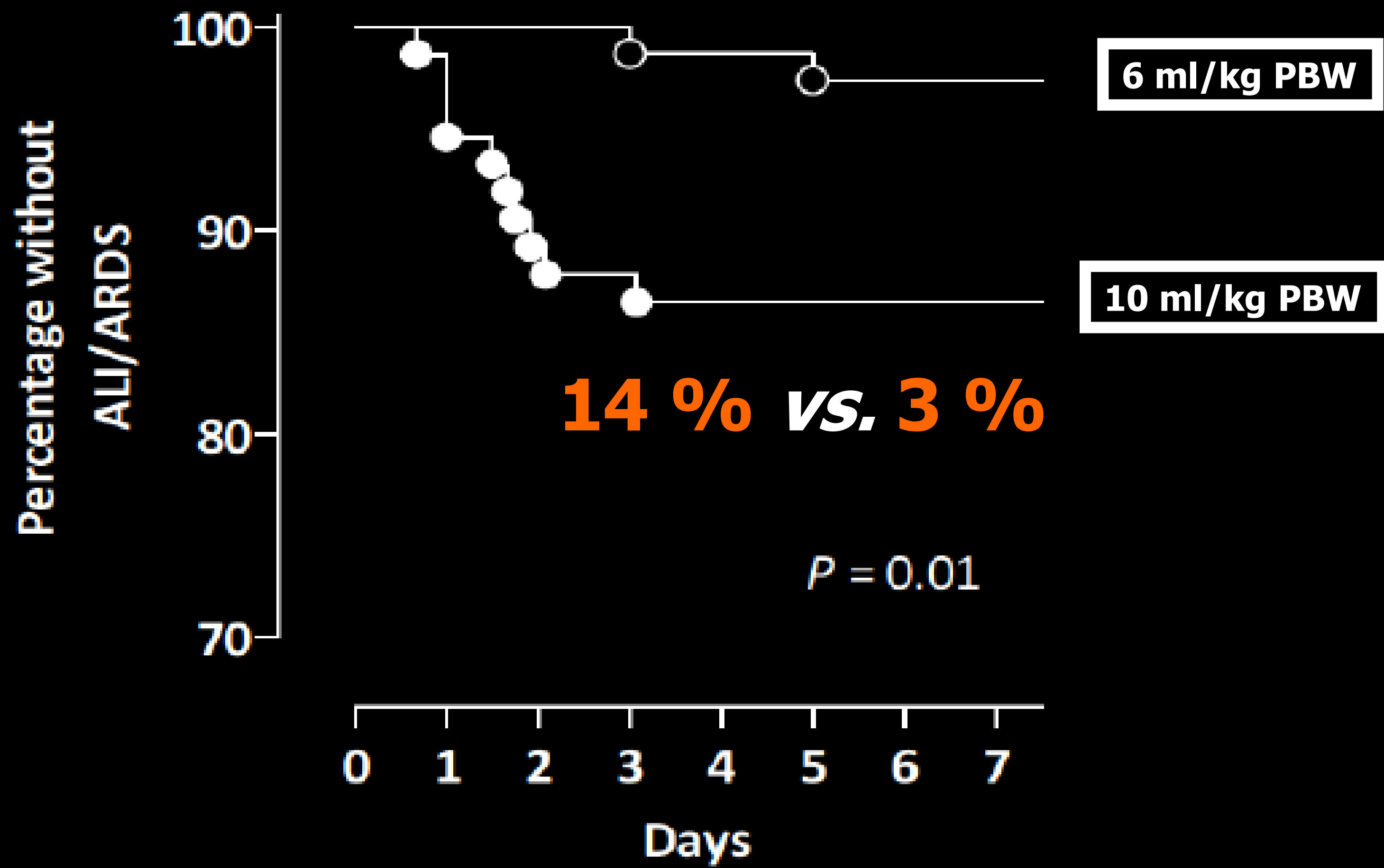
Incidence ALI: N=80 patients (24%)



Gajic O. et al **Crit Care Med** 2004

Ventilation with lower tidal volumes as compared to conventional tidal volumes for patients without acute lung injury - A preventive randomized controlled trial

Rogier M Determann, Annick Royakkers, Esther K Wolthuis, Alexander P Vlaar, Goda Choi, Frederique Paulus, Jorrit-Jan Hofstra, Mart J de Graaff, Johanna C Korevaar and Marcus J Schultz. . **Crit care 2010**

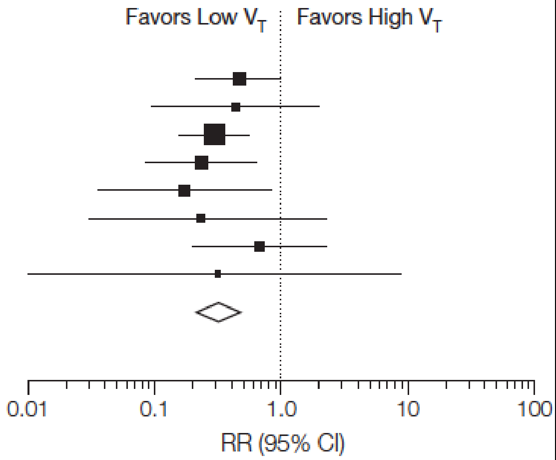


Lower Tidal Volumes in Patients without Preexisting Lung Injury

Serpa Neto A et al , JAMA. 2012 Oct 24;308(16):1651-9

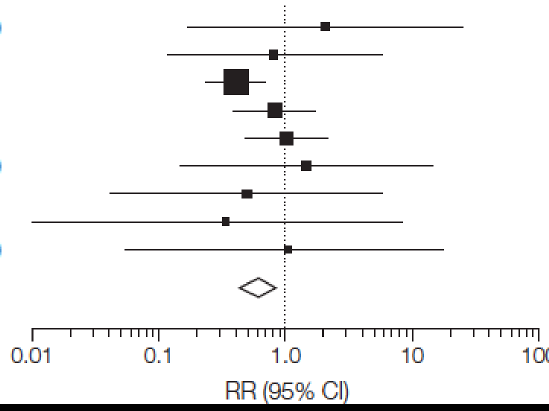
	High V_T, No.		Low V_T, No.			
	Events	Total	Events	Total	Weight, %	RR (95% CI)
Lung injury						
Gajic et al,[16] 2004	32	100	12	66	18.1	0.47 (0.22-1.00)
Michelet et al,[20] 2006	6	26	3	26	4.6	0.43 (0.10-1.97)
Yilmaz et al,[23] 2007	60	212	17	163	40.7	0.29 (0.16-0.53)
Licker et al,[26] 2009	20	533	5	558	17.7	0.23 (0.09-0.62)
Determann et al,[27] 2010	10	74	2	76	8.6	0.17 (0.04-0.82)
Yang et al,[31] 2011	4	50	1	50	3.4	0.23 (0.03-2.18)
Fernandez-Bustamante et al,[29] 2011	5	75	7	154	5.6	0.67 (0.20-2.17)
Weingarten et al,[32] 2012	1	20	0	20	1.3	0.32 (0.01-8.26)
Subtotal (95% CI)		**1090**		**1113**	**100.0**	**0.33 (0.23-0.47)**
Total events	138		47			

Heterogeneity: $\chi^2_7 = 3.74$; $P = .81$, $I^2 = 0\%$
Test for overall effect: $z = 6.06$; $P < .001$



	High V_T, No.		Low V_T, No.			
	Events	Total	Events	Total	Weight, %	RR (95% CI)
Mortality						
Michelet et al,[20] 2006	1	26	2	26	1.0	2.08 (0.18-24.51)
Wolthuis et al,[22] 2007	2	13	3	23	2.5	0.82 (0.12-5.71)
Yilmaz et al,[23] 2007	69	212	27	163	55.7	0.41 (0.25-0.68)
Licker et al,[26] 2009	15	533	13	558	16.7	0.82 (0.39-1.75)
Determann et al,[27] 2010	23	74	24	76	17.7	1.02 (0.51-2.04)
Fernandez-Bustamante et al,[29] 2011	1	75	3	154	1.5	1.47 (0.15-14.38)
Sundar et al,[30] 2011	2	74	1	75	2.2	0.49 (0.04-5.48)
Yang et al,[31] 2011	1	50	0	50	1.7	0.33 (0.01-8.21)
Weingarten et al,[32] 2012	1	20	1	20	1.1	1.00 (0.06-17.18)
Subtotal (95% CI)		**1077**		**1145**	**100.0**	**0.64 (0.46-0.86)**
Total events	115		74			

Heterogeneity: $\chi^2_8 = 6.94$; $P = .54$, $I^2 = 0\%$
Test for overall effect: $z = 2.68$; $P = .007$



Lower Tidal Volumes in Patients without Preexisting Lung Injury

Serpa Neto A et al , JAMA. 2012 Oct 24;308(16):1651-9

Table 3. Summary of Stratified Analyses of Pooled Relative Risks

Stratified Analysis	No. of Trials	No. of Patients	Risk Ratio (95% CI)	*P* Value	Heterogeneity, *Q*
Acute Lung Injury					
Setting					
Operation room	5	1512	0.34 (0.18-0.63)	<.001	0.73
ICU	3	691	0.33 (0.21-0.51)	<.001	0.43
Mortality					
Setting					
Operation room	6	1661	0.86 (0.46-1.60)	.63	0.94
ICU	3	561	0.57 (0.38-0.84)	.005	0.10

Lower Tidal Volumes in Patients without Preexisting Lung Injury in ICU: A Metaanalysis

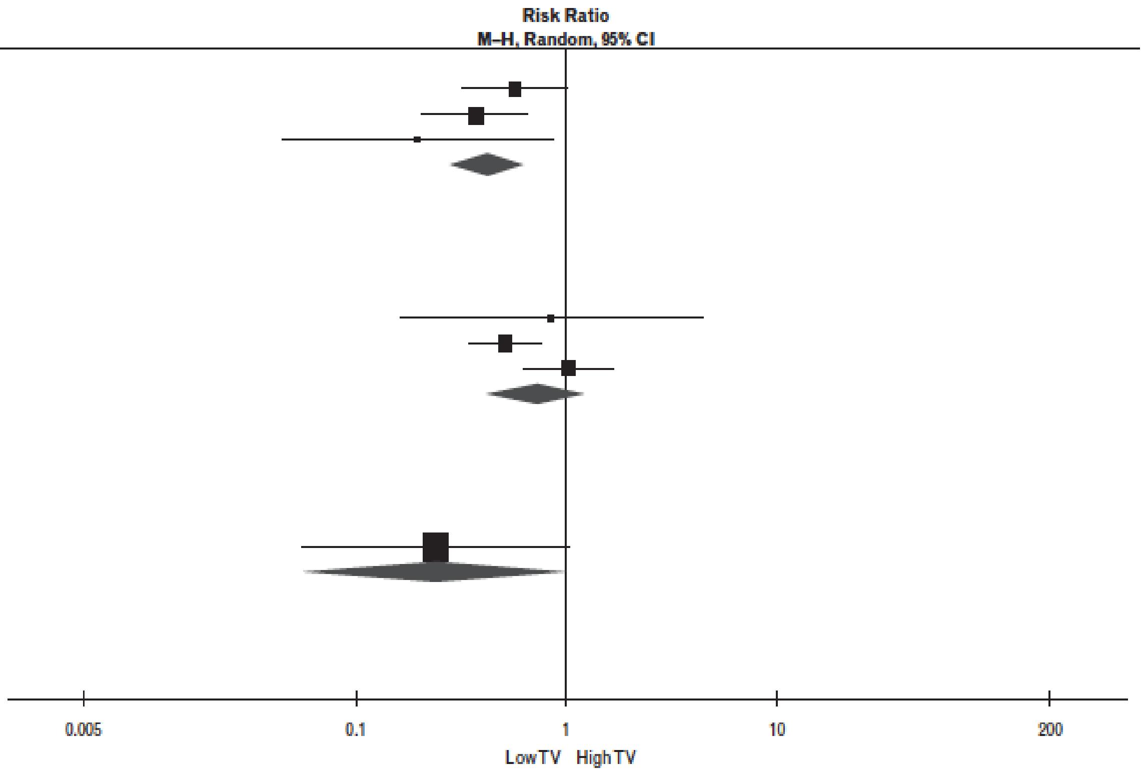
Serpa Neto A et al , Curr Opin Crit Care 2014, 20:25–32

