Ventilation mécanique 2024

Laszlo L. Szegedi M.D., PhD

Département d'Anesthésiologie-Réanimation

H.U.B Hôpital Erasme, Université Libre de Bruxelles

Brussels, Belgium

Disclosure

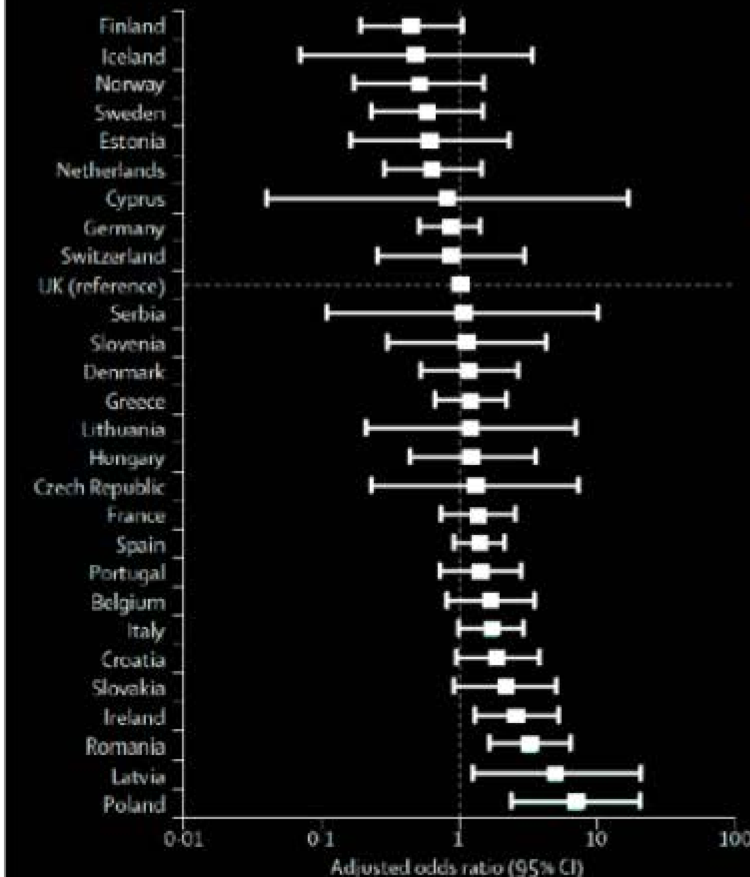
In the past 5 years:

- Dräger, Lubeck, Germany
- Edwards Lifesciences, Switzerland
- Cook Medical, Ireland

No conflict of interest for this presentation

European Surgical Outcomes Study (EuSOS) group for the Trials groups of the European Society of Intensive Care Medicine and the European Society of Anaesthesiology*

Prospectively collected data from 46 539 patients undergoing inpatient surgery in 498 hospitals across 28 European nations



Overall crude mortality: 4%

Postoperative mortality was much more higher than expected in non-cardiac surgery

