Чи є протективна вентиляція стратегією, що попереджає розвиток післяопераційних легеневих ускладнень?

С.Воротинцев

Запорізький державний медичний університет

Київ
23 квітня 2015

No conflict of interests

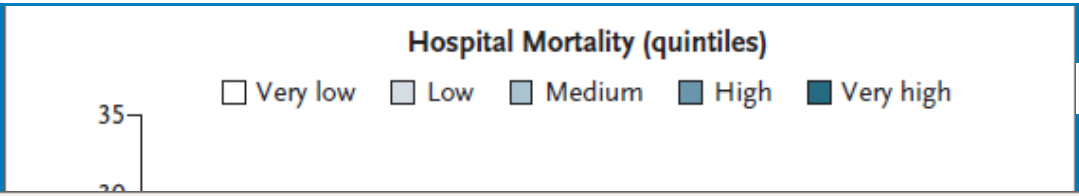
Annual figures for the European high-risk surgical population

Ghaferi A. N Engl J Med 2009; 361: 1368-75
Weiser T Lancet 2008; 372: 139-144; Pearse R Crit Care 2006; 10: R81

- 20 million in-patient general procedures
- 2.6 million high-risk procedures
- 1.3 million patients develop complications
- > 300,000 deaths in hospital

Variation in Hospital Mortality Associated with Inpatient Surgery

Amir A. Ghaferi, M.D., John D. Birkmeyer, M.D.,
and Justin B. Dimick, M.D., M.P.H.



N Engl J Med 2009;361:1368-75.

Table 2. Incidence of Major Complications and Mortality after Complications, According to Hospital Quintile of Mortality.

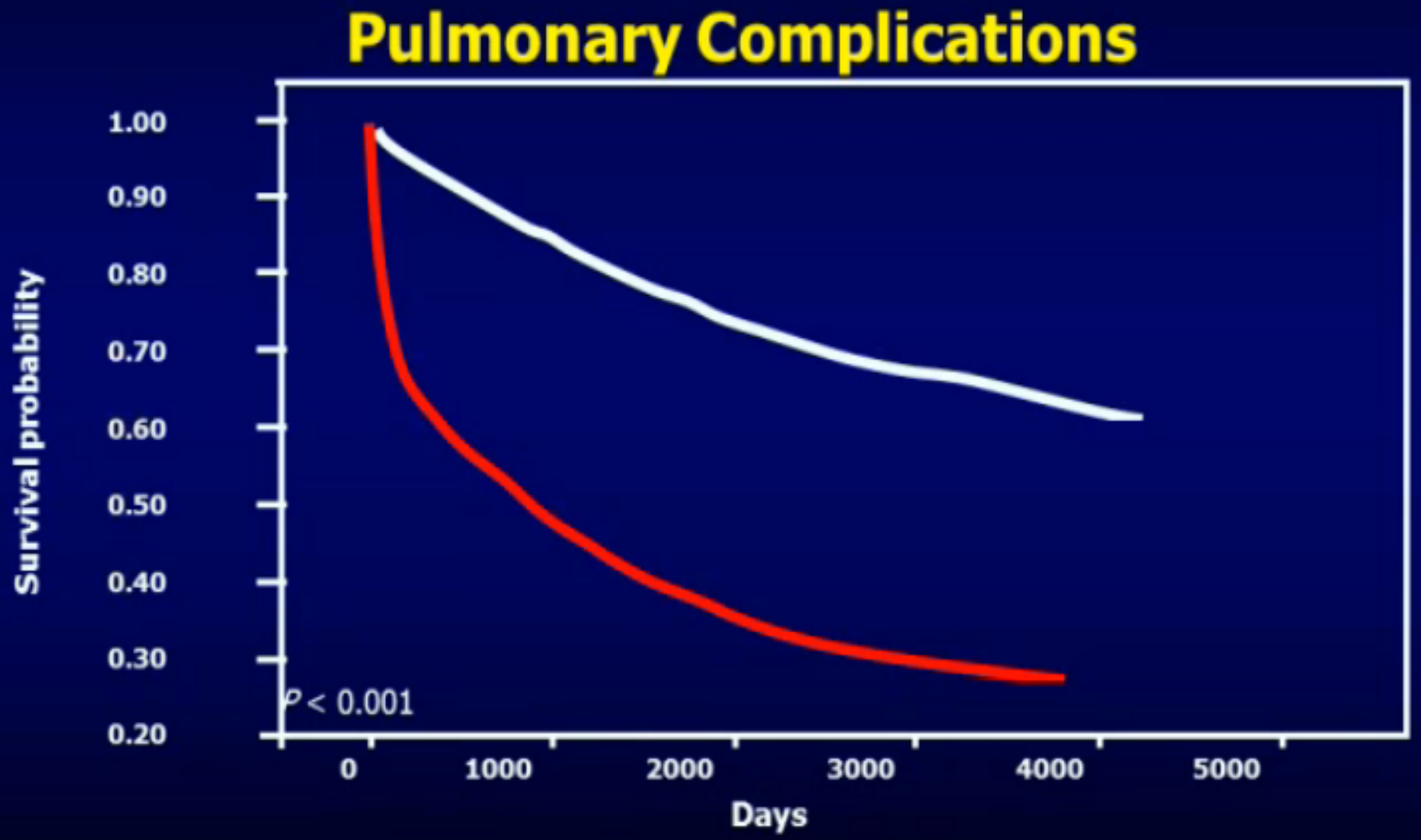
Variable	Very Low Mortality	Low Mortality	Medium Mortality	High Mortality	Very High Mortality	Odds Ratio for Very High vs. Very Low Mortality (95% CI)
	percent of patients					
Incidence of complication						
Pneumonia	2.0	2.4	1.8	2.4	2.1	1.06 (0.70–1.60)
Mechanical ventilation >48 hr	6.6	7.1	6.3	7.0	8.1	1.24 (0.99–1.56)
Mortality after major complication						
Pneumonia	16.5	15.9	20.6	17.0	25.5	1.73 (1.22–2.44)
Mechanical ventilation >48 hr	20.6	23.1	28.7	27.3	31.0	1.73 (1.36–2.20)

Figure 1. Rates of All Complications, Major Complications, and Death after Major Complications, According to Hospital Quintile of Mortality.

Although rates of all complications and major complications did not vary significantly across hospital mortality quintiles, the rate of death in patients with major complications was almost twice as high in hospitals with very high overall mortality as in those with very low overall mortality (21.4% vs. 12.5%, P<0.001).

Determinants of Long-Term Survival After Major Surgery and the Adverse Effect of Postoperative Complications

Khuri SF et al. Ann Surg 2005;242: 326–343



Anesthesiology 2010; 113:1338–50

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Prediction of Postoperative Pulmonary Complications in a Population-based Surgical Cohort

Jaume Canet, M.D., Ph.D.,* Lluís Gallart, M.D., Ph.D.,† Carmen Gomar, M.D., Ph.D.,‡ Guillem Paluzie, M.D.,§ Jordi Vallès, M.D.,† Jordi Castillo, M.D., Ph.D.,† Sergi Sabaté, M.D., Ph.D.,‖ Valentín Mazo, M.D.,# Zahara Briones, M.Math.,** Joaquín Sanchis, M.D., Ph.D.††; on behalf of the ARISCAT Group‡‡

High or intermediate risk for postoperative pulmonary complications following surgery: ARISCAT risk score ≥ 26

13% (score 26 – 44) – 54% (score > 45) risk to develop PPCs

Assess Respiratory Risk in Surgical Patients in Catalonia

	Multivariate Analysis OR (95% CI) n = 1,624*	β Coefficient	Risk Score†
Age, yr			
≤50	1		
51–80	1.4 (0.6–3.3)	0.331	3
>80	5.1 (1.9–13.3)	1.619	16
Preoperative Spo_2, %			
≥96	1		
91–95	2.2 (1.2–4.2)	0.802	8
≤90	10.7 (4.1–28.1)	2.375	24
Respiratory infection in the last month	5.5 (2.6–11.5)	1.698	17
Preoperative anemia (≤10 g/dl)	3.0 (1.4–6.5)	1.105	11
Surgical incision			
Peripheral	1		
Upper abdominal	4.4 (2.3–8.5)	1.480	15
Intrathoracic	11.4 (4.9–26.0)	2.431	24
Duration of surgery, h			
≤2	1		
>2 to 3	4.9 (2.4–10.1)	1.593	16
>3	9.7 (4.7–19.9)	2.268	23
Emergency procedure	2.2 (1.0–4.5)	0.768	8

European Society of Anaesthesiology

Periscope

	PERISCOPE (5384)	ARISCAT (2464)	P value
PPCs	424 (7.9%)	123 (5.0)	P<0.001
Postoperative respiratory failure	**246** [4.6%]	63 (2.6)	P<0.001
(167 mild [3.1%], 49 intermediate [0.9%], 30 severe [0.6%; ALI/ARDS])		----------	
Pleural effusion	**163** (3.0%)	43 (1.7)	P=0.001
Atelectasis	**124** (2.3%)	35 (1.4)	P=0.011
Suspected pulmonary infection	**123** (2.3%)	40 (1.6)	P=0.053
Suspected pulmonary infiltrate	**121** (2.2%)	----------	
Bronchospasm	**42** (0.8%)	44 (1.8)	P<0.001
Cardiogenic pulmonary oedema	**40** (0.7%)	----------	
Pneumothorax	**30** (0.6%)	8 (0.3)	P=0.120
Aspiration pneumonitis	**12** (0.2%)	9 (0.4)	P=0.170

Prospective Evaluation of a RIsk Score for postoperative pulmonary COmPlications in Europe

Strategies to prevent postoperative pulmonary complications

Guldner, Pelosi, Gama de Abreu Curr Opin Anesthesiol 2013, 26:141–151

Preoperatively

- Assess general physical status and identify risk factors
  - Preoperative SpO_2
  - Measurement of albumin
- Preoperative "optimization"
  - Cessation of smoking?
  - Treat infection and/or bronchospasm
  - Alleviate anemia
- Education regarding physiotherapy

Strategies to prevent postoperative pulmonary complications

Guldner, Pelosi, Gama de Abreu Curr Opin Anesthesiol 2013, 26:141–151

Postoperatively

- Selective use of nasogastric tube
  - If PONV
  - Inability to oral feeding
  - Abdominal distension
- Effective pain management and minimize respiratory depression
- Early postoperative respiratory therapy
  - Incentive deep breathing
  - Early use of CPAP or BiPAP
- Early hydration, mobilization of secretions and ambulation

Strategies to prevent postoperative pulmonary complications

Guldner, Pelosi, Gama de Abreu Curr Opin Anesthesiol 2013, 26:141–151

Intraoperatively

- Anaesthetic/surgical plan
  - Consider regional anesthesia for pain control
  - Consider laryngeal mask
  - Choose short-acting drugs/avoid PORC
  - Limit duration of surgery
  - If feasible use laparoscopic techniques
  - Reduce emergent surgery
- Ventilatory strategies
  - Protective ventilation (Low tidal volume 6-8 ml/kg IBW/PEEP)
  - Limit high oxygen concentrations
  - Maintain $PaCO_2$

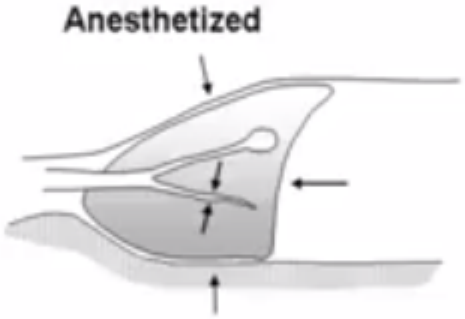
Ventilator-induced Lung Injury in Healthy and Diseased Lungs

Better to Prevent than Cure!