		Effect of low tidal volume			
Author	**Year**	**Duration mechanical ventilation**	**Mortality**	**Inflammatory markers**	**Development of ARDS**
Lee *et al.* [39]	1990	↓	↔	NR	↓
Gajic *et al.* [40]	2004	NR	↔	NR	↓
Wolthuis *et al.* [41]	2007	↔	↔	NR	NR
Yilmaz *et al.* [42]	2007	↓	↓	NR	↓
Determann *et al.* [8]	2010	↔	↔	↓	↓
Pinheiro de Oliveira *et al.* [43]	2010	↔	↔	↓	NR

Lower Tidal Volumes in Patients without Preexisting Lung Injury in ICU: A Metaanalysis

Serpa Neto A et al , Curr Opin Crit Care 2014, 20:25–32

Study or Subgroup	Low TV Events	Low TV Total	High TV Events	High TV Total	Weight	Risk Ratio M–H, Random, 95% CI	Year
1.2.1 Lung Injury							
Gajic 2004 [40]	12	66	32	100	40.4%	0.57 [0.32, 1.02]	2004
Yilmaz 2007 [42]	17	163	60	212	52.0%	0.37 [0.22, 0.61]	2007
Determann 2010 [8]	2	76	10	74	7.6%	0.19 [0.04, 0.86]	2010
Subtotal (95% CI)		**305**		**386**	**100.0%**	**0.42 [0.28, 0.63]**	
Total events	31		102				
Heterogeneity: $Tau^2 = 0.02$; $chi^2 = 2.35$, df = 2 (P = 0.31); $I^2 = 15\%$							
Test for overall effect: Z = 4.10 (P < 0.0001)							
1.2.2 Mortality							
Wolthuis 2007 [41]	3	23	2	13	9.7%	0.85 [0.16, 4.44]	2007
Yilmaz 2007 [42]	27	163	69	212	47.4%	0.51 [0.34, 0.76]	2007
Determann 2010 [8]	24	76	23	74	42.9%	1.02 [0.63, 1.63]	2010
Subtotal (95% CI)		**262**		**299**	**100.0%**	**0.72 [0.41, 1.26]**	
Total events							
Heterogeneity: $Tau^2 = 0.13$; $chi^2 = 4.95$, df = 2 (P = 0.08); $I^2 = 60\%$							
Test for overall effect: Z = 1.15 (P < 0.25)							
1.2.3 Pulmonary Infection							
Lee 1999 [39]	2	47	10	56	100.0%	0.24 [0.05, 1.03]	1999
Subtotal (95% CI)		**47**		**56**	**100.0%**	**0.24 [0.05, 1.03]**	
Total events	2		10				
Heterogeneity: Not applicable							
Test for overall effect: Z = 1.92 (P < 0.06)							



PROTECTIVE VENTILATION IN ICU

PROTECTIVE VENTILATION NETWORK

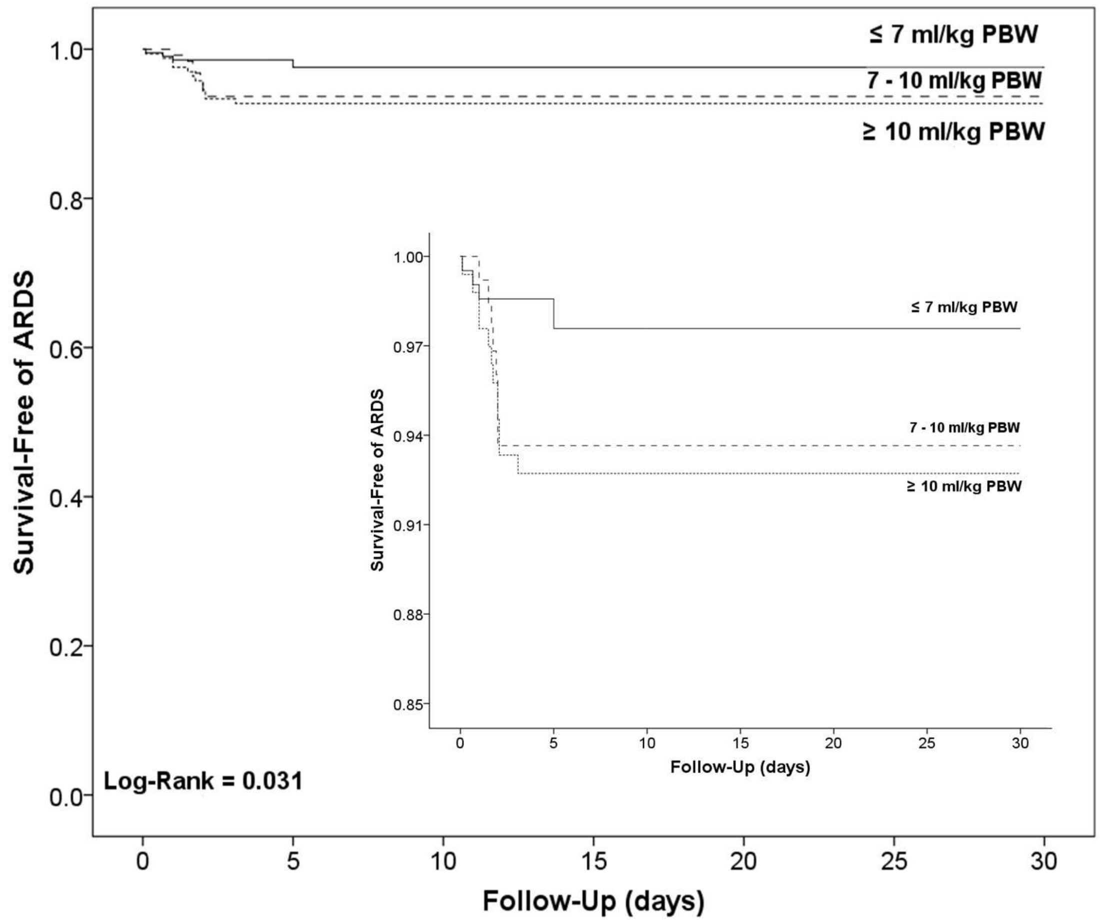
LUNG PROTECTIVE VENTILATION WITH LOWER TIDAL VOLUMES TO PREVENT ACUTE RESPIRATORY DISTRESS SYNDROME IN INTENSIVE CARE UNIT PATIENTS UNDER MECHANICAL VENTILATION: A systematic review and meta-analysis using individual data of 2,184 patients

Ary Serpa Neto MD MSc, Sabrine NT Hemmes MD, Carmen SV Barbas MD PhD, Michelle Biehl MD, Rogier M Determann MD PhD, Jonathan Elmer MD PhD, Gilberto Friedman MD PhD, Ognjen Gajic MD PhD, Rita Linko MD PhD, Roselaine Pinheiro de Oliveira MD PhD, Esther K Wolthuis MD PhD, Marcelo Gama de Abreu MD PhD, Paolo Pelosi MD, Marcus J Schultz MD PhD

Serpa Neto A,

PROTECTIVE VENTILATION IN ICU

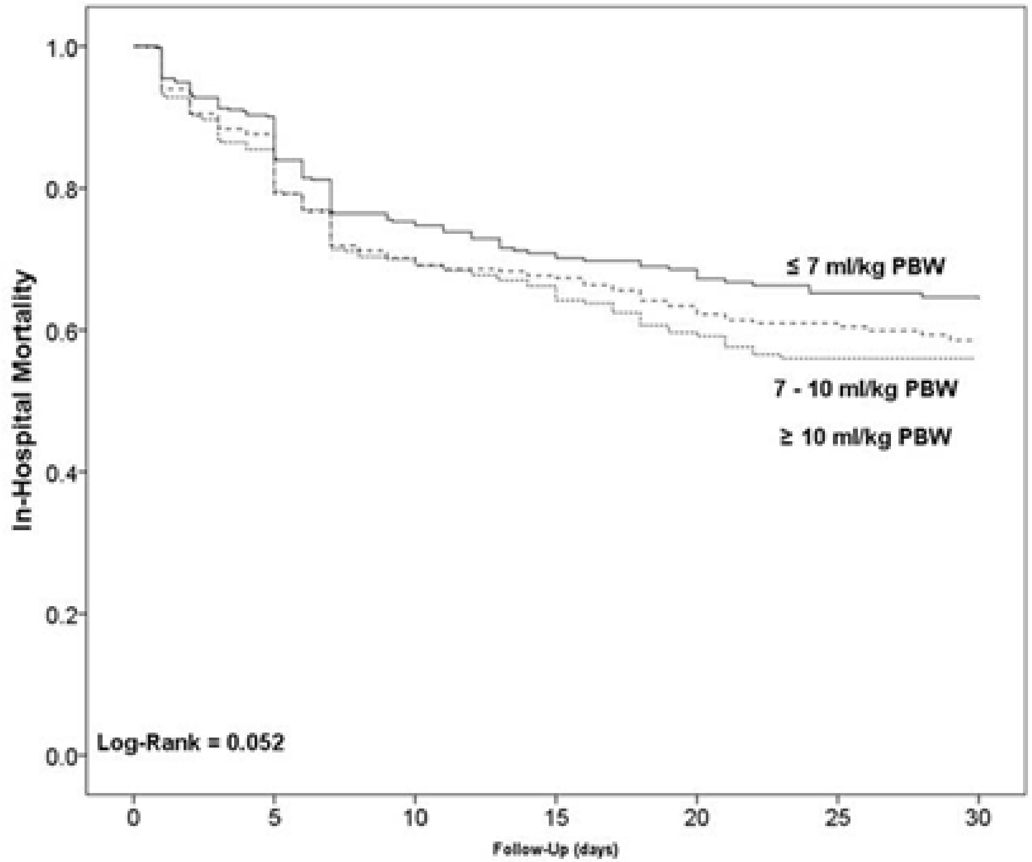
PROTECTIVE VENTILATION NETWORK



Number at Risk							
≤ 7 ml/kg PBW	506	387	278	192	101	85	34
7 – 10 ml/kg PBW	625	495	398	287	207	121	93
≥ 10 ml/kg PBW	464	293	198	117	78	54	29