73.8% of the patients who died were never admitted to critical care at any stage

What is not "really" new...
But still remains a common clinical problem

Temporal Patterns of Postoperative Complications

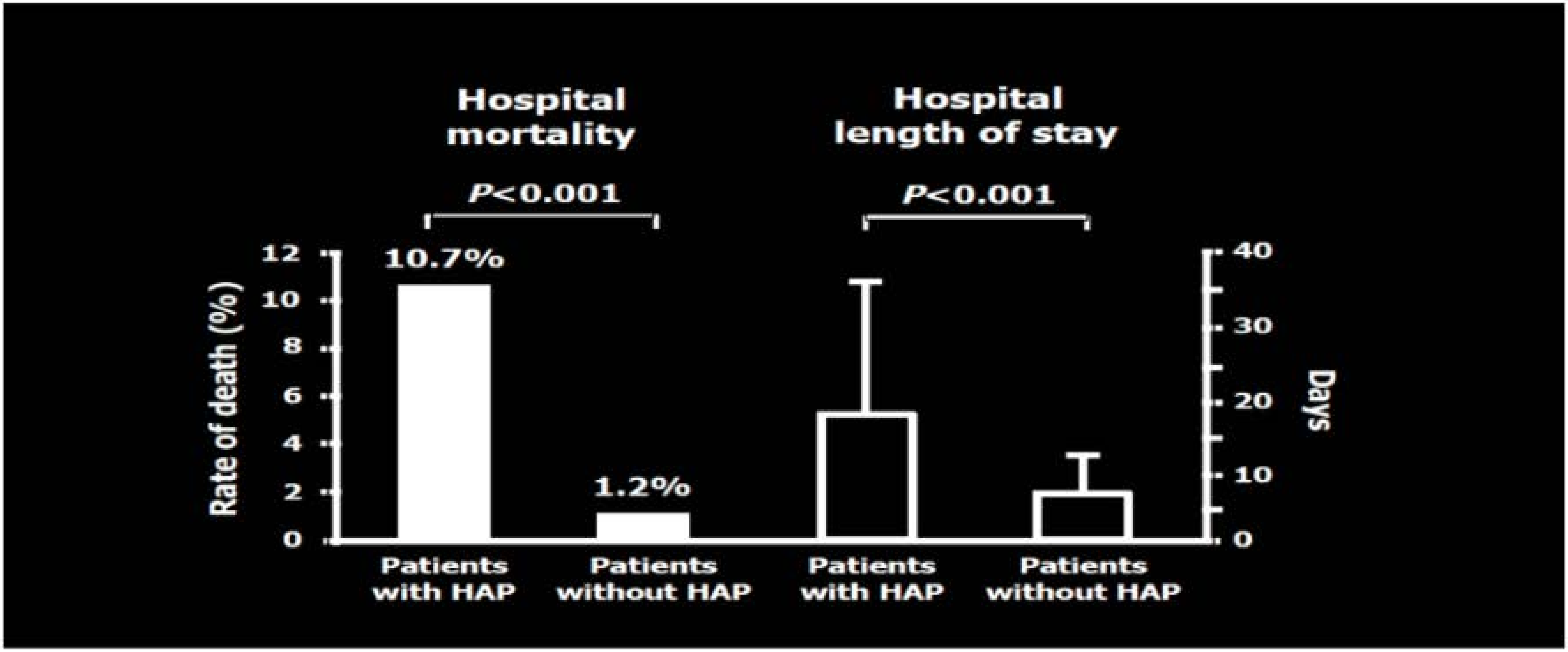
Jon S. Thompson; B. Timothy Baxter; John G. Allison; Frank E. Johnson; Kelvin K. Lee; Woo Young Park

1021 patients with intraabdominal surgery studied prospectively during the postoperative period

Cardiac complications	N=135 (**13%**)
Myocardial infarction	4%
Congestive heart failure	3%
Hypotension	3%
Cardiac arrhythmia	2%
[illegible]	[illegible]
Pulmonary complications	N=213 (**21%**)
Respiratory failure	12%
Pneumonia	7%
Respiratory depression	2%
Others	
Sepsis	4%
Renal failure	2%
Cardiovascular accident	2%
Total	N=435 (**42%**)

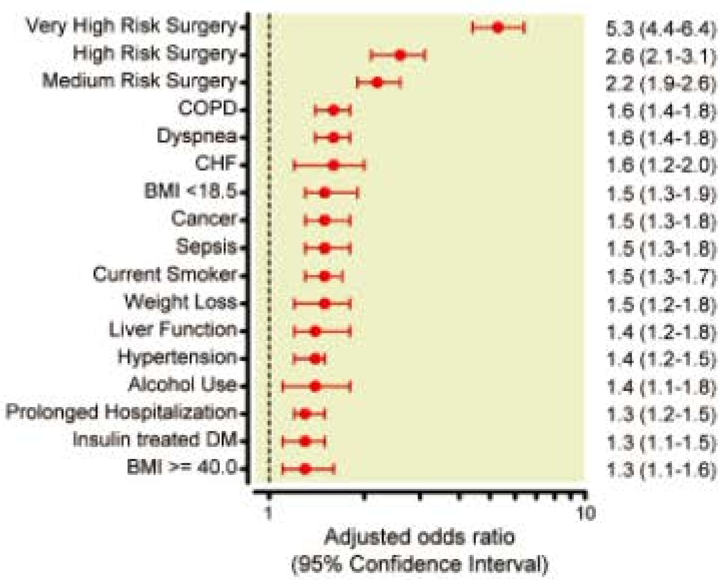
Arch Surg 2003;138:596-603

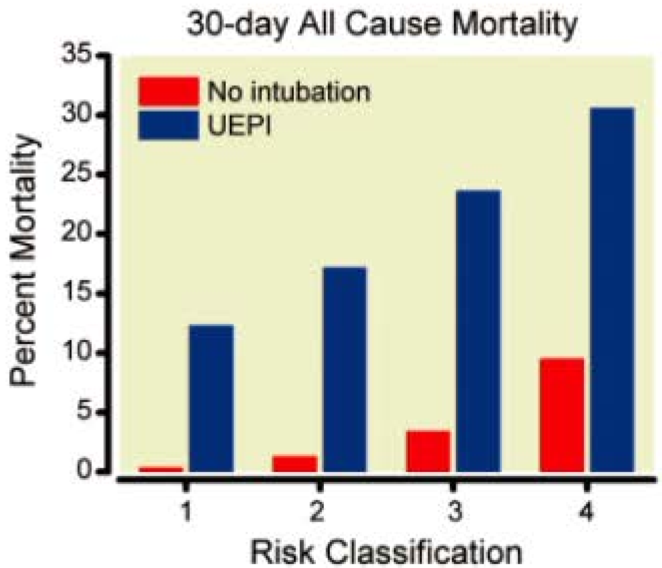
Clinical and Economic Outcomes of Hospital Acquired Pneumonia (HAP)
in Intra-Abdominal Surgery Patients
David A. Thompson, Martin A. Makary, Todd Dorman, MD and Peter J. Pronovost