Paolo Pelosi, M.D.,* Patricia R. M. Rocco, M.D., Ph.D.

Anesthesiology 2011; 115:923–5

"... the experimental data provided suggest that nonprotective ventilation in healthy lungs makes the lungs weaker."

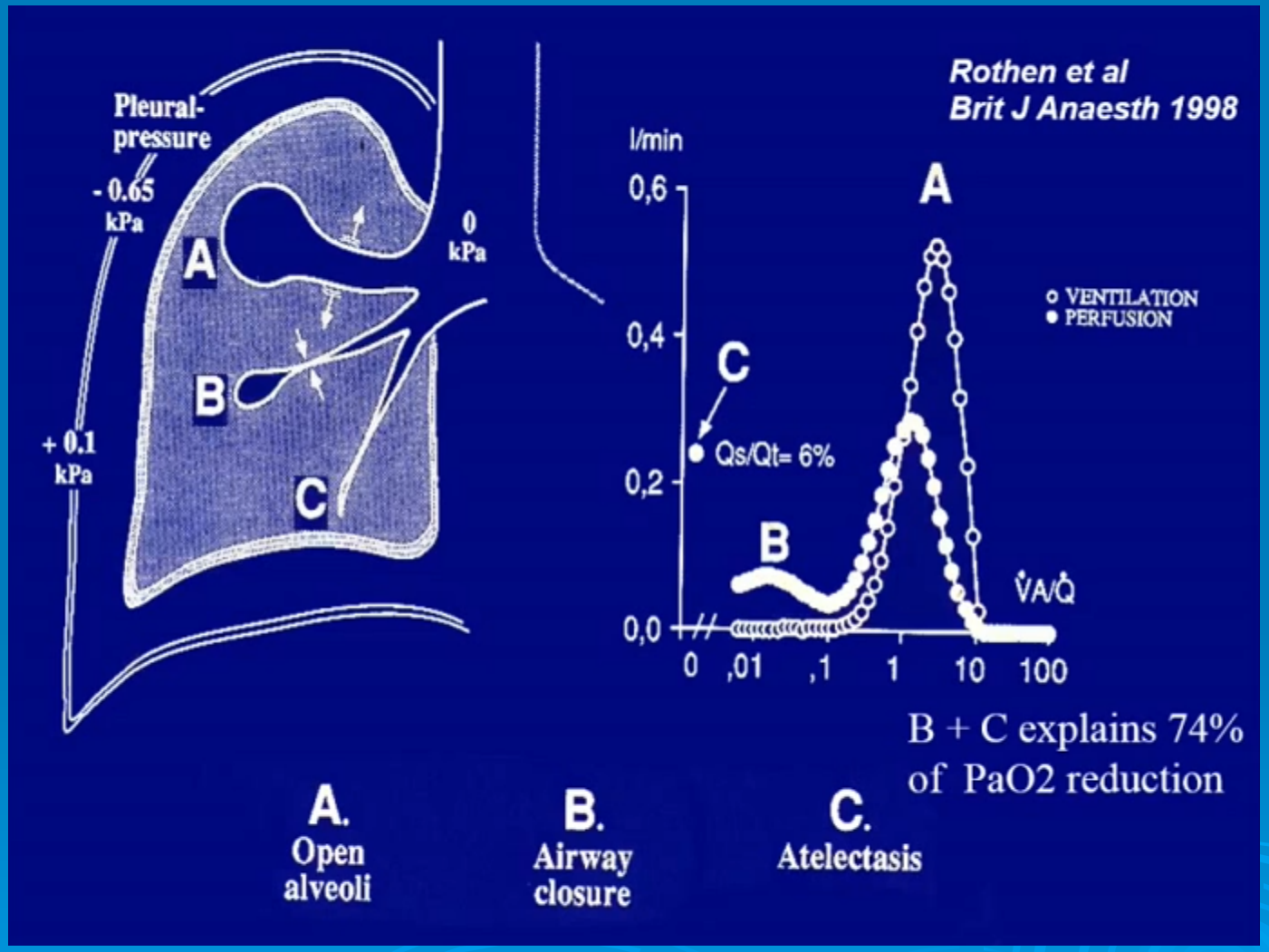


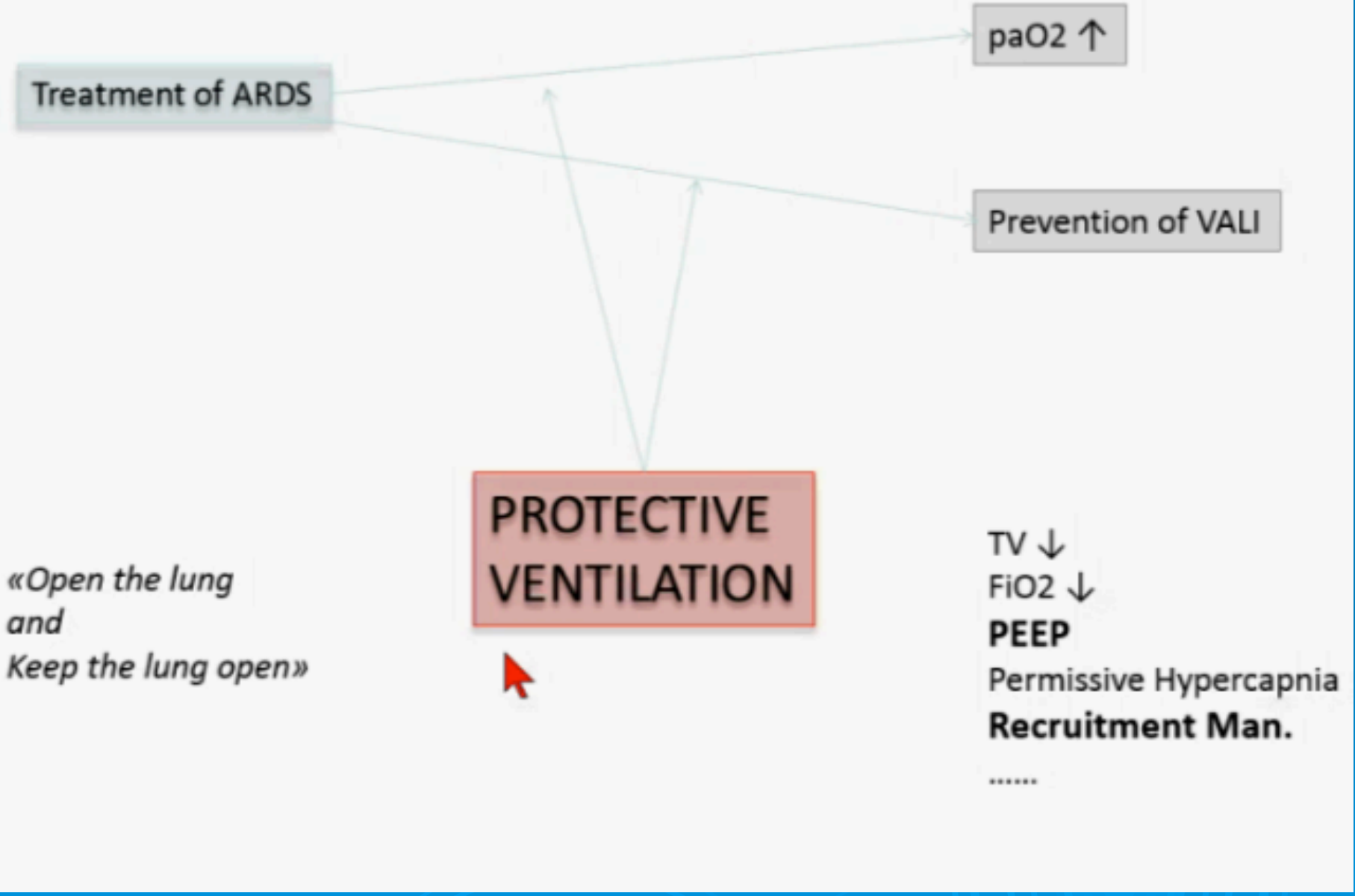
Anesthesia

1. FRC ↓ loss of tone
2. C_{lung} ↓ smaller volume
3. Raw ↑ reduced airway dimensions

→ airway closure
→ atelectasis

Hedenstierna, in Miller´s Anesthesia 2009


Rothen et al
Brit J Anaesth 1998
Pleural-
pressure
- 0.65
kPa
+ 0.1
kPa
0
kPa
A
B
C
l/min
0,6
0,4
0,2
0,0
Qs/Qt= 6%
VENTILATION
PERFUSION
V̇A/Q̇
0
,01
,1
1
10
100
B + C explains 74%
of PaO2 reduction
A.
Open
alveoli
B.
Airway
closure
C.
Atelectasis

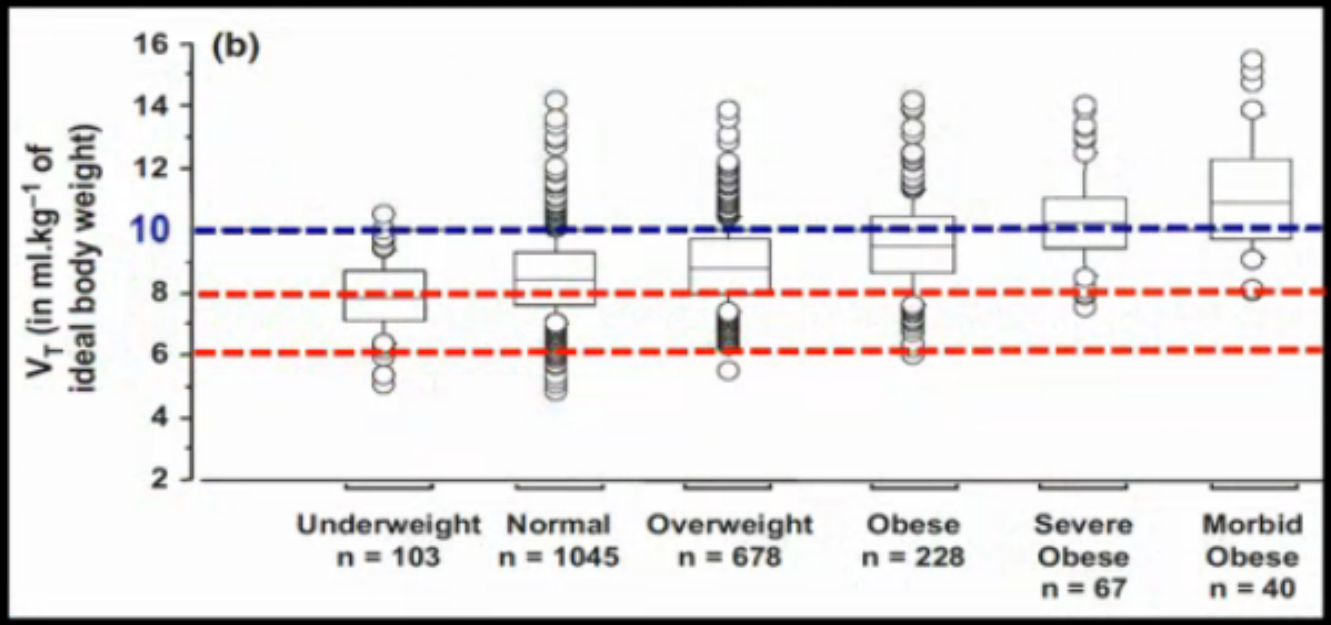

Treatment of ARDS
paO2 ↑
Prevention of VALI
PROTECTIVE VENTILATION
«Open the lung and Keep the lung open»
TV ↓
FiO2 ↓
PEEP
Permissive Hypercapnia
Recruitment Man.
.....