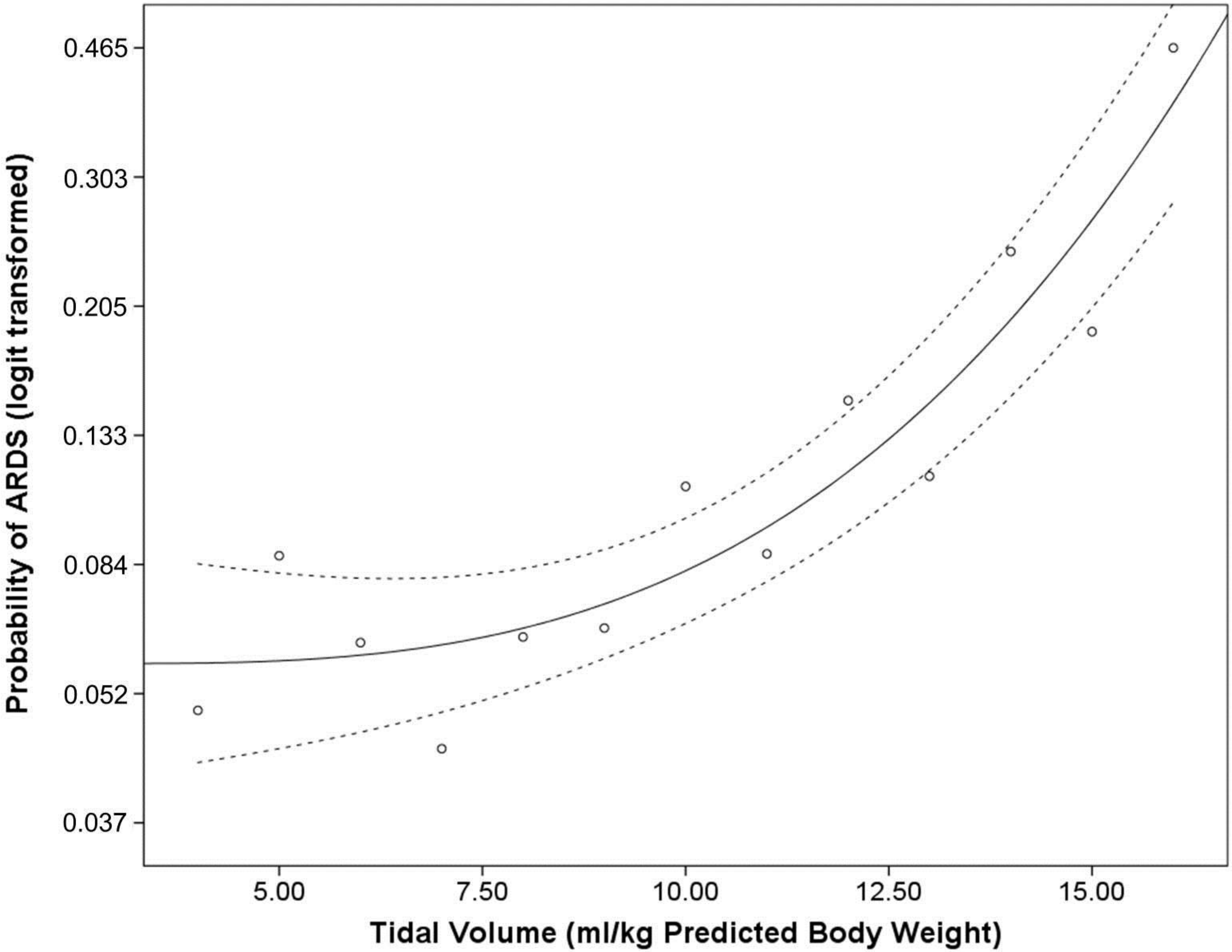
PROTECTIVE VENTILATION IN ICU

mortality



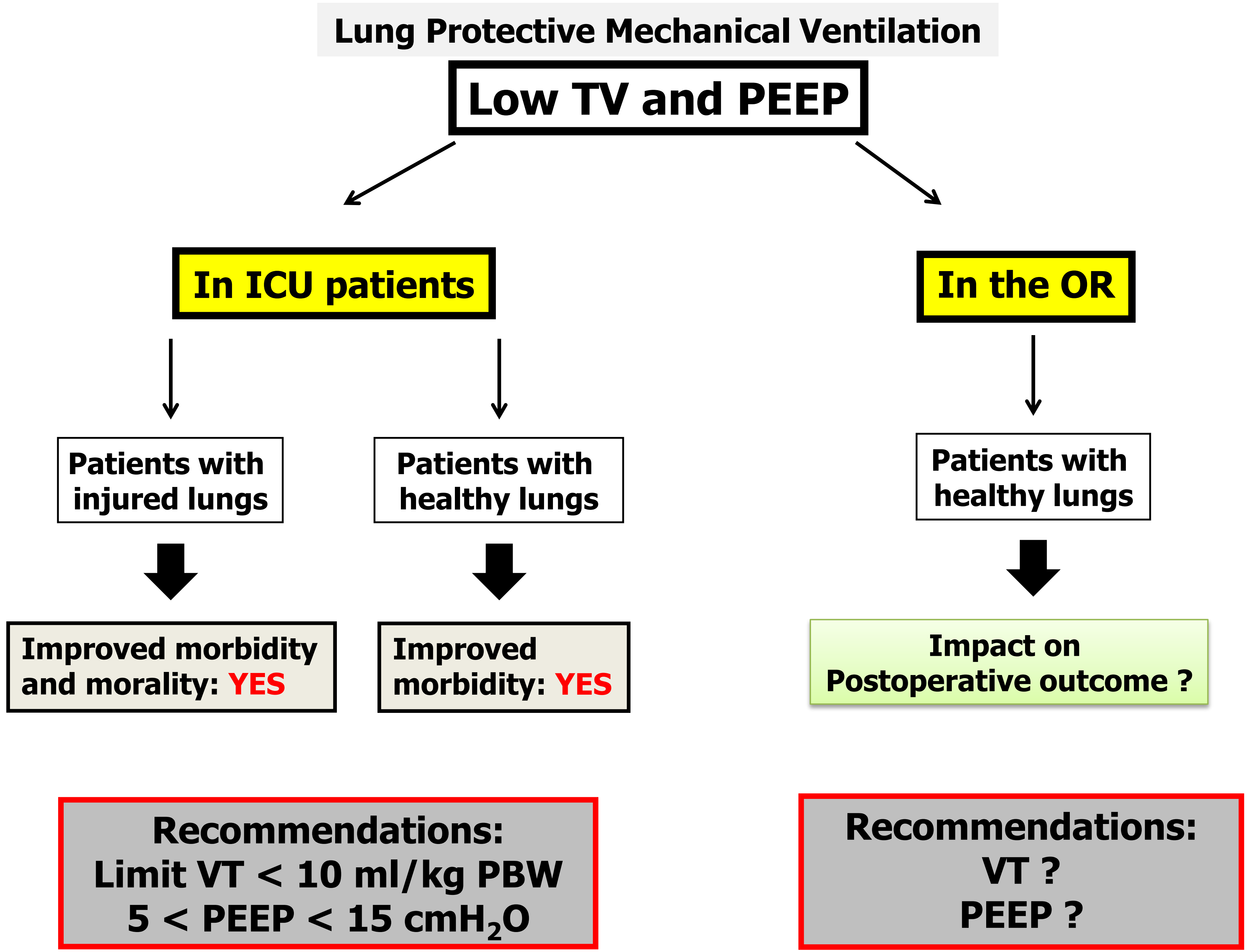
Number at Risk							
≤ 7 ml/kg PBW	512	385	239	179	142	93	35
7 – 10 ml/kg PBW	598	436	243	189	145	101	45
≥ 10 ml/kg PBW	498	353	199	149	110	72	29

PROTECTIVE VENTILATION IN ICU



… and in the operating room,

What is the evidence ?


Lung Protective Mechanical Ventilation
Low TV and PEEP
In ICU patients
In the OR
Patients with injured lungs
Patients with healthy lungs
Patients with healthy lungs
Improved morbidity and morality: YES
Improved morbidity: YES
Impact on Postoperative outcome ?
Recommendations:
Limit VT < 10 ml/kg PBW
5 < PEEP < 15 cmH_2O
Recommendations:
VT ?
PEEP ?