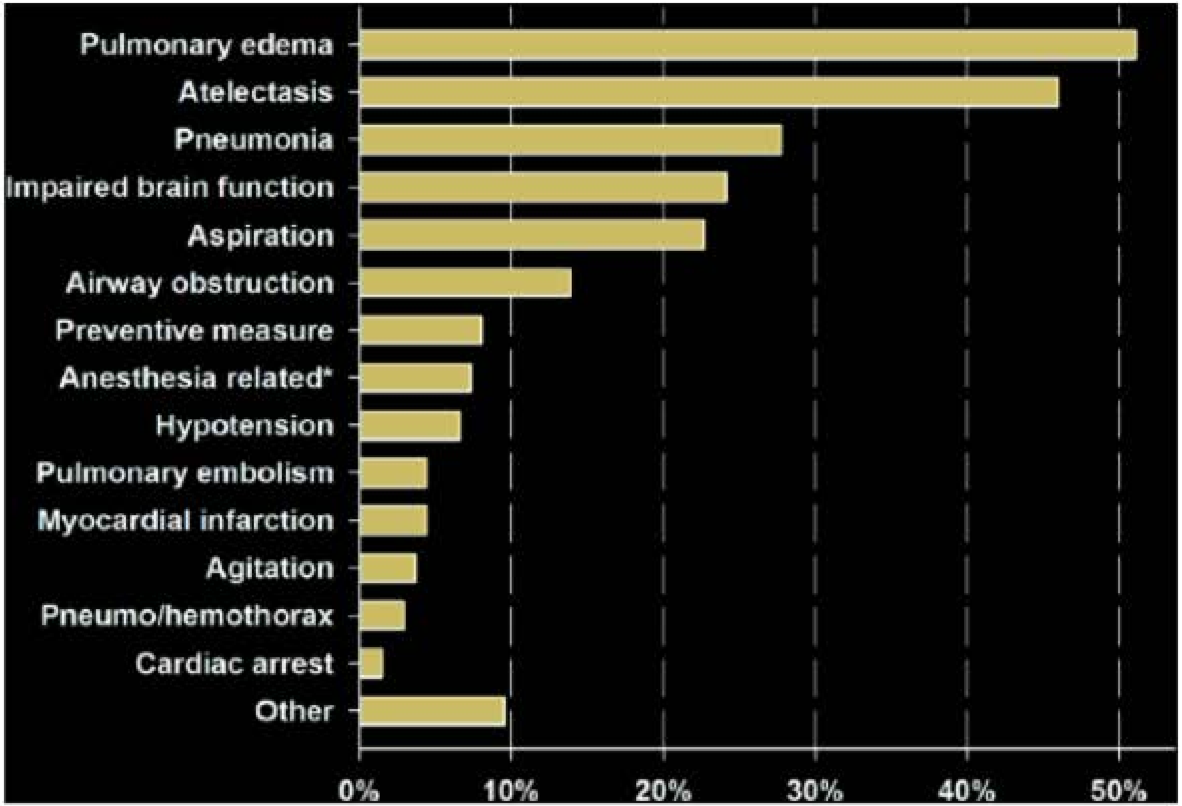
Independent Predictors and Outcomes of Unanticipated Early Postoperative Tracheal Intubation after Nonemergent, Noncardiac Surgery

49.4% of unanticipated postoperative tracheal intubations occurred within 3 days after surgery





UEPI was an independent predictor of all-cause 30-day mortality ($P<0.001$; adjusted odds ratio, 9.2; 95% CI, 5.6–15.0).



Reintubation for IRA within the first 3 days after surgery is associated with an increased risk (x72) for in-hospital death: 16% versus 0,26%

Perioperative Risk Factors for Postoperative Pulmonary Complications

Patient risk factors	Surgical factors	Anesthetic factors
Age > 70	Thoraco-abdominal procedures	General anesthesia
Obesity	Upper abdominal incision	Pain
Tabac	Muscle disruption	Fluid excess
Alcool use	Muscle dysfunction	Ventilatory settings
Steroid use	Emergency procedure	
Denutrition	Duration > 2-3 hours	
Preoperative anemia	Pneumoperitoneum	
Respiratory disease *COPD* *Recent infection* *Low preoperative* SpO_2	Body positioning Transfusion > 4 units	