VALI: TV

A multicentre observational study of intraoperative ventilatory management during general anaesthesia: tidal volumes and relation to body weight

Jaber S et al. Anaesthesia 2012; 67, 999–1008

2161 patients between January and June 2006 in 97 anaesthesia units from 49 French hospitals



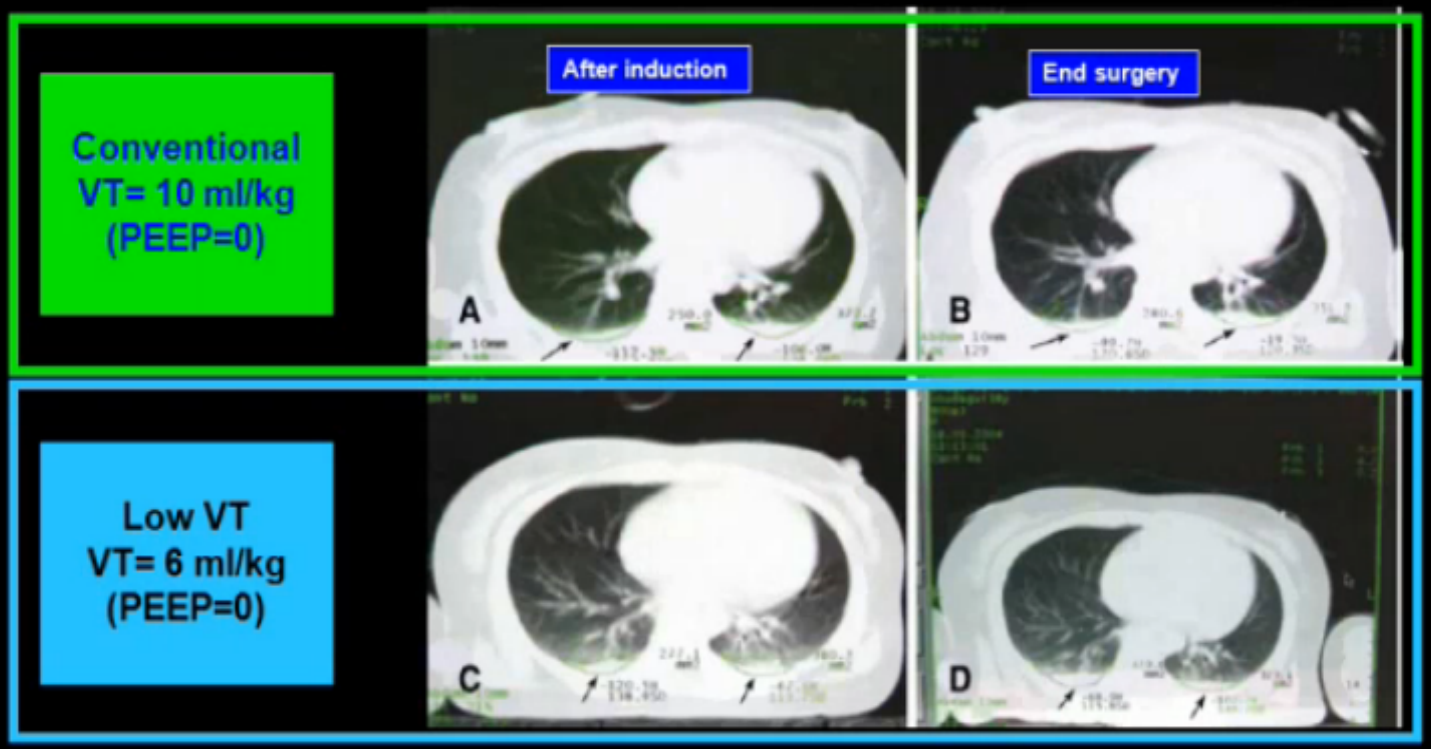
- **Approximately 30% of patients still ventilated with $V_T \geq 10$ ml.kg^{-1} IBW**
- **Female sex and BMI were independently associated with the use of high V_T**

VALI: TV

Low tidal volume does not promote atelectasis during general anesthesia

Hongwei C et al J Clinical Anesthesia 2007; 19:125-129

Atelectasis, as well as alveolar gas exchange, were comparable in patients with 6 or 10 mL/kg

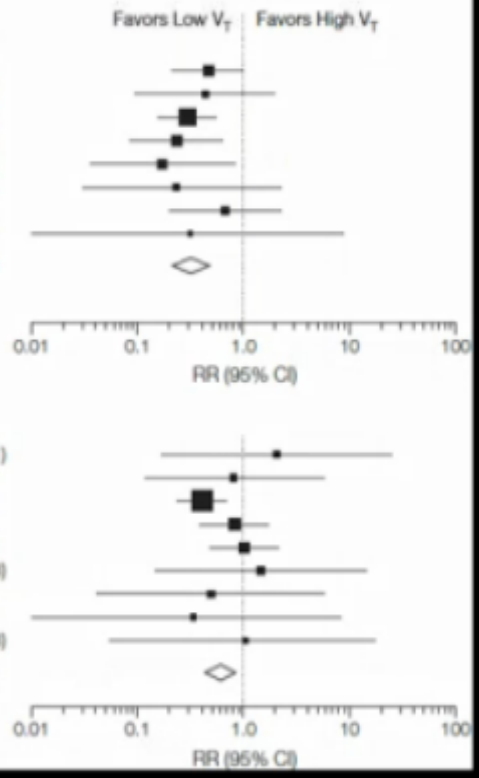


VALI: TV

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: $\chi^2_8=3.74$; $P=.81$, $I^2=0\%$						
Test for overall effect: $z=6.06$; $P<.001$						
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: $z=2.68$; $P=.007$						



VALI: TV

European Society of Anaesthesiology ESA

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  - Documents
  - Status

PROVHILO

PROVHILO: Protective Ventilation During General Anesthesia for Open Abdominal Surgery – a Randomized Controlled Trial

Tidal volume setting

- Ideal Body Weight: IBW (Lorentz) :

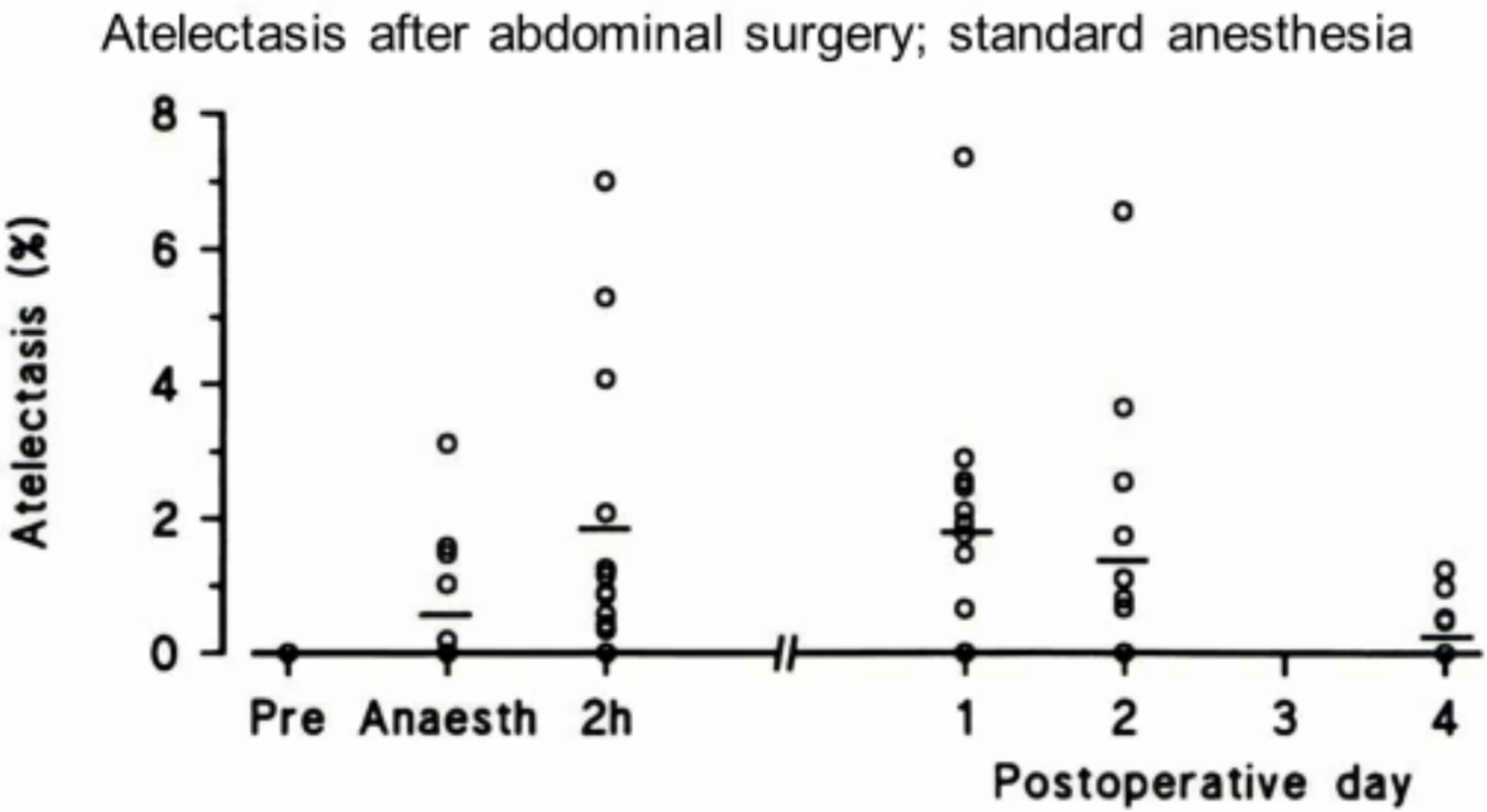
  IBW = X + 0,91 (height in cm - 152,4)
  - Female : X = 45, 5
  - Male : X = 50

Easier to remember !!