1963

The New England Journal of Medicine

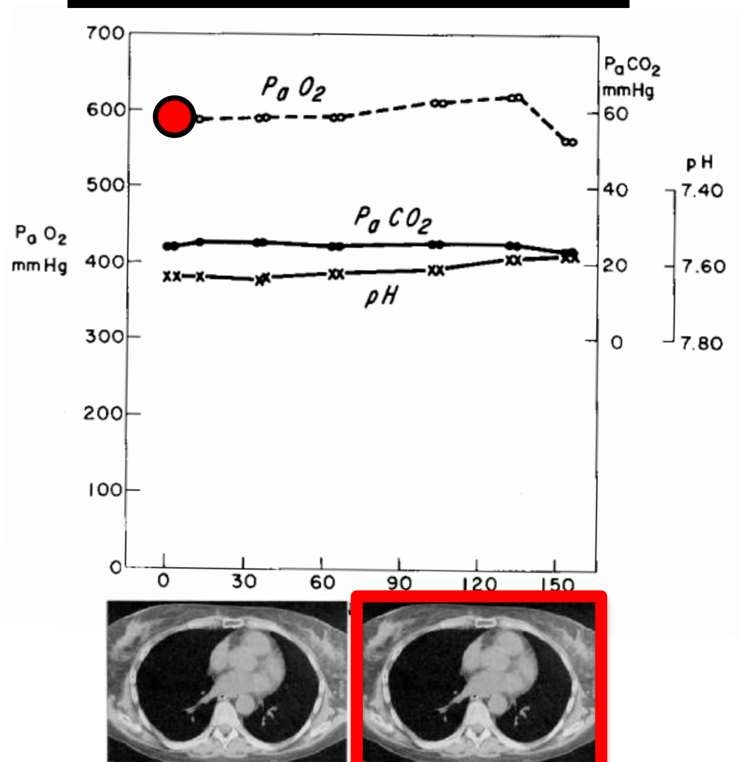
V… NOVEMBER 7, 1963 Number 19

IMPAIRED OXYGENATION IN SURGICAL PATIENTS DURING GENERAL ANESTHESIA WITH CONTROLLED VENTILATION*

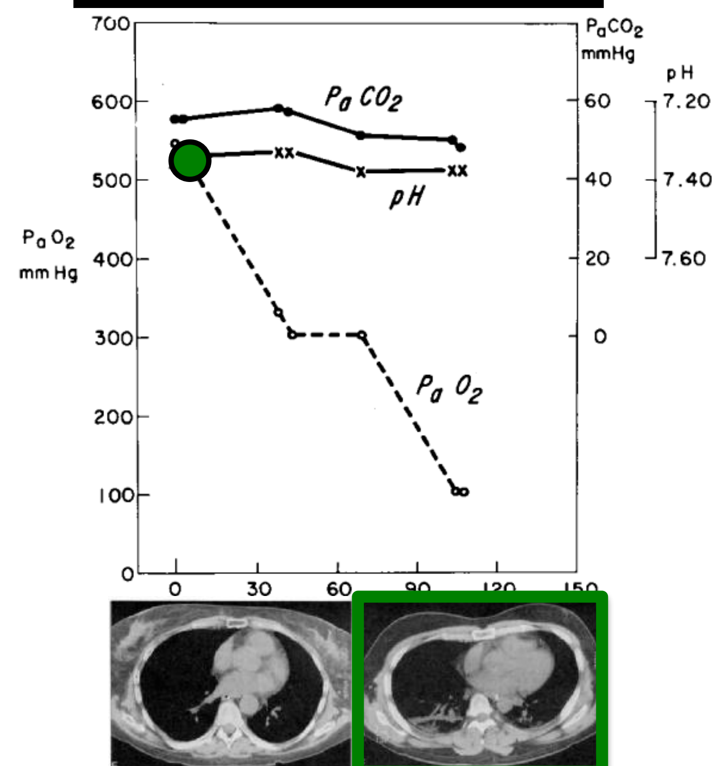
A Concept of Atelectasis

H. H. Bendixen, M.D.,† J. Hedley-Whyte, M.B., B.Chir.,‡ and M. B. Laver, M.D.§

Large TV and zero PEEP



Low TV and zero PEEP



Protective Mechanical Ventilation during General Anesthesia for Open Abdominal Surgery Improves Postoperative Pulmonary Function

Paolo Severgnini, Gabriele Selmo, Christian Lanza, Alessandro Chiesa, Alice Frigerio, Alessandro Bacuzzi, Gianlorenzo Dionigi, Raffaele Novario, Cesare Gregoretti, Marcelo Gama de Abreu, Marcus J. Schultz, Samir Jaber, Emmanuel Futier, Maurizio Chiaranda, **Paolo Pelosi**

Anesthesiology 2013; 118:1307-21

N = 56 Patients undergoing elective open abdominal surgery

STANDARD VENTILATION	*VS.*	**LUNG-PROTECTIVE VENTILATION**
VT = 9 ml/kg PBW		**VT= 7 ml/kg PBW**
zero PEEP		**10 cmH_2O PEEP + RM**

Need for large RCT in Protective ventilation in anesthesia

● Protective Ventilation During General Anesthesia for Open Abdominal Surgery (PROVHILO study)

High versus low positive end-expiratory pressure during general anaesthesia for open abdominal surgery (PROVHILO trial): a multicentre randomised controlled trial

The PROVE Network Investigators for the Clinical Trial Network of the European Society of Anaesthesic* **Lancet 2014; 384: 495-503**

The NEW ENGLAND JOURNAL of MEDICINE

N ENGL J MED 369;5 NEJM.ORG AUGUST 1, 2013

ORIGINAL ARTICLE

A Trial of Intraoperative Low-Tidal-Volume Ventilation in Abdominal Surgery

Emmanuel Futier, M.D., Jean-Michel Constantin, M.D., Ph.D., Catherine Paugam-Burtz, M.D., Ph.D., Julien Pascal, M.D., Mathilde Eurin, M.D., Arthur Neuschwander, M.D., Emmanuel Marret, M.D., Marc Beaussier, M.D., Ph.D., Christophe Gutton, M.D., Jean-Yves Lefrant, M.D., Ph.D., Bernard Allaouchiche, M.D., Ph.D., Daniel Verzilli, M.D., Marc Leone, M.D., Ph.D., Audrey De Jong, M.D., Jean-Etienne Bazin, M.D., Ph.D., Bruno Pereira, Ph.D., and Samir Jaber, M.D., Ph.D., for the IMPROVE Study Group*

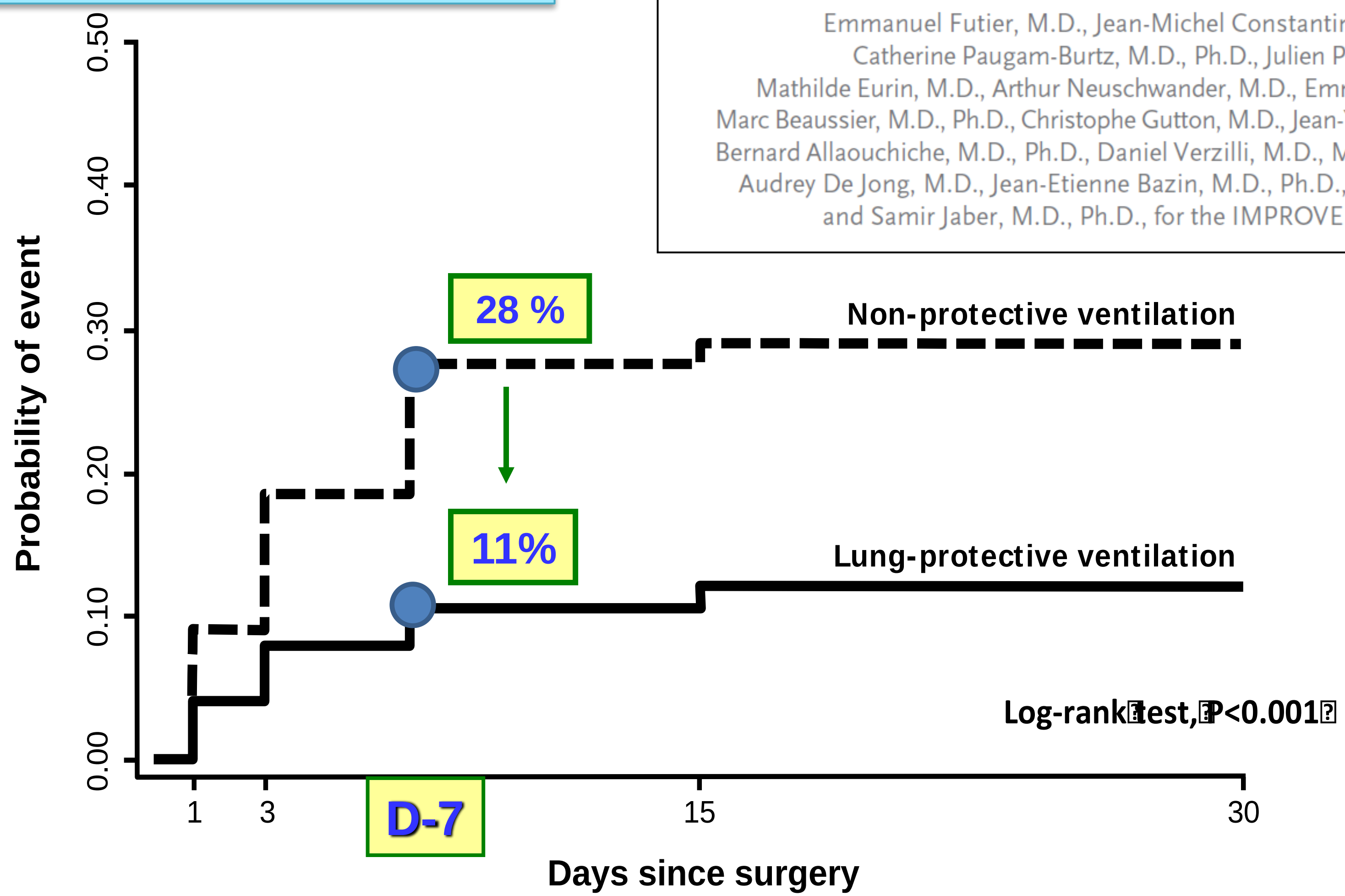
Postoperative Pulmonary and Extra-pulmonary Complications

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE **NEJM 2013**

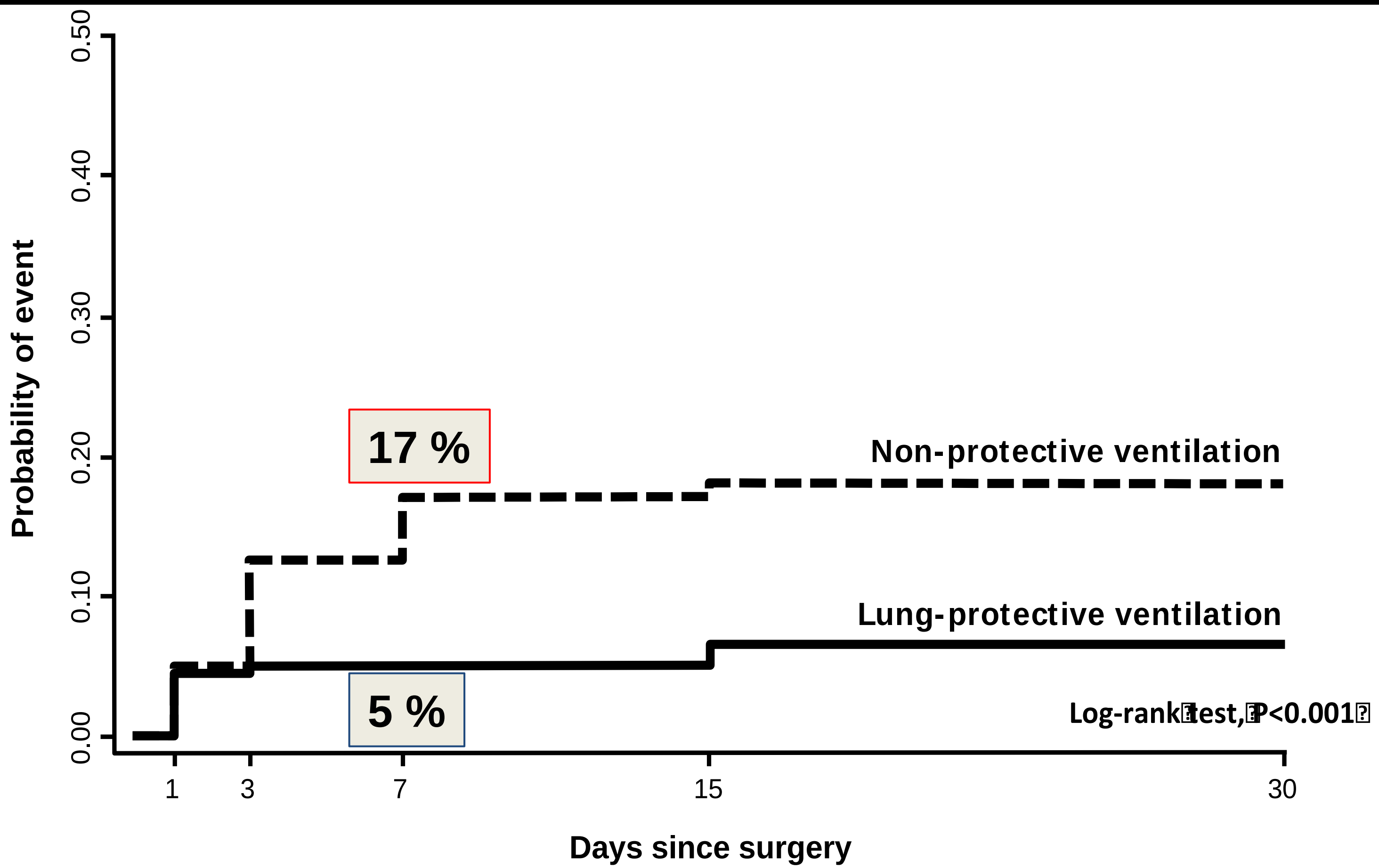
A Trial of Intraoperative Low-Tidal-Volume Ventilation in Abdominal Surgery