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

Kan balg niet aansturen
08:49
40
0
80
cmH2O
Ppeak
Pmean
2
1
PEEP
RespFreq /min
0
1
Uit
Uit
MV l/min
0.0
TVexp ml
27
O2
AIR
6.0
0.00
Vers-gas: O2 + AIR
Volumegestuurd: Ventil. AAN, I:E = 1:2
Extra data
O2 %
100
Totale flow l/min
6.00
Sev %
Uit
Slagvolume ml
500
Resp.freq. /min
12
PEEP cmH2O
Uit
Circuit O2 %
81

1963

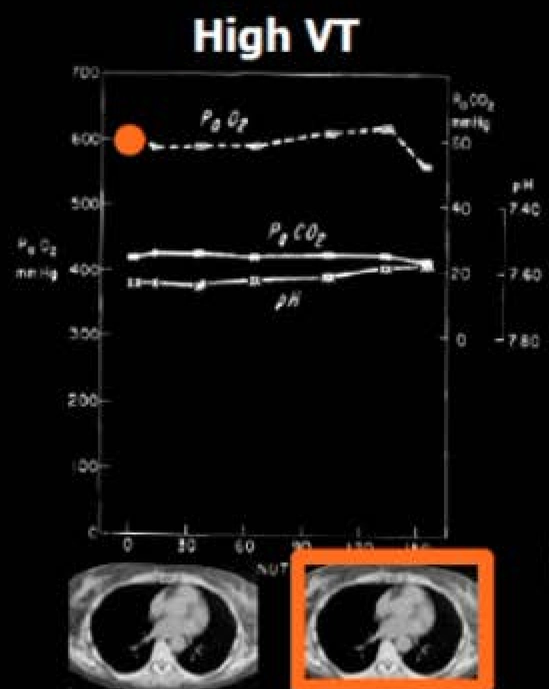
The New England
Journal of Medicine

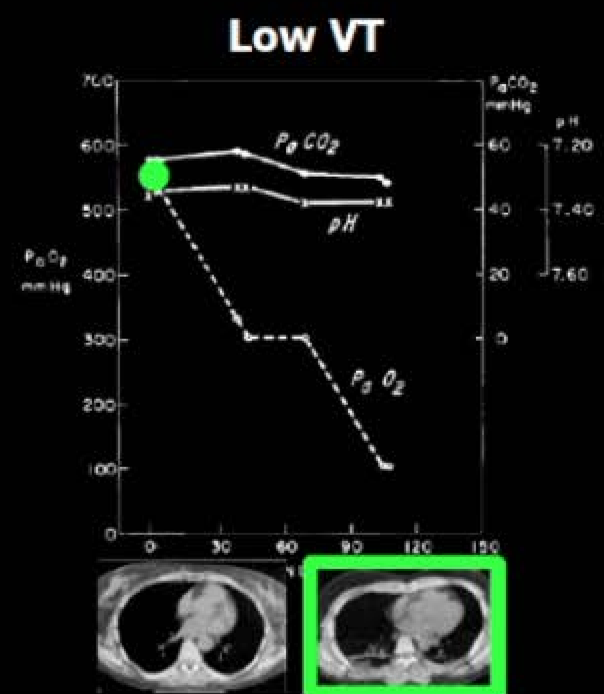
Volume 269 NOVEMBER 7, 1963 Number 19

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.§





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A relation between the degree of ventilation and the magnitude of fall in arterial oxygen tension was found. Large tidal volumes appear to protect against falls in oxygen tension, presumably by providing continuous hyperinflation. Shallow tidal volumes lead to atelectasis and increased shunting, with impaired oxygenation.

2000

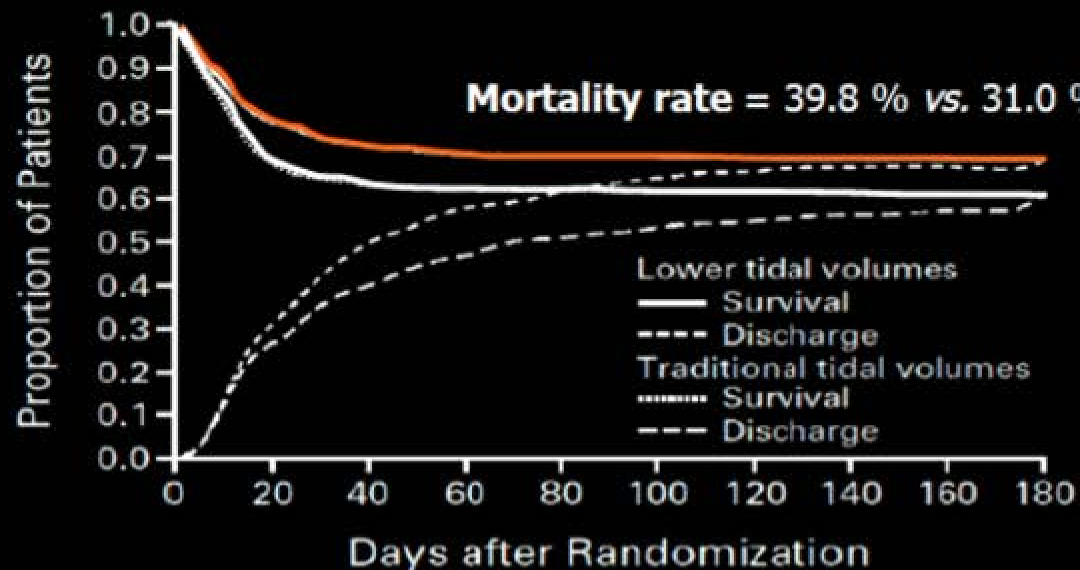
The New England Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