- IBW (kg) = Height (cm) - 100 in MALE
- IBW (kg) = Height (cm) - 110 in FEMALE

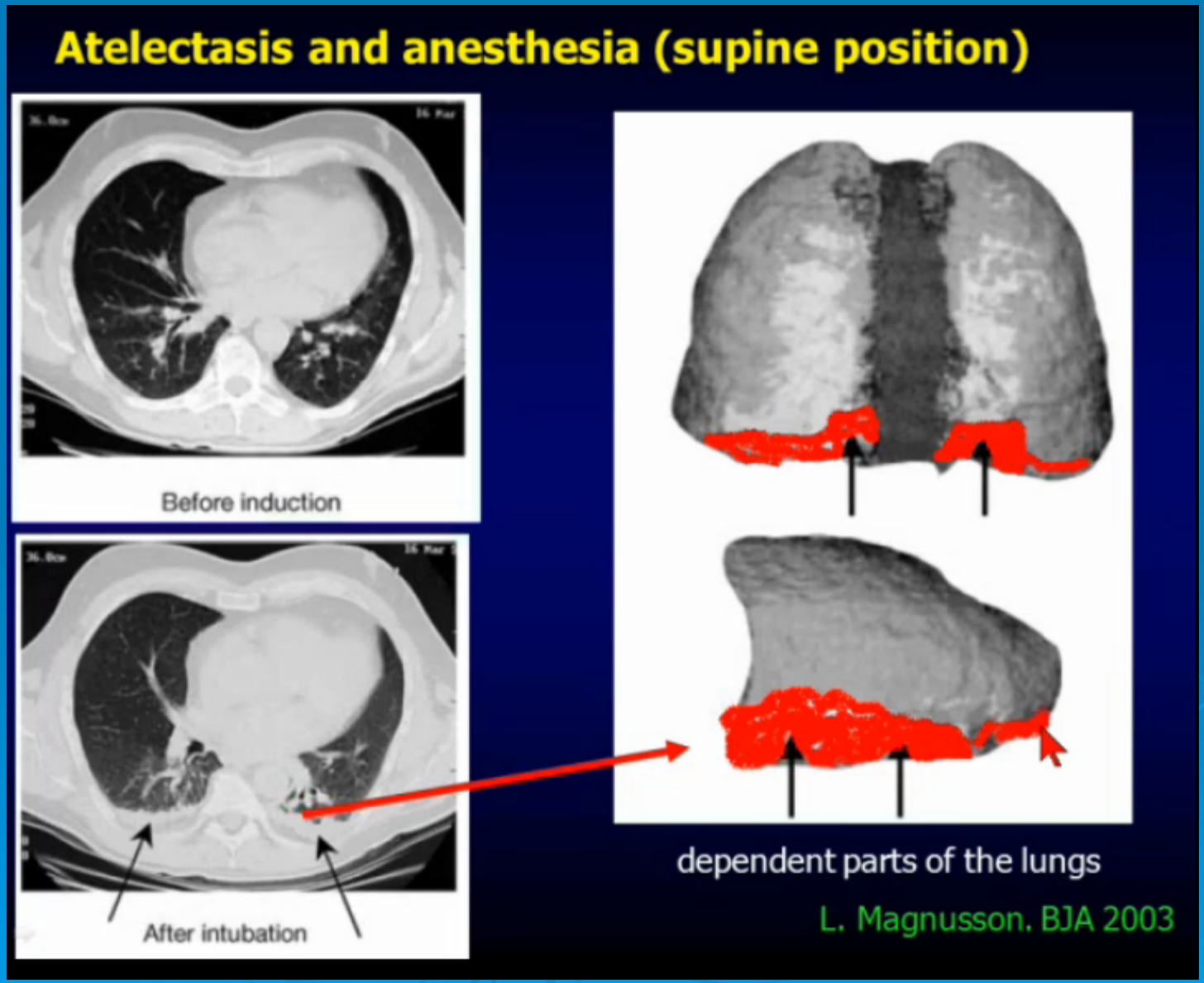
Prev data:
BMI < 40 kg/m2 – TV = 7 ml/kg IBM
P Pelosi, Stockholm 2014

VALI: ателектазы

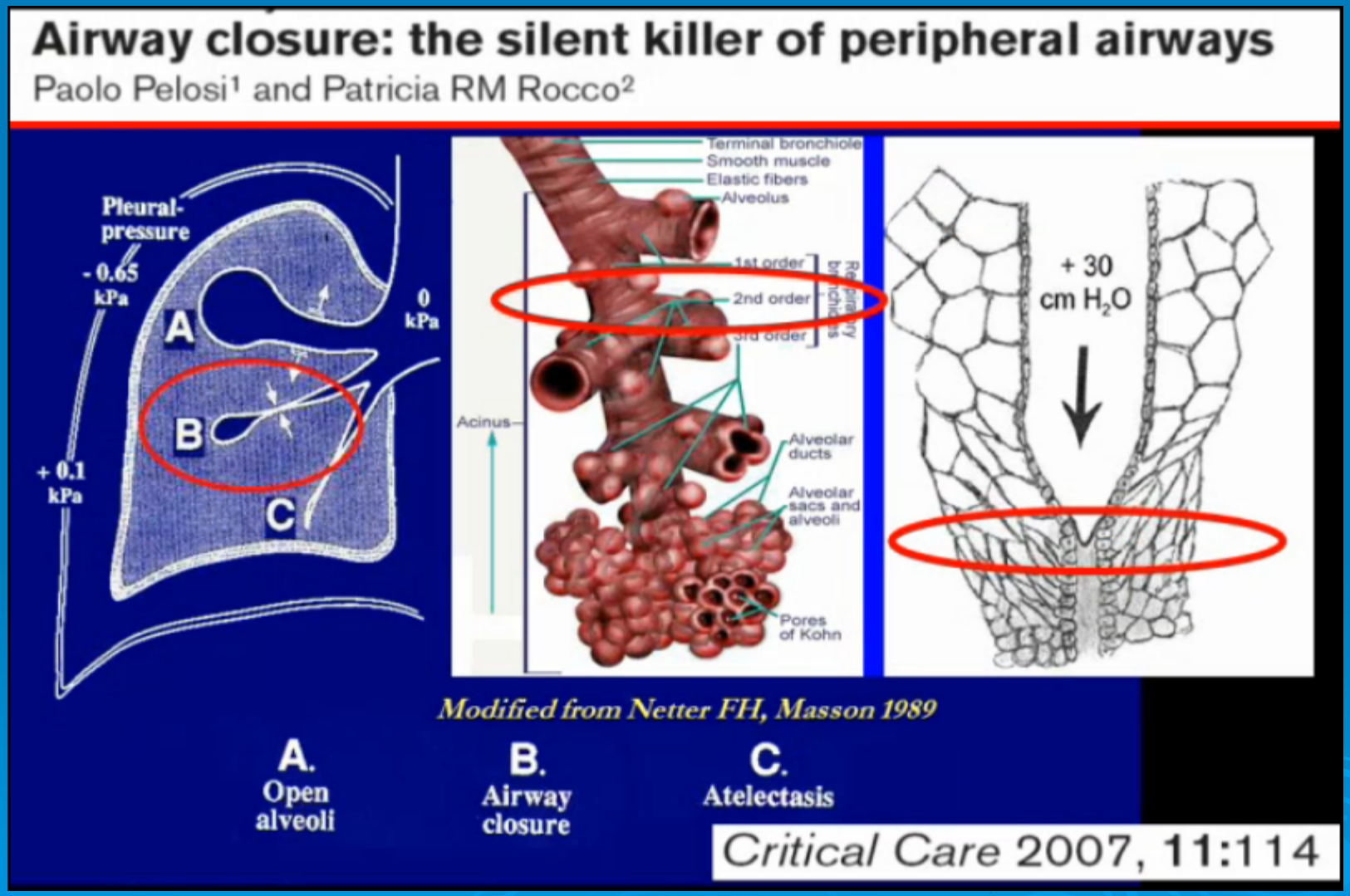


Lindberg et al Acta Anaesthesiol Scandinav 1992

VALI: ателектазы



VALI: закрытие дыхательных путей



What to do ?

Pelosi P, Gregoretti C. Best Pract Res Clin Anaesthesiol. 2010 Jun;24(2):211-25

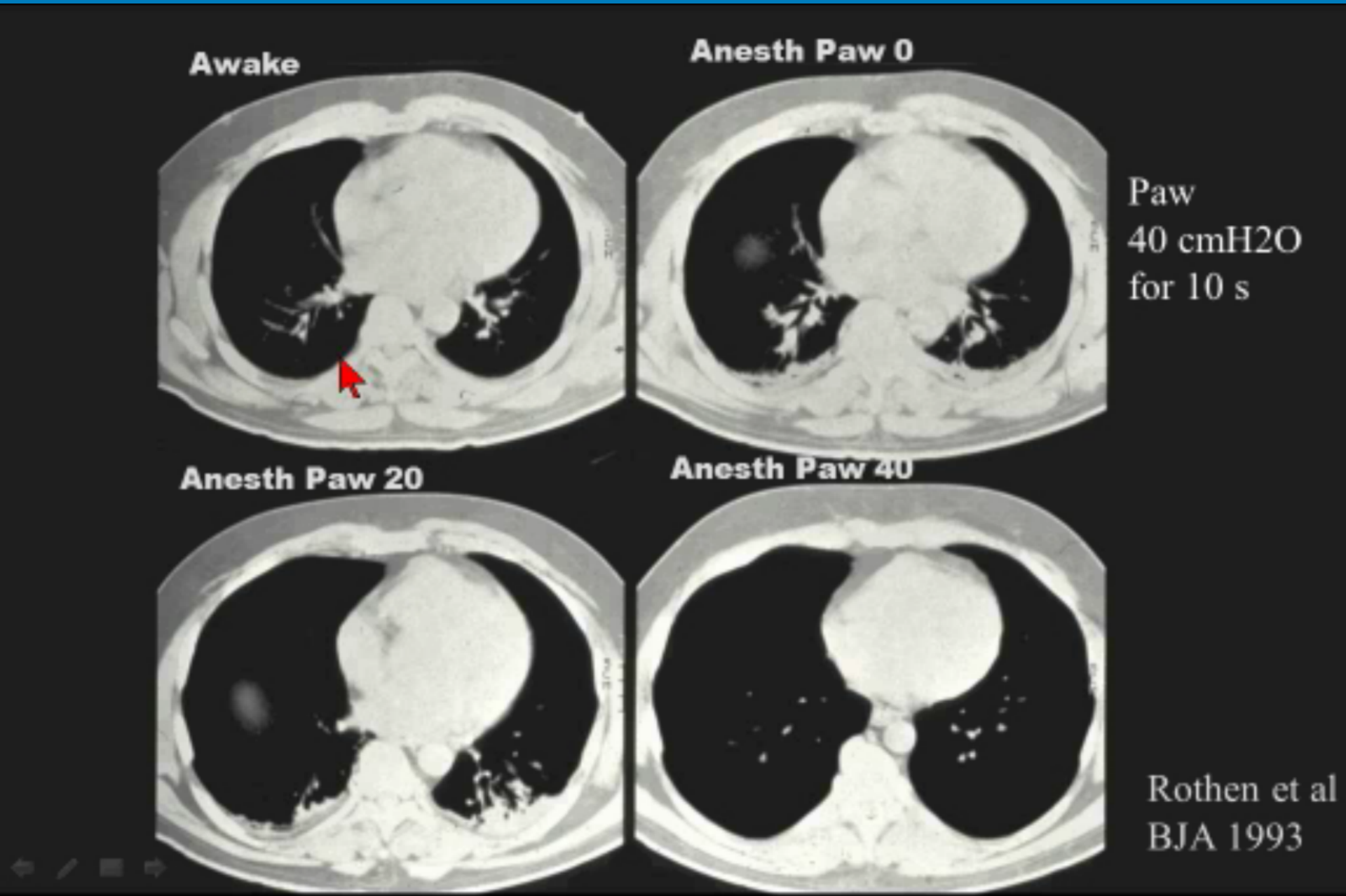
Airway closure

- Low Tidal Volume (<10 ml/Kg IBW)
- PEEP (to raise EELV)