Emmanuel Futier, M.D., Jean-Michel Constantin, M.D., Ph.D., Catherine Paugam-Burtz, M.D., Ph.D., Julien Pascal, M.D., Mathilde Eurin, M.D., Arthur Neuschwander, M.D., Emmanuel Marret, M.D., Marc Beaussier, M.D., Ph.D., Christophe Gutton, M.D., Jean-Yves Lefrant, M.D., Ph.D., Bernard Allaouchiche, M.D., Ph.D., Daniel Verzilli, M.D., Marc Leone, M.D., Ph.D., Audrey De Jong, M.D., Jean-Etienne Bazin, M.D., Ph.D., Bruno Pereira, Ph.D., and Samir Jaber, M.D., Ph.D., for the IMPROVE Study Group*



Intraoperative Protective Ventilation in Abdominal Surgery : The IMPROVE Trial

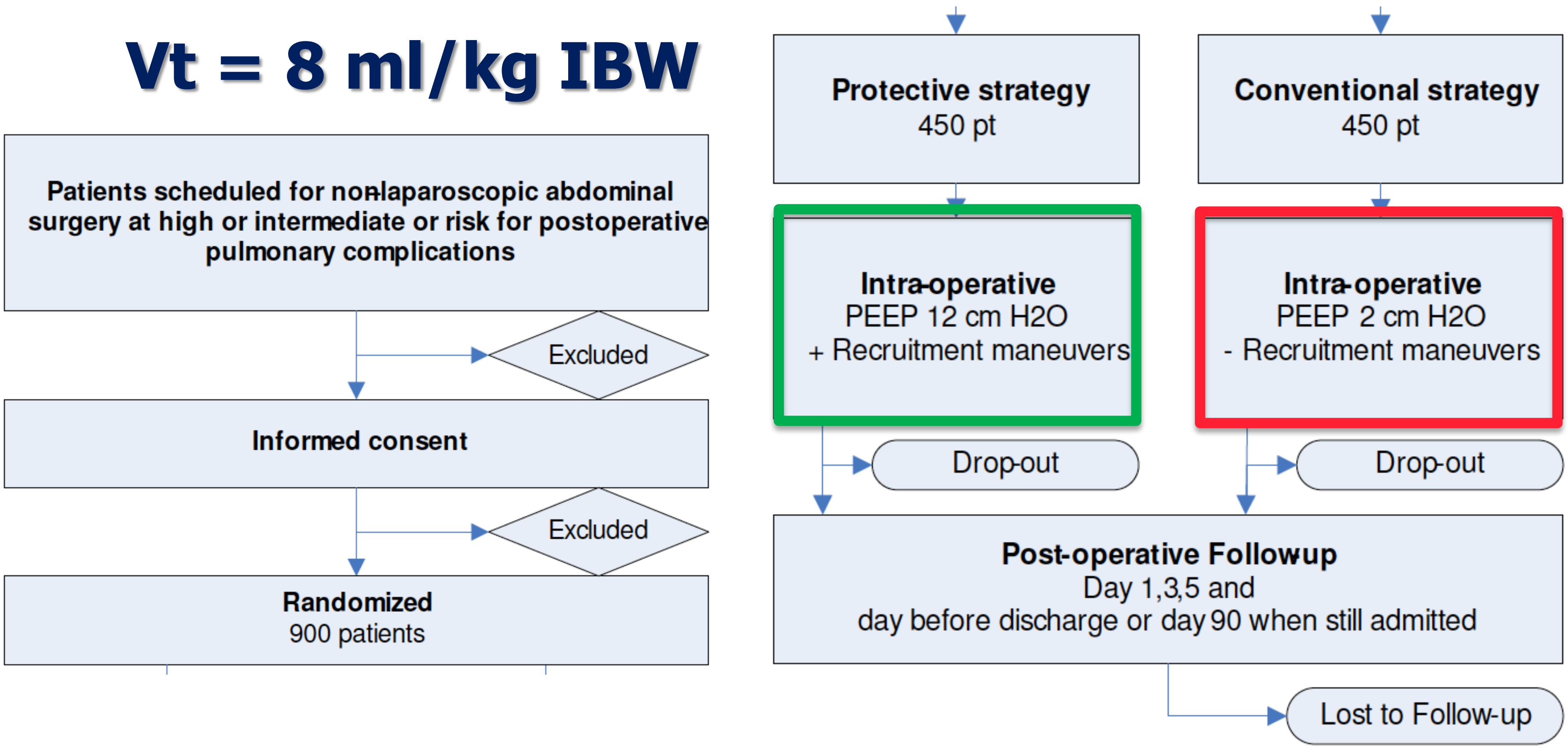
Probability for requiring intubation or non-invasive ventilation for ARF to Postoperative Day 30



High versus low positive end-expiratory pressure during general anaesthesia for open abdominal surgery (PROVHILO trial): a multicentre randomised controlled trial

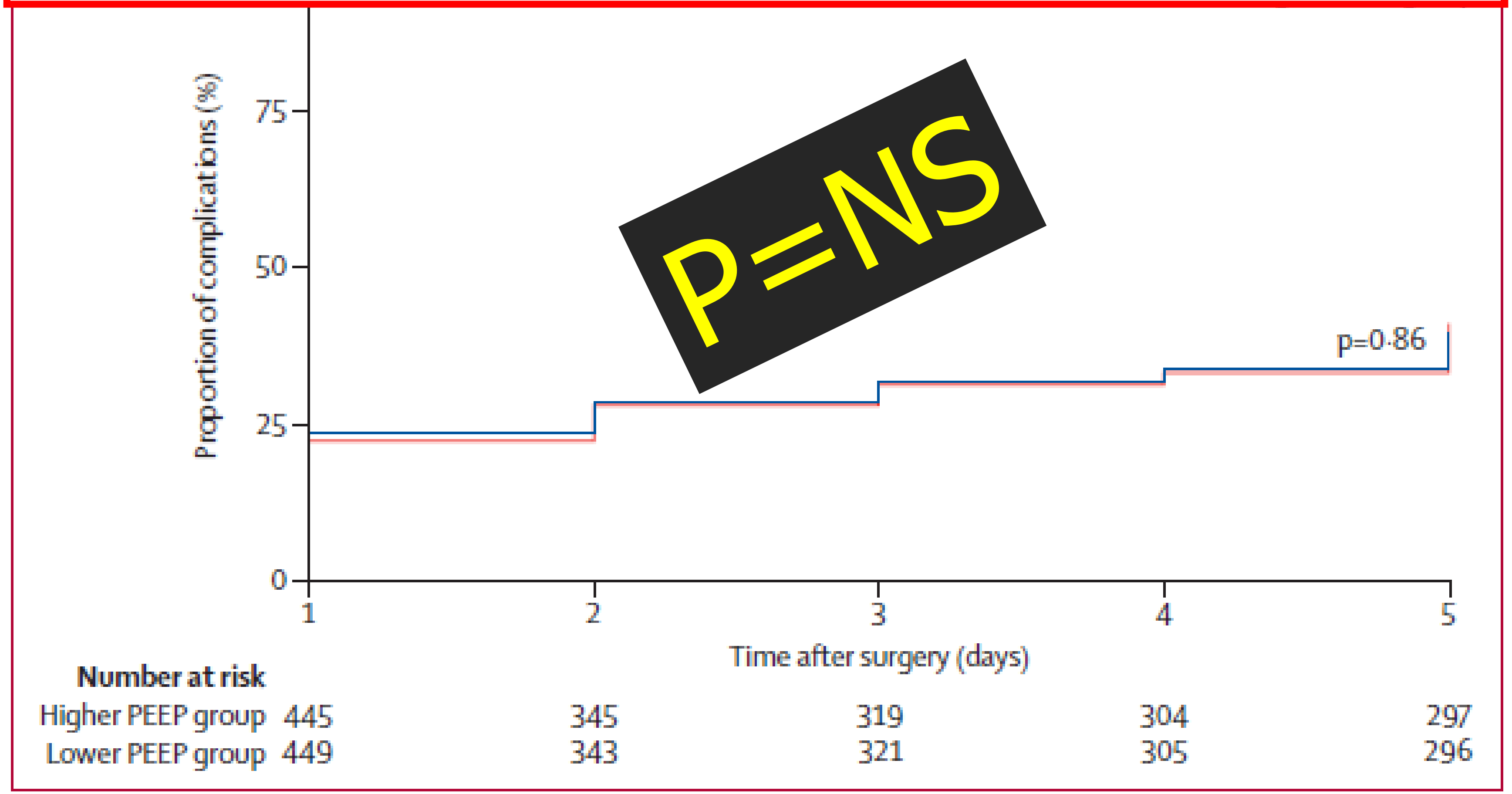
The PROVE Network Investigators for the Clinical Trial Network of the European Society of Anaesthesiology*

Vt = 8 ml/kg IBW



High versus low positive end-expiratory pressure during general anaesthesia for open abdominal surgery (PROVHILO trial): a multicentre randomised controlled trial

The PROVE Network Investigators for the Clinical Trial Network of the European Society of Anaesthesiology*