High VT 12 ml/kg PBW ***vs.*** **Low TV 6 ml/kg PBW**

(Pplat < 50 cmH_2O) (Pplat < 30 cmH_2O)

Mortality rate = 39.8 % *vs.* 31.0 % (P=0.007)



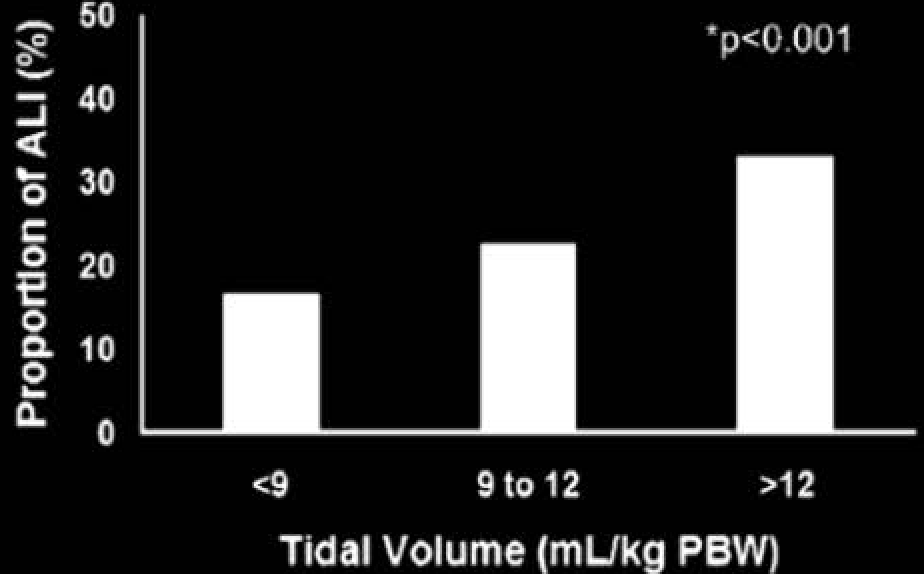
Is there a rationale to use lung protective ventilation in patients with normal lungs?

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

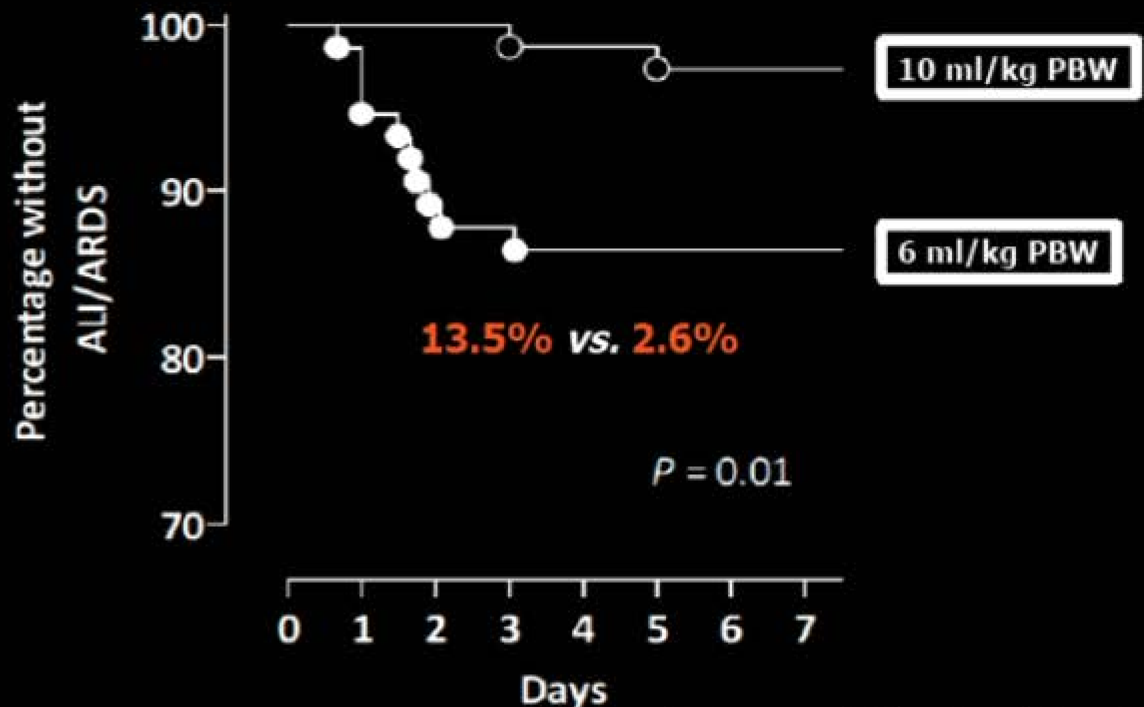
Incidence ALI: N=80 patients (24%)