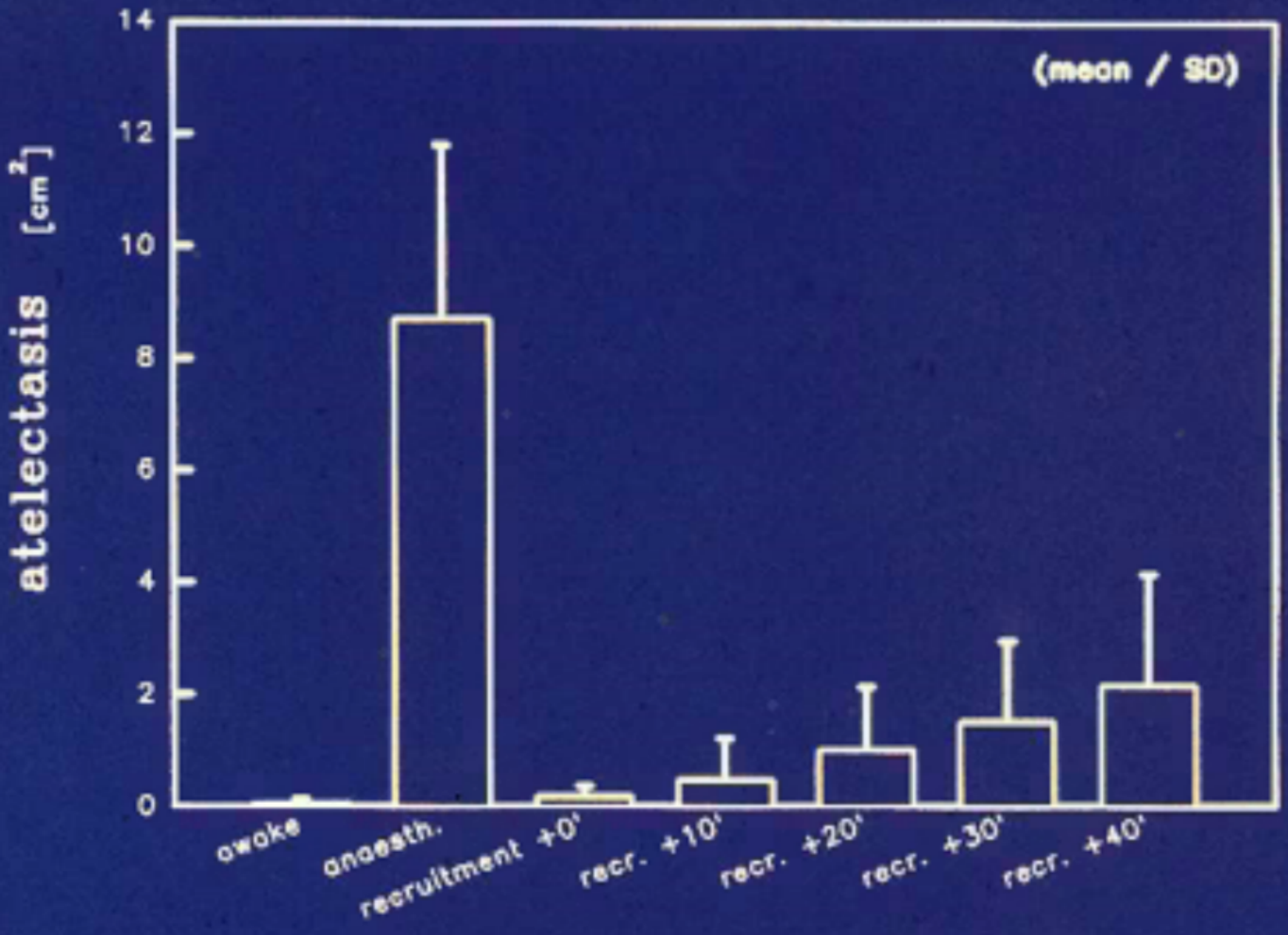
Atelectasis

- Recruitment
- PEEP (keep the lung open)
- Avoid high F_IO_2 (<0.8)

Paw


Awake
Anesth Paw 0
Anesth Paw 20
Anesth Paw 40
Paw
40 cmH2O
for 10 s
Rothen et al
BJA 1993