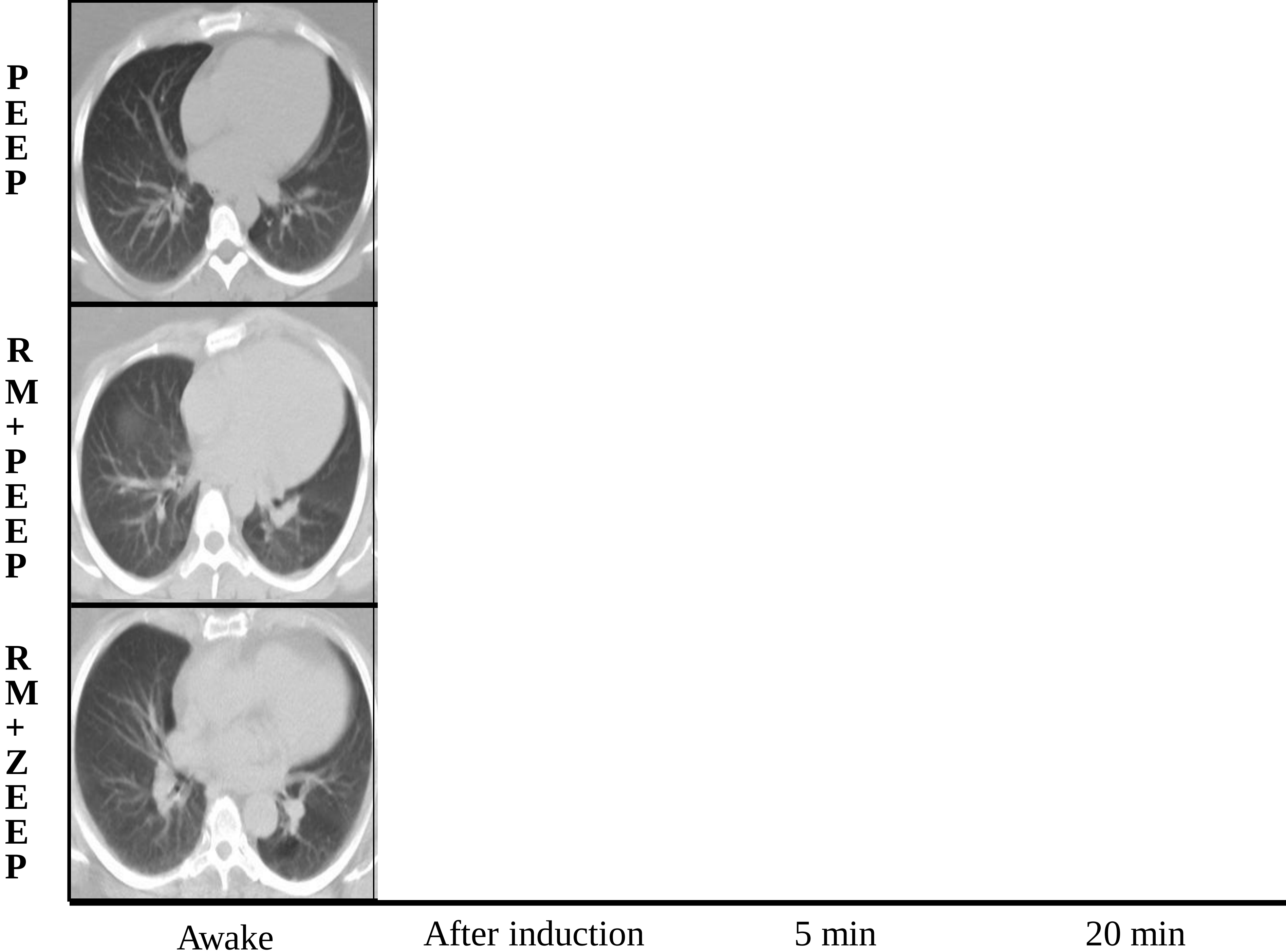


Controversy or complementary results ?

IMPROVE *vs.* PROVILO ?

	IMPROVE trial N=400		PROVHILO trial N=900	
	Non-protective group (n=200)	**Protective group (n=200)**	High PEEP group (n=445)	Low PEEP group (n=449)
VT, ml/kg IBW	**11.1±1.1**	**6.4±0.8**	7.2±1.5	7.1±1.2
PEEP, cmH_2O	**0**	**6 [6-8]**	12 [12-12]	2 [0-2]
RM	**NO**	**CPAP 30-30 Every 30-45 min**	Increase in VT (step of 4 cmH_2O) until a Pplat of 30-35 cmH_2O	NO
		9 [6-12]	After intubation: 99% Before extubation: 85%	
FiO_2, %	**47.2±7.6**	**46.4±7.3**	40 [40-49]	41 [40-50]
Duration of surgery	**2-4 hr: 39.6% 4-6 hr: 39.1% >6 hr: 21.4%**	**2-4 hr: 38.5% 4-6 hr: 39.0% >6 hr: 22.6%**	200 [140-300] min	190 [140-262] min
Laparoscopic surgery	**21 %**		Not included	

PEEP or RM alone are not enough !


PEEP
RM+PEEP
RM+ZEEP
Awake
After induction
5 min
20 min

QUESTION n°2

Quelle est la procédure qui marche le plus et/ou le mieux ?

« petit volume courant » (6 ml/kg)

ou

PEP

ou

Manœuvre de recrutement

Réponse (probable) n°2

Quelle est la procédure qui marche le plus et/ou le mieux ?

« petit volume courant » (6 ml/kg)

~~ou~~ +

PEP

~~ou~~ +

Manœuvre de recrutement

Réponse (probable) n°2

Quelle est la procédure qui marche le plus et/ou le mieux ?

« petit volume courant » (6 ml/kg)

ou X

\+

PEP

ou X

\+

Manœuvre de recrutement

= Association des 3 procédures ++

= VENTILATION PROTECTRICE

Intraoperative Mechanical Ventilation

INTRAOPERATIVE VENTILATOR SETTINGS AND POSTOPERATIVE ACUTE RESPIRATORY DISTRESS SYNDROME:
An individual data meta-analysis of 3,659 patients

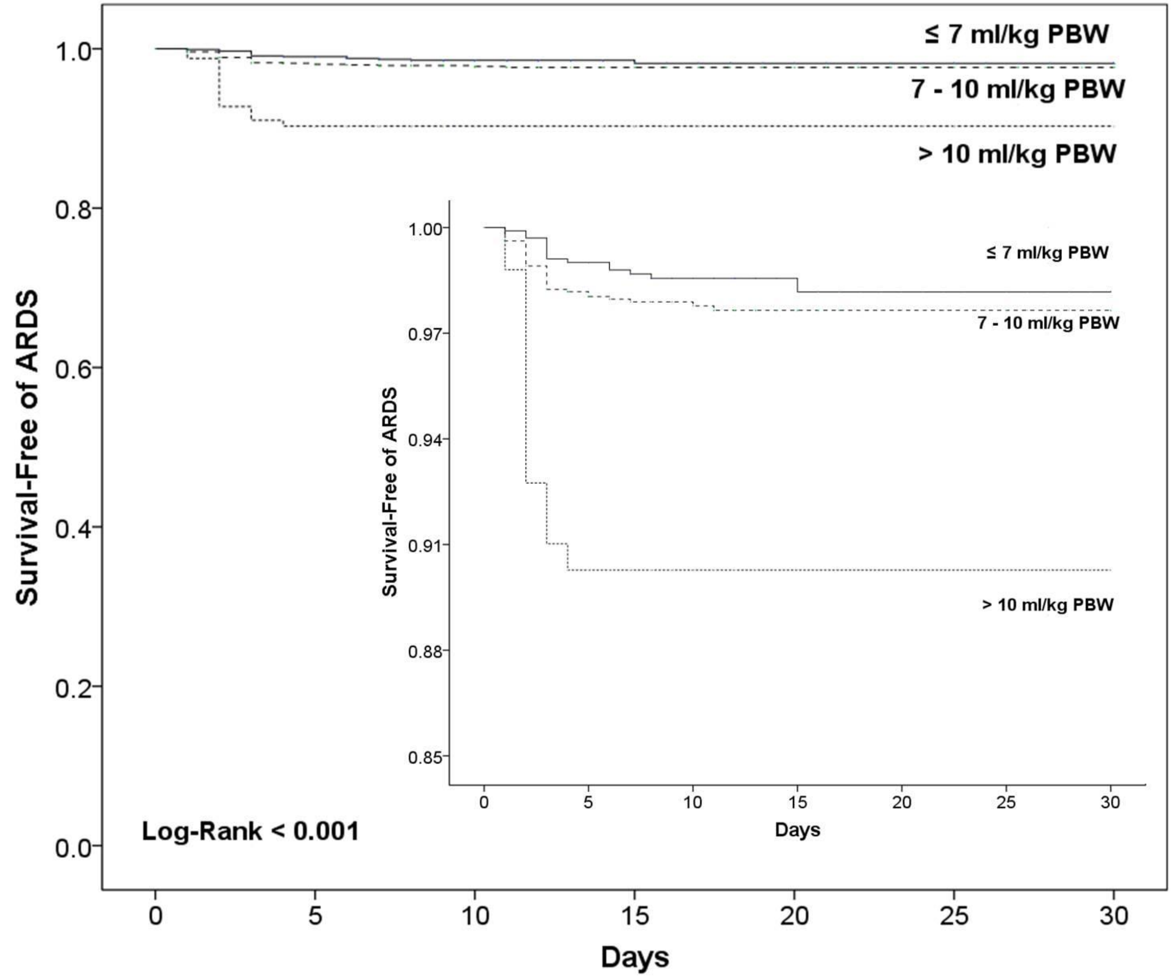
Incidence of mortality and morbidity related to postoperative lung injury in patients who have undergone abdominal or thoracic surgery: a systematic review and meta-analysis

Ary Serpa Neto, Sabrine NT Hemmes, Carmen SV Barbas, Martin Beiderlinden, Ana Fernandez-Bustamante, Emmanuel Futier, Markus W Hollmann, Samir Jaber, Alf Kozian, Marc Licker, Wen-Qian Lin, Pierre Moine, Federica Scavonetto, Thomas Schilling, Gabriele Selmo, Paolo Severgnini, Juraj Sprung, Tanja Treschan, Carmen Unzueta, Toby N Weingarten, Esther K Wolthuis, Hermann Wrigge, Marcelo Gama de Abreu, Paolo Pelosi, Marcus J Schultz, for the the PROVE Network investigators

Serpa Neto et al. LANCET, respiratory 2014.