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



Determann RM et al. Crit Care 2010

...and in the OR?

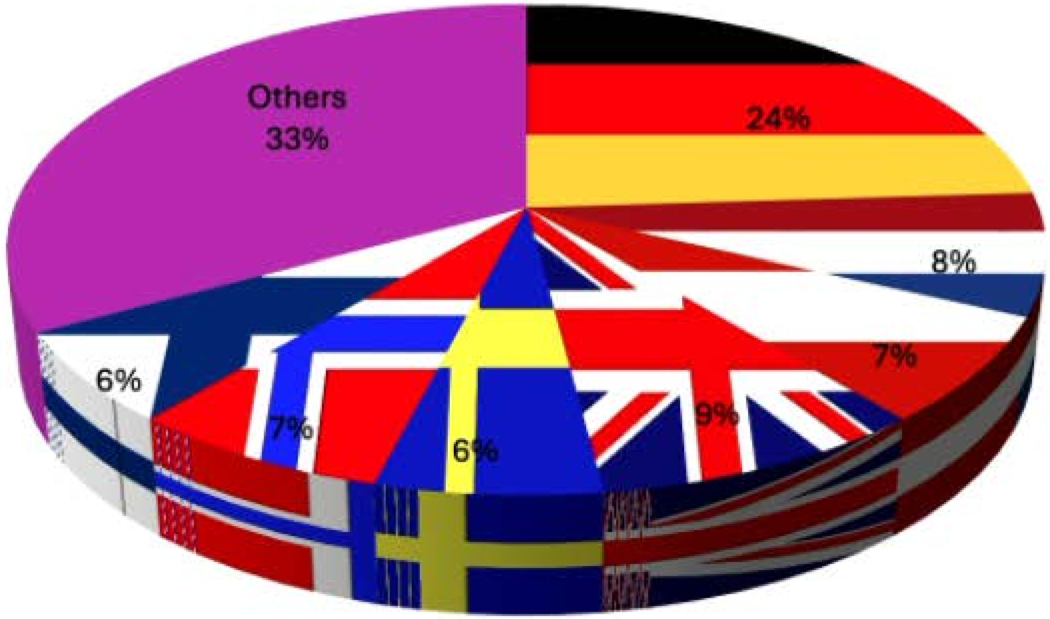
Disclosure

We support each other...

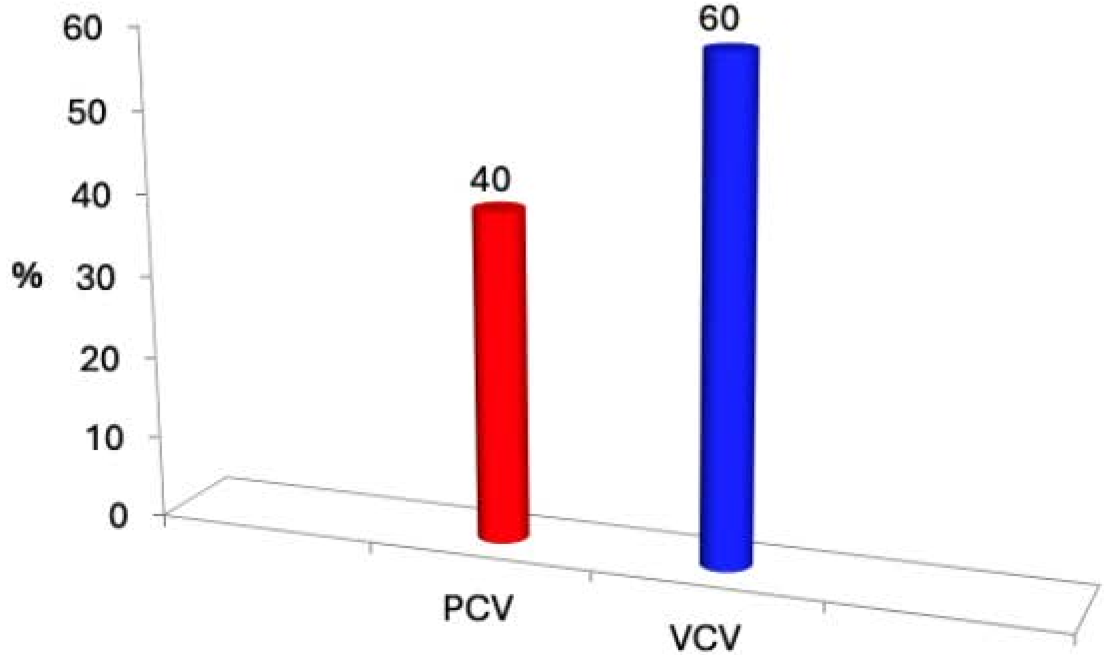
Survey on Anaesthesia for Thoracic Surgery