RM

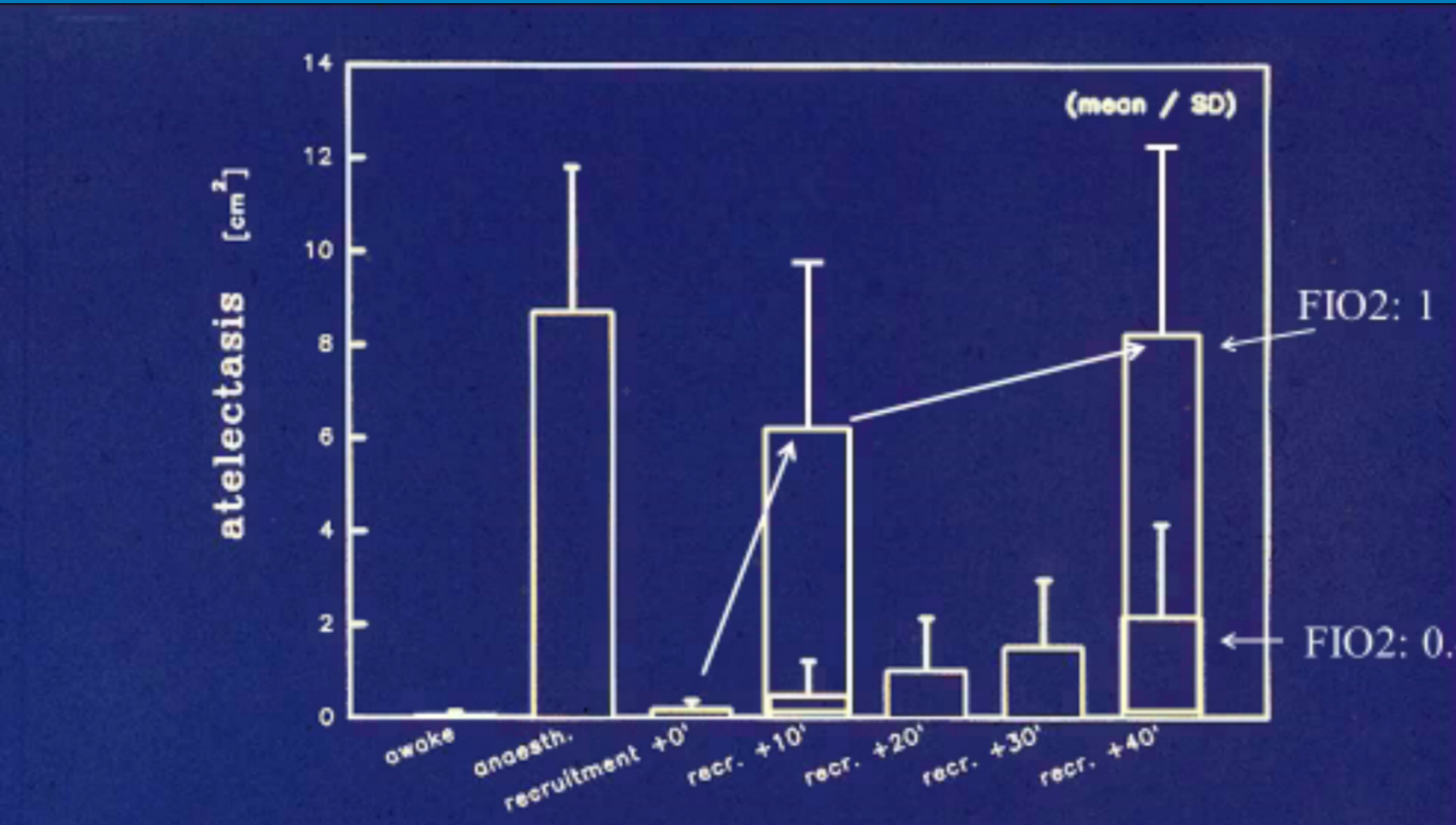


FIO2: 0.4

Rothen, BJA 1993

Atelectasis before and after Recruitment Manoeuvre

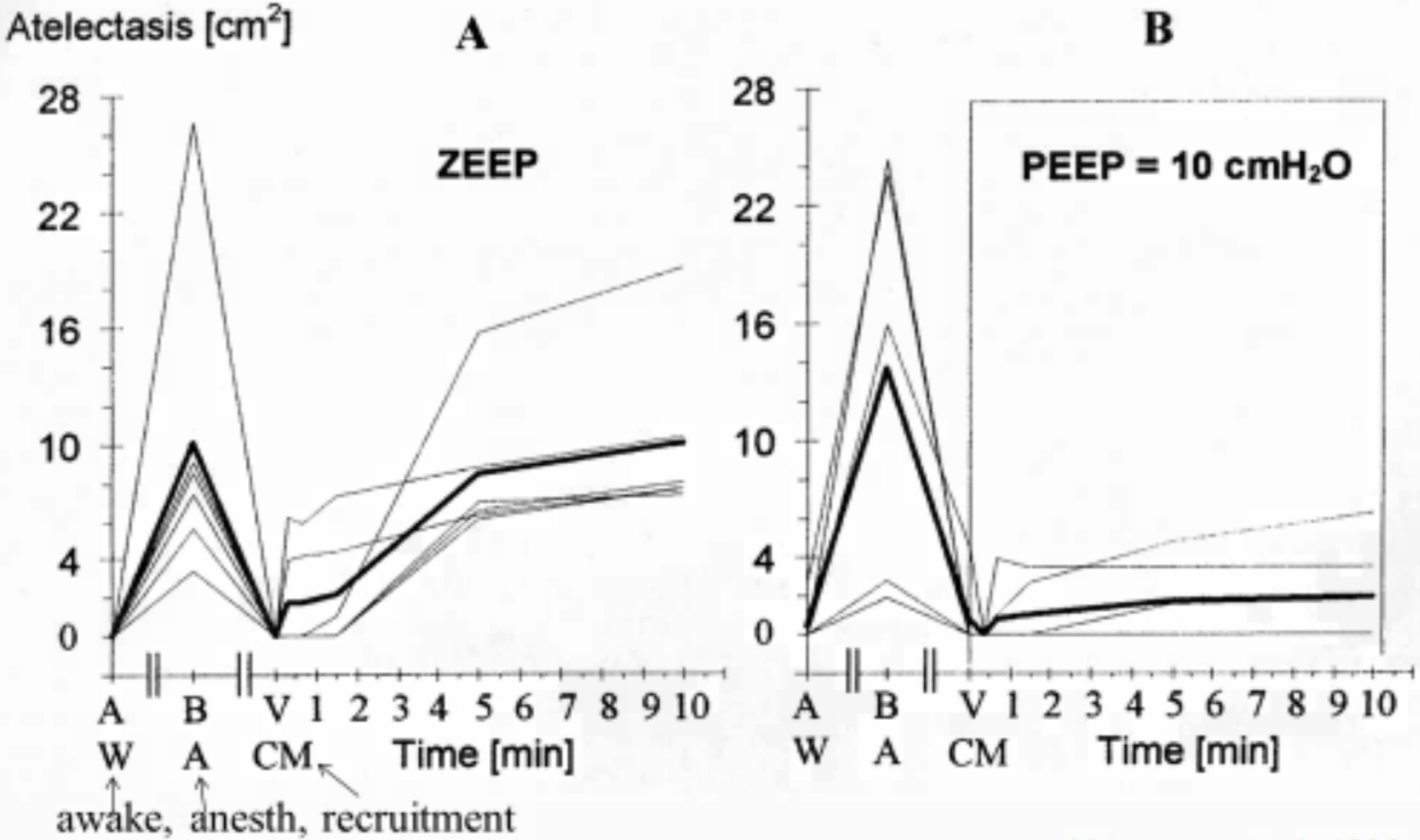
FiO2



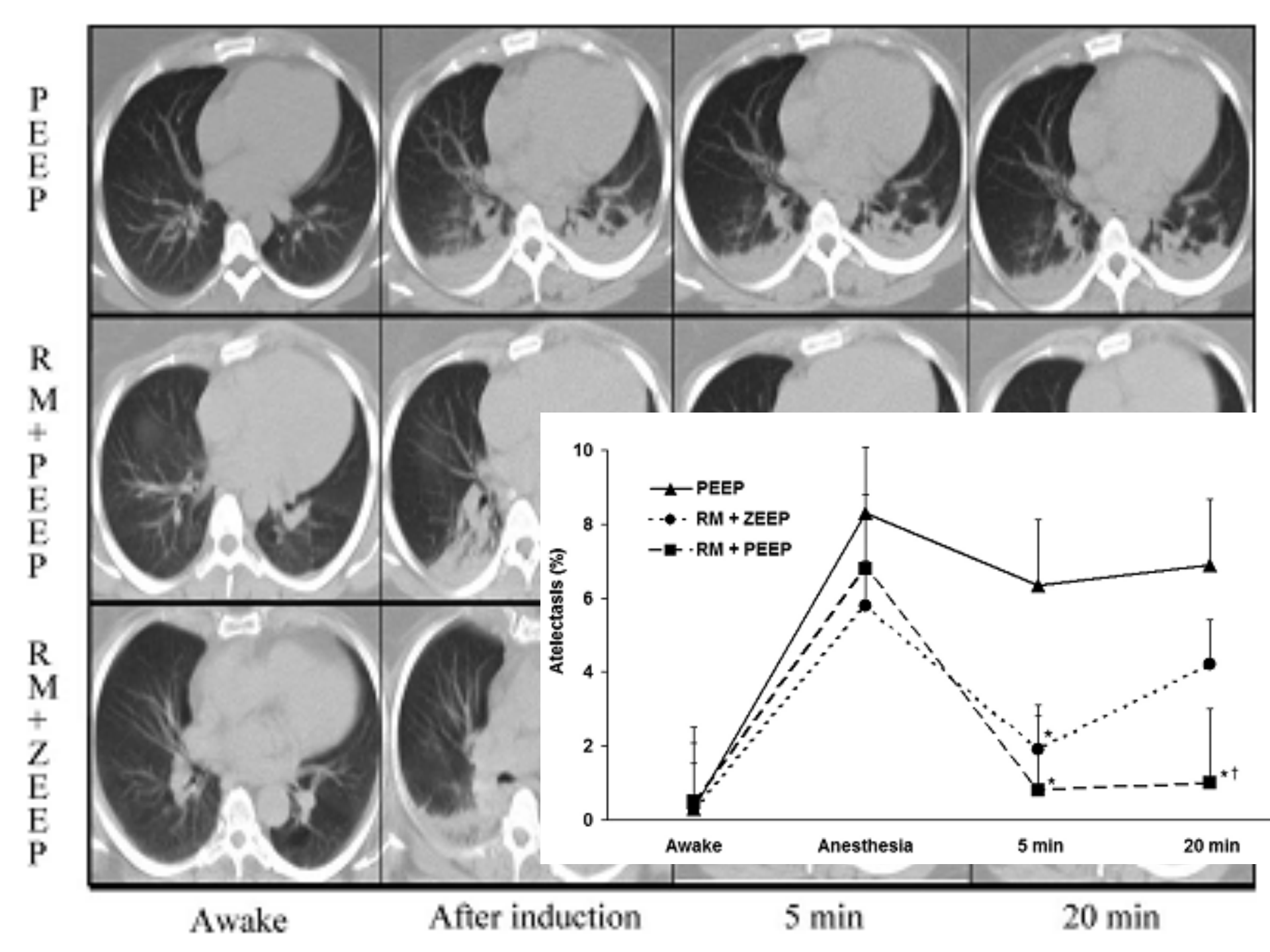
Rothen, BJA 1993
Rothen, Anesthesiology. 1996

Atelectasis before and after Recruitment Manoeuvre

RM + PEEP



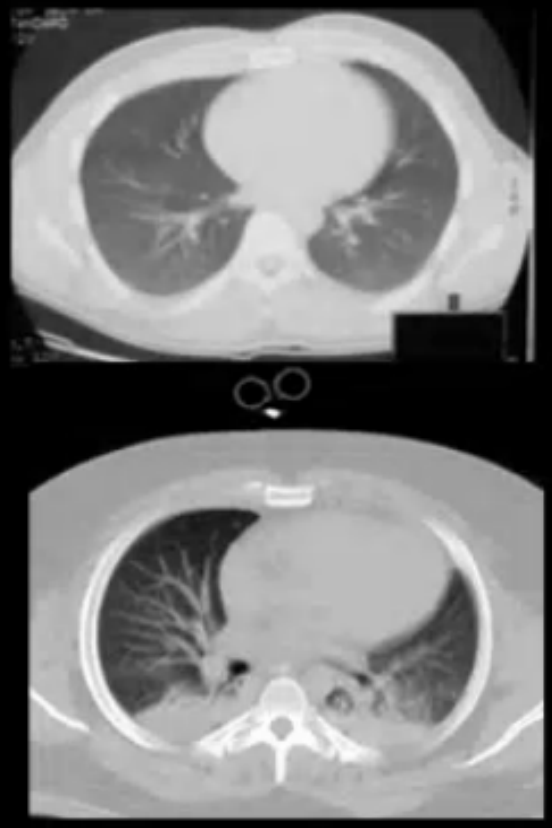
Neumann et al 1999


PEEP
RM + PEEP
RM + ZEEP
Awake
After induction
5 min
20 min
Atelectasis (%)
10
8
6
4
2
0
PEEP
RM + ZEEP
RM + PEEP
Awake
Anesthesia
5 min
20 min
*
*
*†

Protective ventilation setting during general anesthesia ?

Shultz MJ et al Anesthesiology 2007; 106;1226.1231
Pelosi P and Rocco PR. Anesthesiology 2011: 115: 923-925
Pelosi P et a. . Trends in Anaesthesia and Crit Care 2013: 3; 77-81

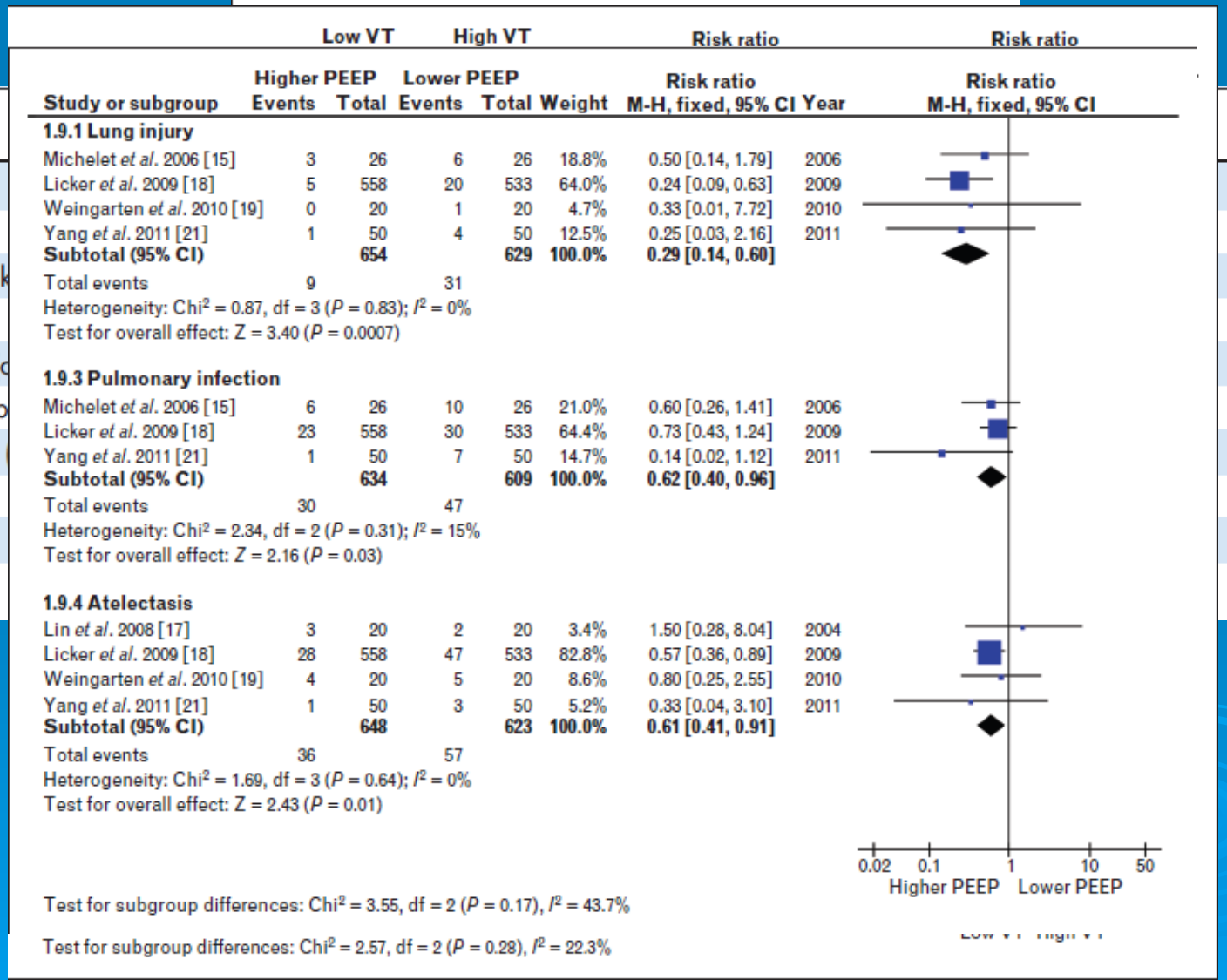
- Tidal Volume 6-8 ml/Kg PBW
- Increase RR to control pHa/$PaCO_2$
- Plateau Pressure < 20 cmH_2O
- PEEP 5-10 cmH_2O
- RM 30-40 cmH_2O – PEEP/VT – PC/VC
- Monitor Paw-Time/Check PEEPi