Intraoperative Mechanical Ventilation

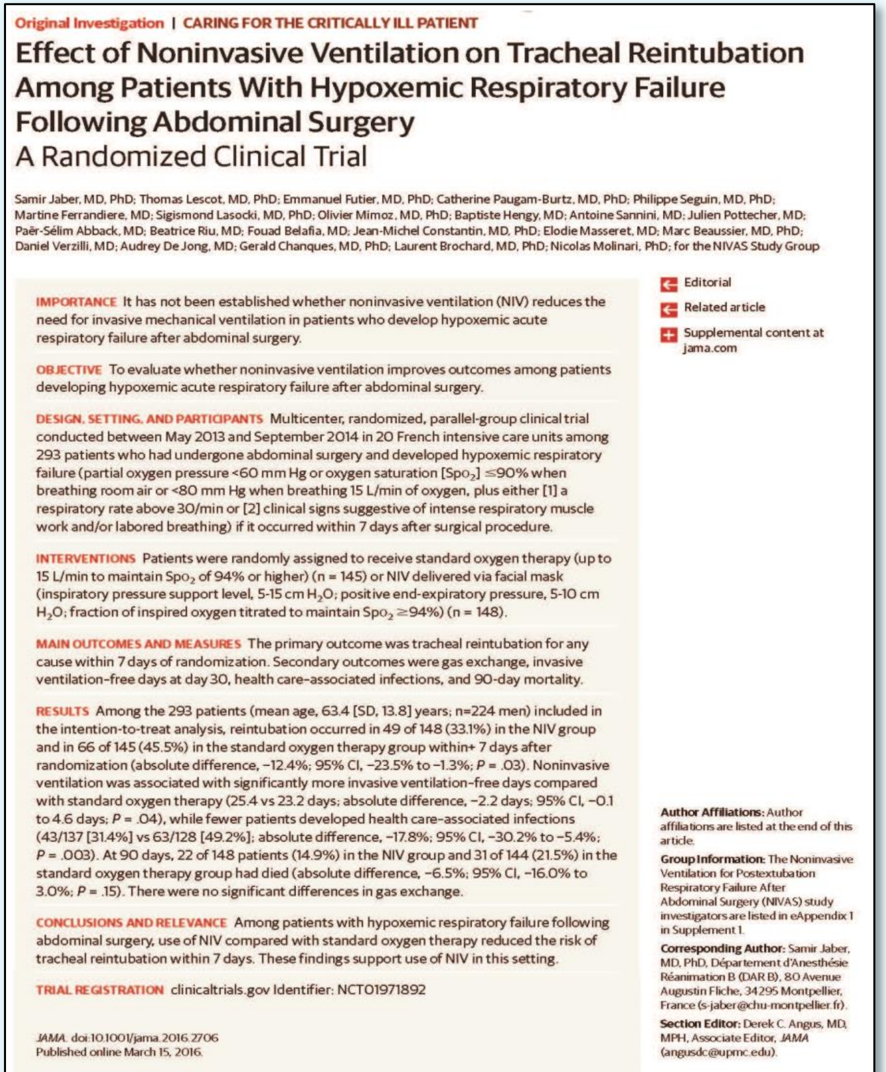
PROTECTIVE
VENTILATION
NETWORK



Number at Risk

	0	5	10	15	20	25	30
≤ 7 ml/kg PBW	1,004	785	429	202	128	92	37
7 – 10 ml/kg PBW	1,512	1,144	674	356	201	139	59
> 10 ml/kg PBW	403	285	179	109	71	48	18

Serpa Neto et al. LANCET, respiratory 2014.



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

IMPORTANCE It has not been established whether noninvasive ventilation (NIV) reduces the need for invasive mechanical ventilation in patients who develop hypoxemic acute respiratory failure after abdominal surgery.

OBJECTIVE To evaluate whether noninvasive ventilation improves outcomes among patients developing hypoxemic acute respiratory failure after abdominal surgery.

DESIGN, SETTING, AND PARTICIPANTS Multicenter, randomized, parallel-group clinical trial conducted between May 2013 and September 2014 in 20 French intensive care units among 293 patients who had undergone abdominal surgery and developed hypoxemic respiratory failure (partial oxygen pressure <60 mm Hg or oxygen saturation [Spo_2] ≤90% when breathing room air or <80 mm Hg when breathing 15 L/min of oxygen, plus either [1] a respiratory rate above 30/min or [2] clinical signs suggestive of intense respiratory muscle work and/or labored breathing) if it occurred within 7 days after surgical procedure.

INTERVENTIONS Patients were randomly assigned to receive standard oxygen therapy (up to 15 L/min to maintain Spo_2 of 94% or higher) (n = 145) or NIV delivered via facial mask (inspiratory pressure support level, 5-15 cm H_2O; positive end-expiratory pressure, 5-10 cm H_2O; fraction of inspired oxygen titrated to maintain Spo_2 ≥94%) (n = 148).

MAIN OUTCOMES AND MEASURES The primary outcome was tracheal reintubation for any cause within 7 days of randomization. Secondary outcomes were gas exchange, invasive ventilation-free days at day 30, health care-associated infections, and 90-day mortality.

RESULTS Among the 293 patients (mean age, 63.4 [SD, 13.8] years; n=224 men) included in the intention-to-treat analysis, reintubation occurred in 49 of 148 (33.1%) in the NIV group and in 66 of 145 (45.5%) in the standard oxygen therapy group within+ 7 days after randomization (absolute difference, −12.4%; 95% CI, −23.5% to −1.3%; *P* = .03). Noninvasive ventilation was associated with significantly more invasive ventilation-free days compared with standard oxygen therapy (25.4 vs 23.2 days; absolute difference, −2.2 days; 95% CI, −0.1 to 4.6 days; *P* = .04), while fewer patients developed health care-associated infections (43/137 [31.4%] vs 63/128 [49.2%]; absolute difference, −17.8%; 95% CI, −30.2% to −5.4%; *P* = .003). At 90 days, 22 of 148 patients (14.9%) in the NIV group and 31 of 144 (21.5%) in the standard oxygen therapy group had died (absolute difference, −6.5%; 95% CI, −16.0% to 3.0%; *P* = .15). There were no significant differences in gas exchange.

CONCLUSIONS AND RELEVANCE Among patients with hypoxemic respiratory failure following abdominal surgery, use of NIV compared with standard oxygen therapy reduced the risk of tracheal reintubation within 7 days. These findings support use of NIV in this setting.

TRIAL REGISTRATION clinicaltrials.gov Identifier: NCT01971892

JAMA. doi:10.1001/jama.2016.2706
Published online March 15, 2016.

Editorial
Related article
Supplemental content at jama.com

Author Affiliations: Author affiliations are listed at the end of this article.

Group Information: The Noninvasive Ventilation for Postextubation Respiratory Failure After Abdominal Surgery (NIVAS) study investigators are listed in eAppendix 1 in Supplement 1.

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

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PRIMARY OUTCOME = Re-intubation at D-7

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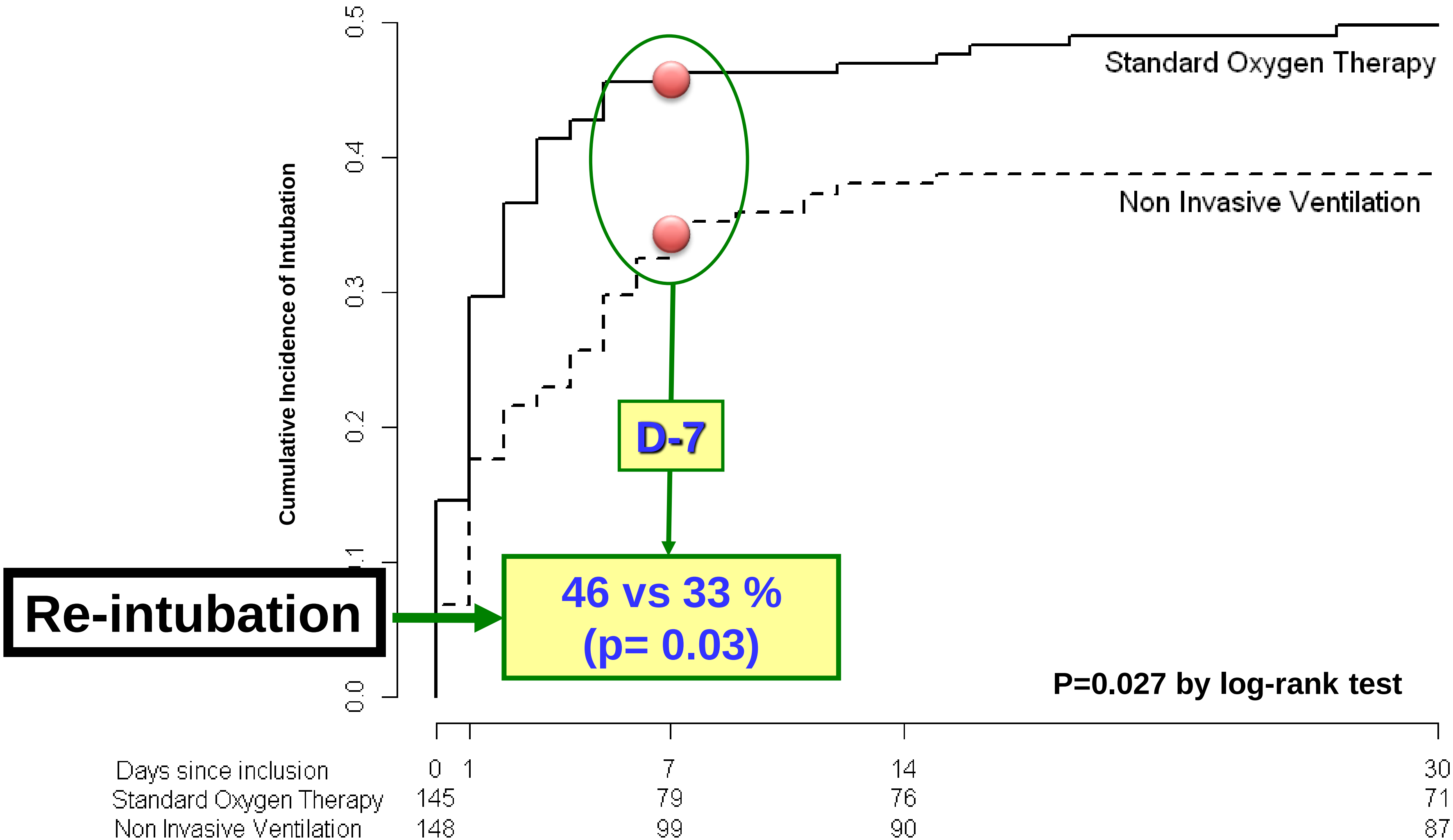
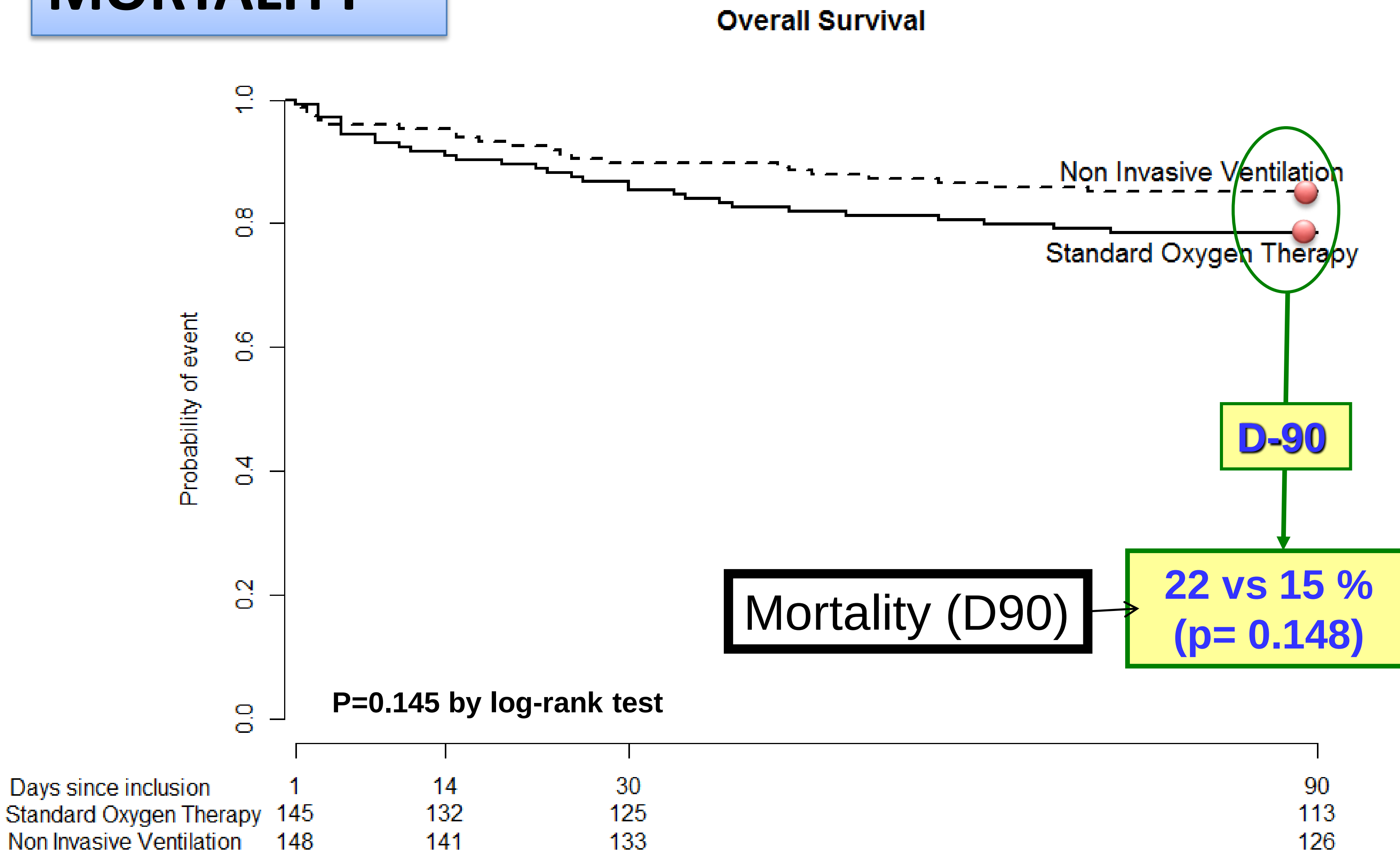