- 24 questions to the regular EACTA members
- Issued from the EACTA thoracic subcom

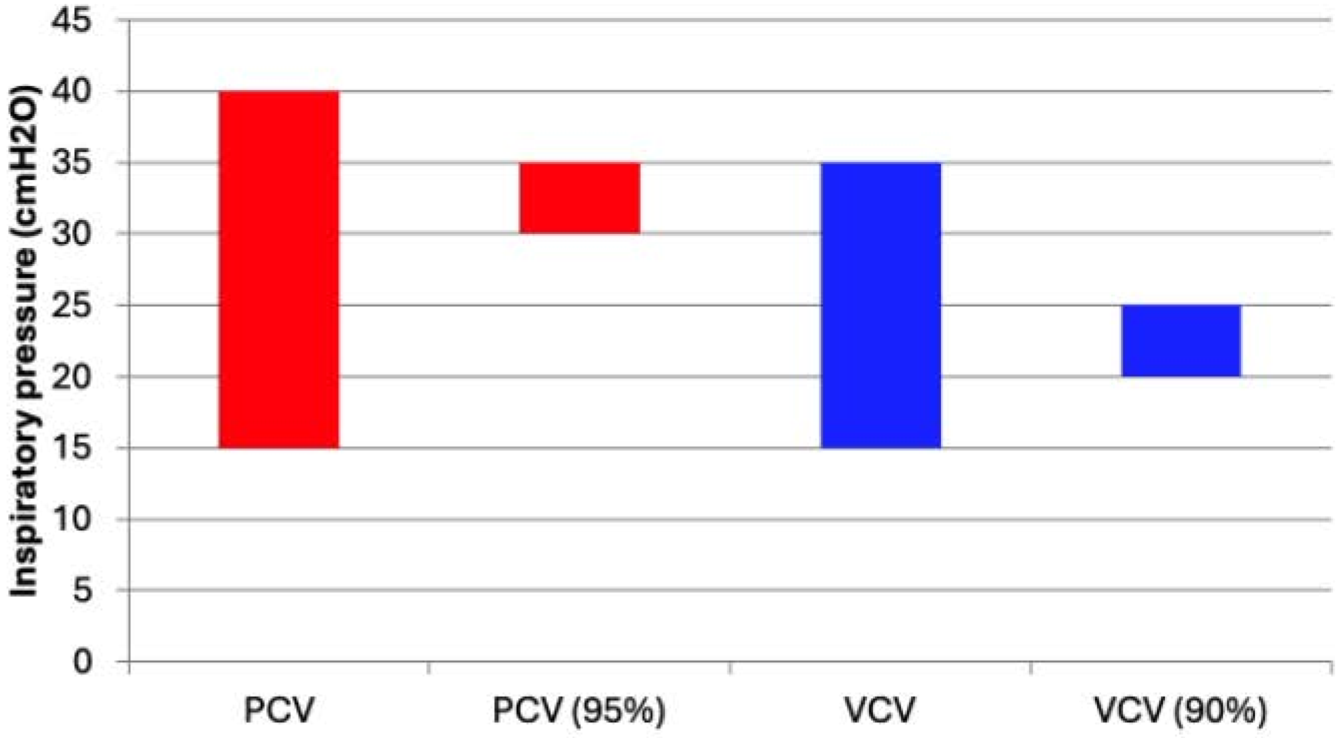
Countries