Intraoperative ventilatory strategies to prevent PPCs: a meta-analysis

Hemmes NT et al Curr Opin Anesthesiol 2013, 26:126–133

	P value
Age (years)	0.910
Weight (kg)	0.965
Tidal volume (ml/k	<0.0001
PEEP (cm H_2O^a)	0.001
Plateau pressure (c	0.021
Respiratory rate (b	0.007
Minute-ventilation	0.917
PaO_2/FiO_2^a	0.797
PaCO2 (mmHg[a])	0.052
pH[a]	0.073



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

Severgnini P et al Anesthesiology. 118: 1307-1321 (2013)

Protective Ventilation

- VT = 7 ml/kg IBW
- PEEP = 10 cmH_2O
- Recruitment Maneuvres after induction and before extubation :
  Pplateau = 30-35 cmH_2O with increasing tidal volume at PEEP 10

Conventional Ventilation

- VT = 9 ml/kg IBW
- PEEP = 0 cmH_2O
- No Recruitment Maneuvres

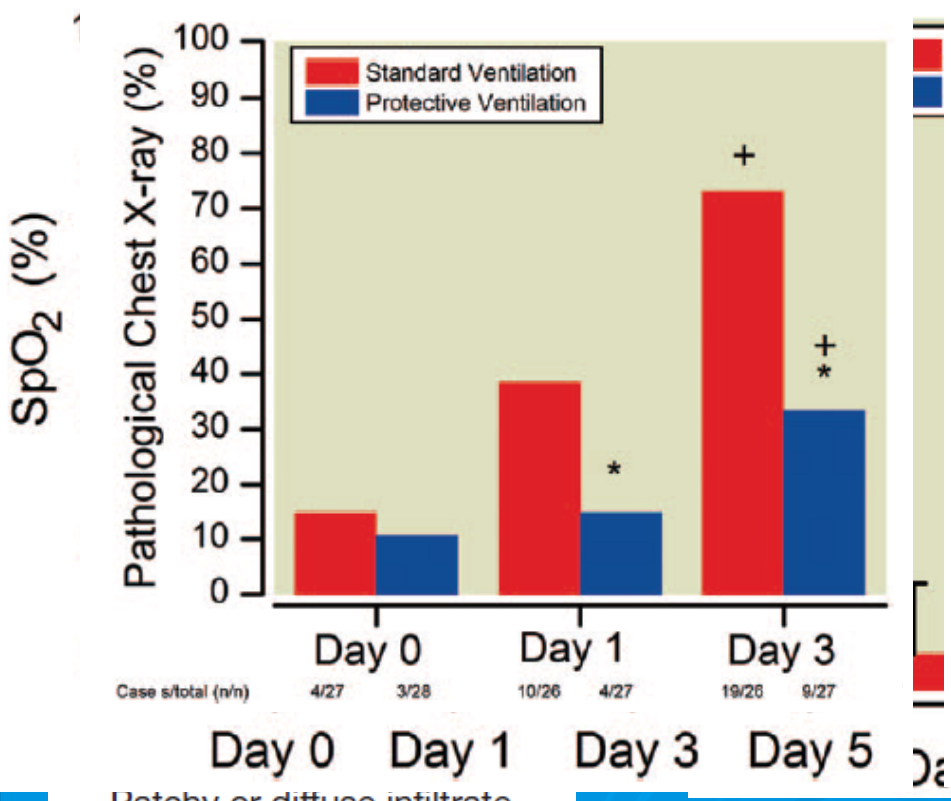
$30<EtCO_2<40$ mmHg e FiO_2 50%

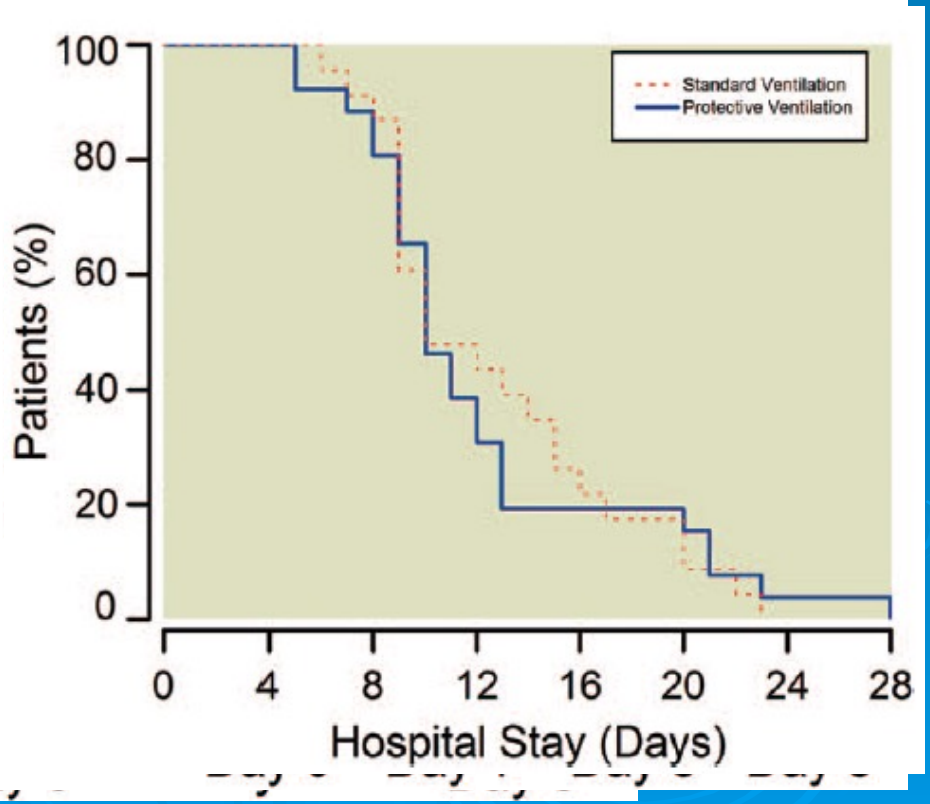
Protective Mechanical Ventilation during General Anesthesia for Open Abdominal Surgery Improves Postoperative Pulmonary Function

Anesthesiology 2013; 118:1307-21

Paolo Severgnini et al.

Components





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

Emmanuel Futier and al.

A Trial of Intraoperative Lung Protective Ventilation in Abdominal Surgery

Lung-Protective Ventilation		Traditional Ventilation
• V_T 6 to 8 ml/kg PBW	VS.	• V_T 10 to 12 ml/kg PBW
• PEEP 6 to 8 cmH_2O		• No PEEP
• Recruitment Maneuver		• No Recruitment Maneuver

Recruitment maneuver = CPAP 30 cmH_2O during 30 sec
After intubation and every 30 min thereafter

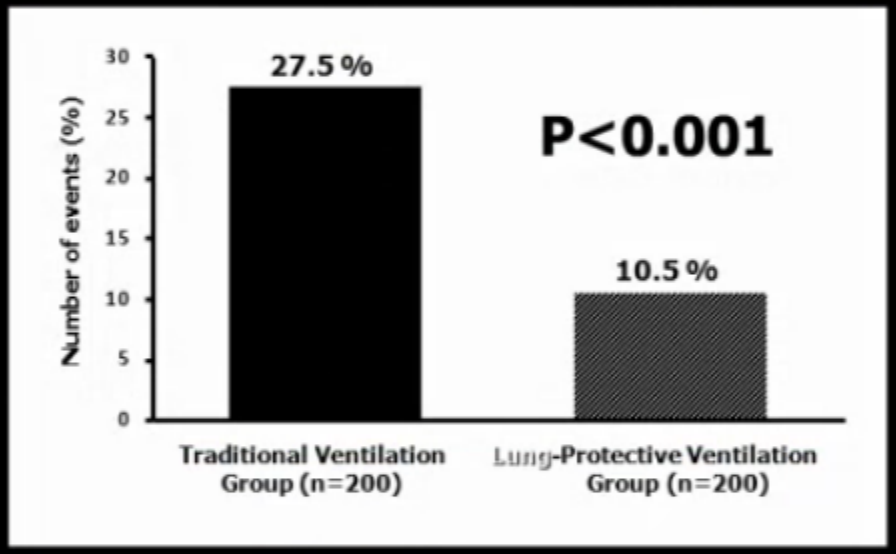
In both groups:
- Plateau pressure < 30 cmH_2O
- Volume-controlled ventilation mode
- FiO_2 adjusted to maintain $SpO_2 \geq 95\%$
- RR adjusted to maintain $ETCO_2$ between 35 and 40 mmHg

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

Emmanuel Futier and al.

A Trial of Intraoperative Lung Protective Ventilation in Abdominal Surgery

Major Pulmonary and Extra-pulmonary Complications at day 7 after surgery

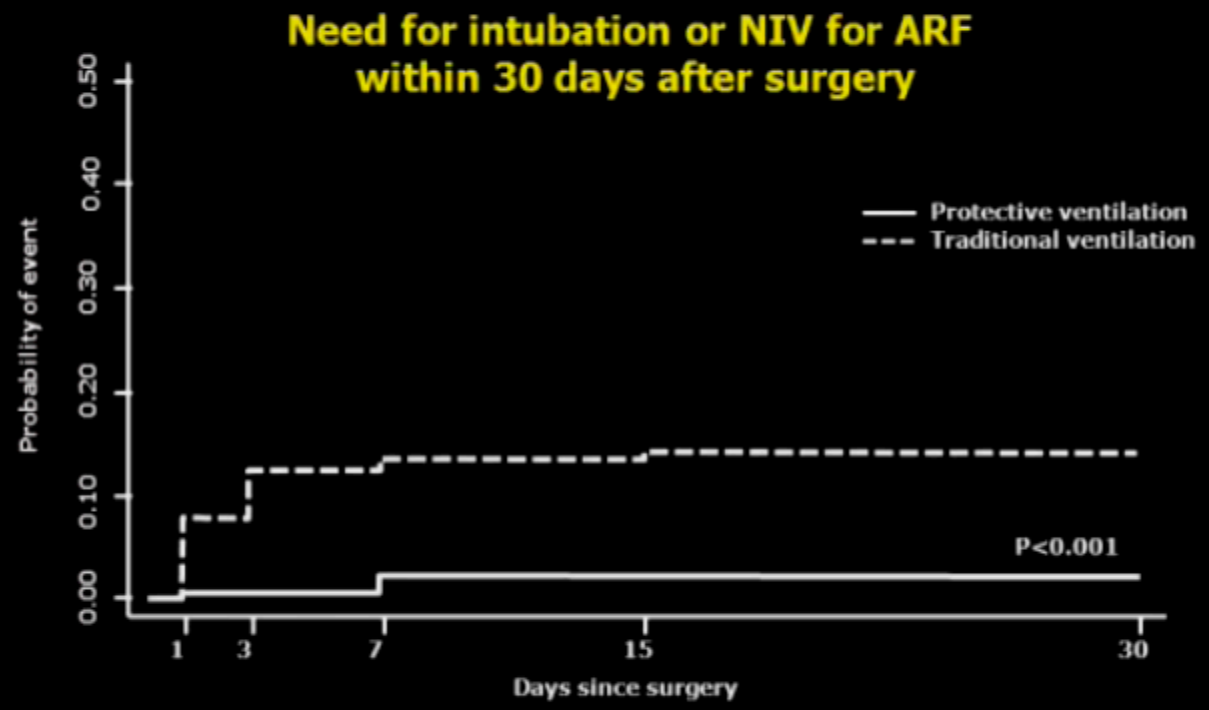


	Non-adjusted		Adjusted	
	Relative risk (95% CI)	P value	Relative risk (95% CI)	P value
Primary outcome	0.38 (0.24-0.61)	<0.001	0.38 (0.23-0.60)	<0.001

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

Emmanuel Futier and al.