Figure = Kaplan–Meier Plots of the Cumulative Incidence of Intubation from Randomization to Day 30.

MORTALITY



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Objectifs

1. Qui sont les patients à risque?

2. Qu'est ce que la ventilation protectrice et préventive ?

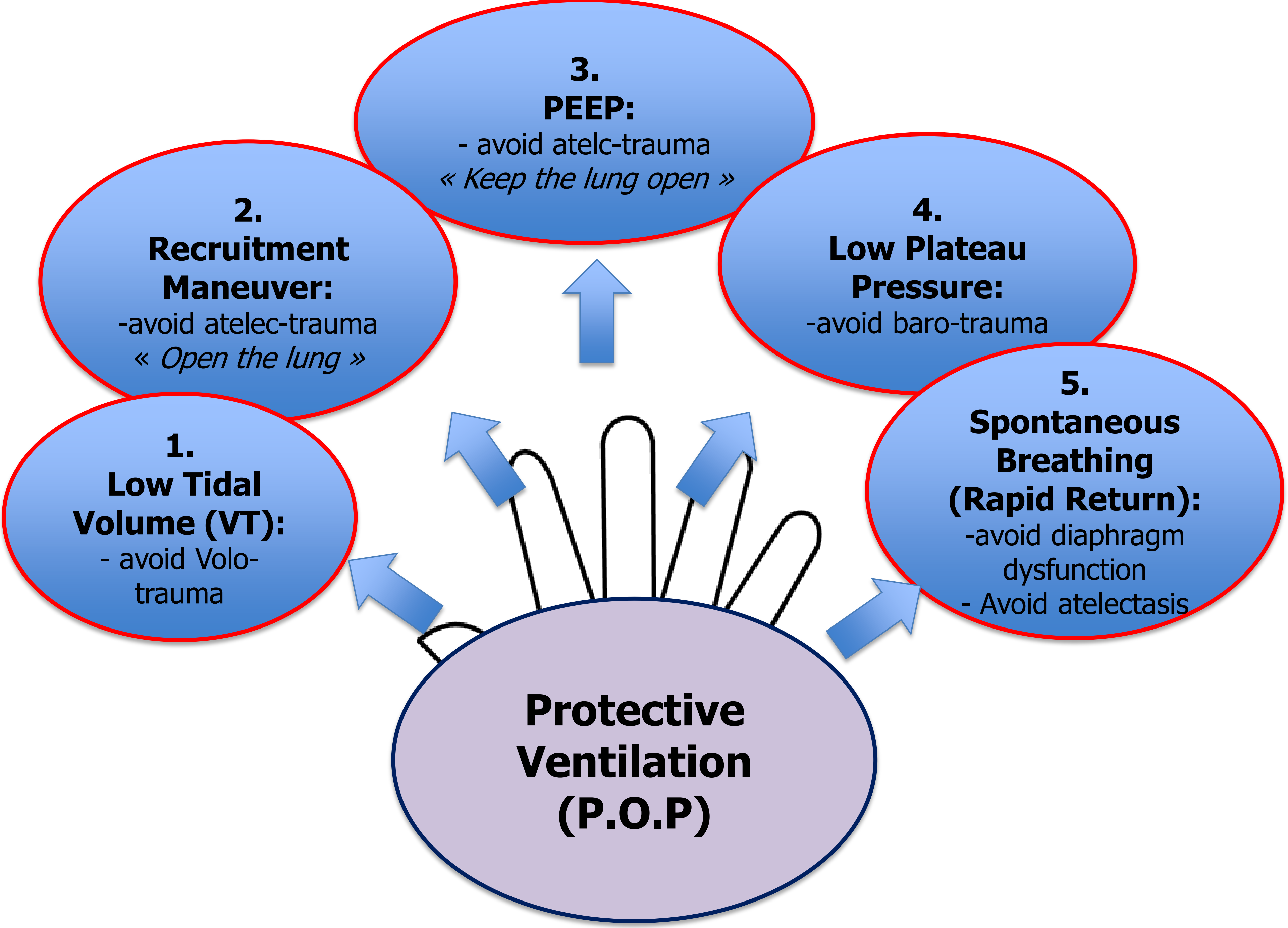
3. Quelles sont les évidences ?

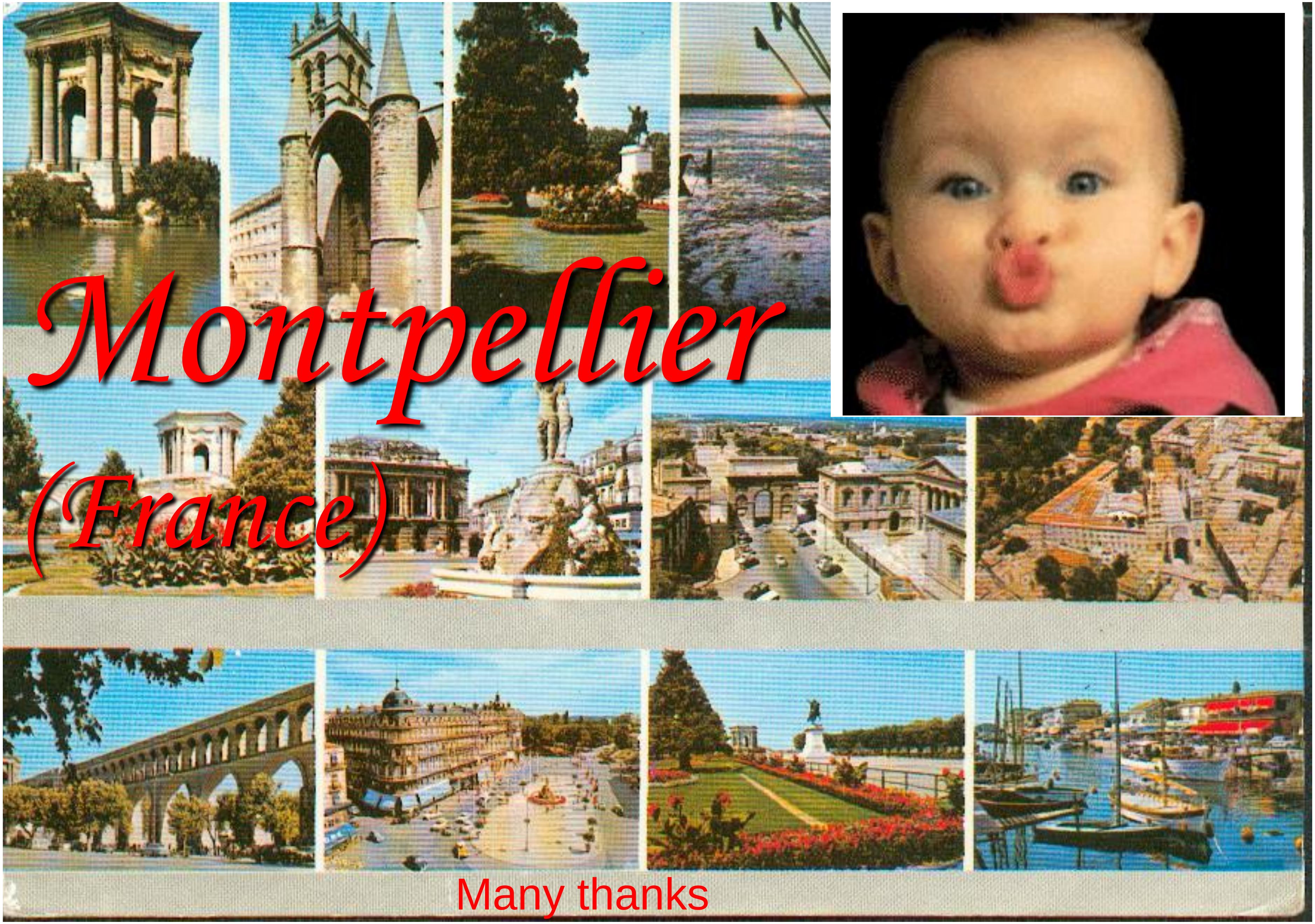
4. Take Home Messages

Take Home Message

5 messages

"Prevention is better than cure"


3.
PEEP:
- avoid atelc-trauma
« Keep the lung open »
2.
Recruitment Maneuver:
-avoid atelec-trauma
« Open the lung »
4.
Low Plateau Pressure:
-avoid baro-trauma
1.
Low Tidal Volume (VT):
- avoid Volo-trauma
5.
Spontaneous Breathing (Rapid Return):
-avoid diaphragm dysfunction
- Avoid atelectasis
Protective Ventilation (P.O.P)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Many thanks