A Trial of Intraoperative Lung Protective Ventilation in Abdominal Surgery



No. at Risk					
Traditional ventilation	190	175	166	164	163
Lung-protective ventilation	191	190	190	187	187

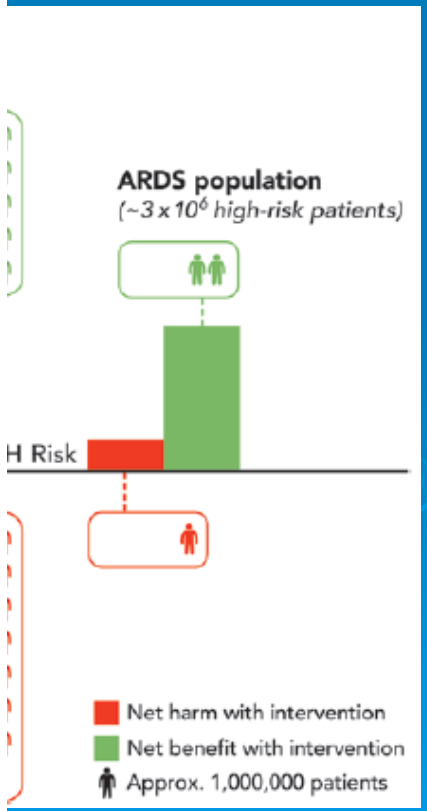
Lung-protective Ventilation in the Operating Room

Time to Implement?

Neil M. Goldenberg, M.D., Ph.D., Benjamin E. Steinberg, M.D., Ph.D.,
Warren L. Lee, M.D., Ph.D., F.R.C.P.C., Duminda N. Wijeysundera, M.D., Ph.D., F.R.C.P.C.,
Brian P. Kavanagh, M.B., F.R.C.P.C.

In summary, we believe that the balance of rationale, evidence, and experience suggests that the ideal approach to intraoperative ventilation is certainly an important question, but that the answer remains unknown. The experience from the ICU, coupled with extensive laboratory data and provocative clinical studies, has set the scene for large-scale trials in the field. In addition, the design—*and reporting*—of such studies should carefully detail the interventions used in terms of V_T and lung recruitment. Fortunately, large-scale perioperative clinical consortia exist that have the capacity to execute such studies. Finally, for anesthesia providers who decide that the current level of evidence is sufficient to change practice, we suggest that they consider carefully the interventions detailed by Futier *et al.* (*i.e.*, management of both V_T by predicted body weight and lung recruitment) and perhaps restrict the specific intervention to comparable patient populations.[1]

Anesthesiology 2014; 121:184–8



PV: ↓SIRS

Anesthesiology 2006; 105:911–9
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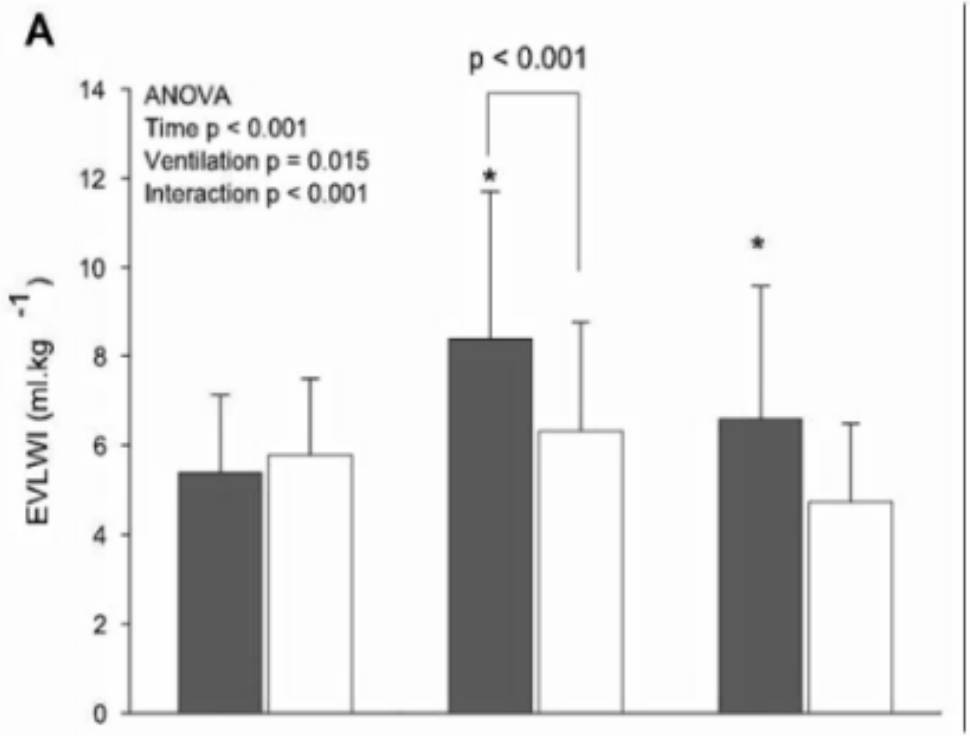
Protective Ventilation Influences Systemic Inflammation after Esophagectomy

A Randomized Controlled Study

Pierre Michelet, M.D., Xavier-Benoît D'Journo, M.D.,† Antoine Roch, M.D., Ph.D.,‡ Christophe Doddoli, M.D.,§ Valerie Marin, M.D.,|| Laurent Papazian, M.D., Ph.D.,# Isabelle Decamps, M.D.,* Fabienne Bregeon, M.D., Ph.D.,** Pascal Thomas, M.D.,†† Jean-Pierre Auffray, M.D.‡‡*



Esophagectomy

26 Pt: TV: 9 mL/kg
ZEEP

26 Pt: TV: 9→5 mL/kg
5 cm PEEP

Protective Ventilation:

1. ↓ Mediators
2. ↑ Oxygenation (?)
3. ↓ EVLW

PV: Obesity

3. Lung protective ventilation: avoid baro/volutrauma.
    1. Atraumatic ventilation mode. Small TV higher freq
    2. Permissive hypercapnia. reduce minute volume
    3. Pressure support ventilation.
    4. Variable volume ventilation better than VCV versus PCV

J P Mulier, 2013

PV: Obesity

European Society of Anaesthesiology ESA

SIAARTI
PRO VITA CONTRA DOLOREM SEMPER

ESPCOP
The European Society for Perioperative Care of the Obese Patient

www.provenet.eu

PV: Obesity

184 / 748 pts

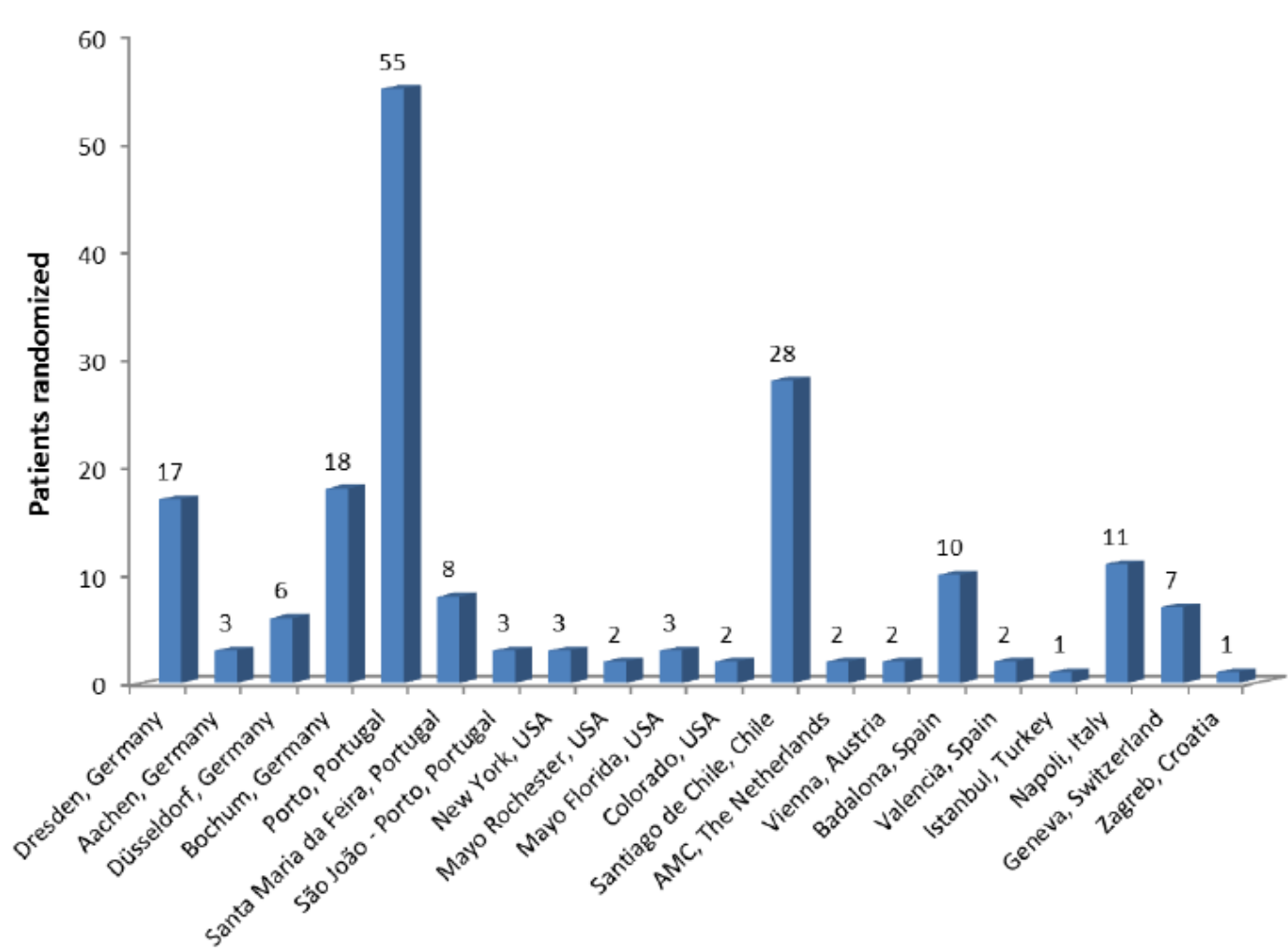
PROBESE TRIAL

PRotective Ventilation with Higher versus Lower PEEP during General Anesthesia for Surgery in OBESE Patients

The PROBESE Randomized Controlled Trial

News Letter 3

Dresden, April 21, 2015



PV: Thorax

«Protect» *(both the lung & its function)*

- Low FiO2
- PEEP (and CPAP)
- Low TV; low driving pressures
- RM (and PEEP)
- Permissive Hypercapnia

Mert Senturk

PV: Future

EDITORIAL

CURRENT OPINION

How can we prevent postoperative pulmonary complications?

Marcelo G. de Abreu[a] and Paolo Pelosi[b]

Curr Opin Anesthesiol 2013, 26:105–106

The building of National and International Networks run by Anesthesiologists

- Clinical studies and randomized controlled trials
- To generate clinical evidence
- To establish standards for improved clinical practice

Дякую за увагу