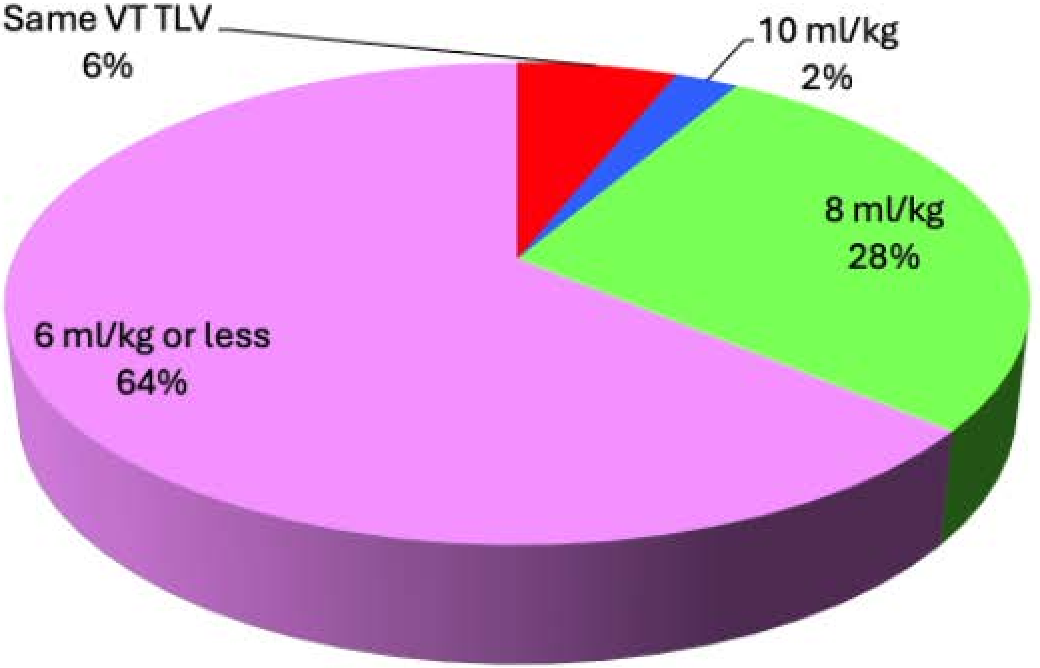
PCV vs VCV



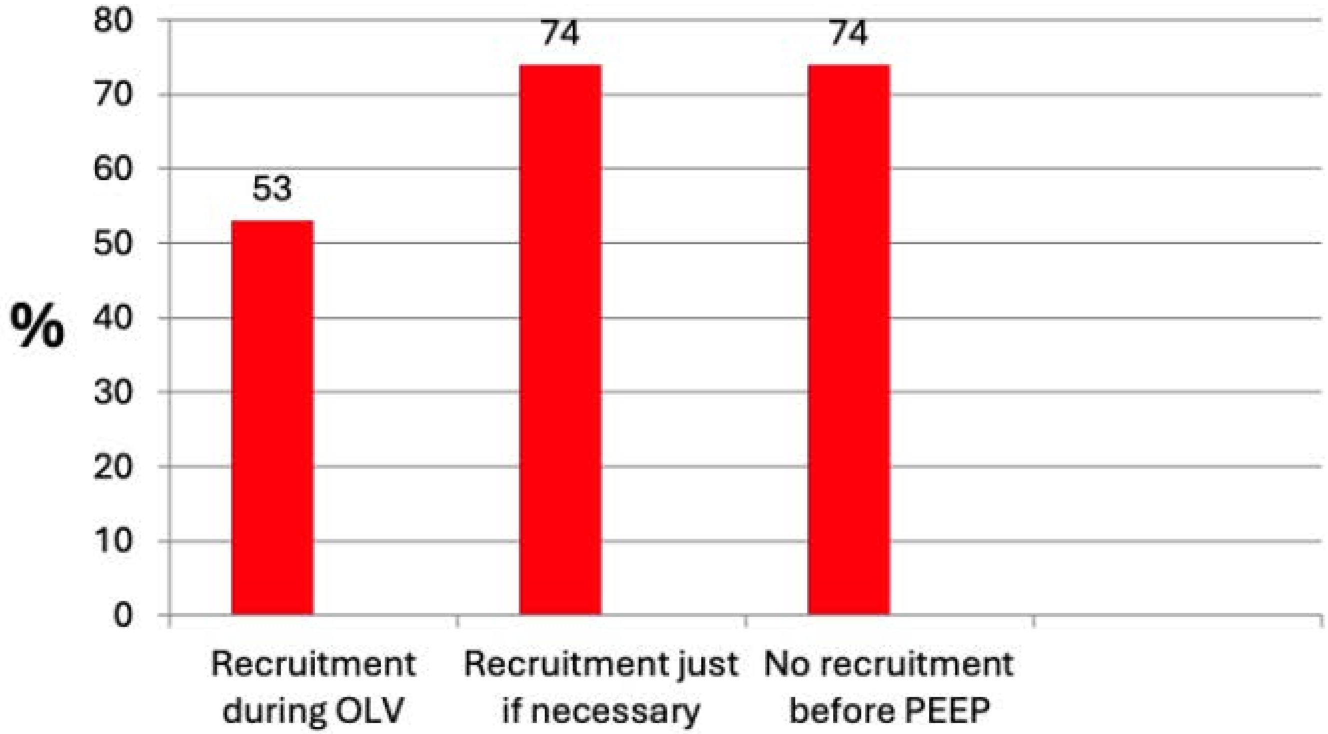
Acceptable inspiratory pressure



Tidal volume during OLV



Recruitment



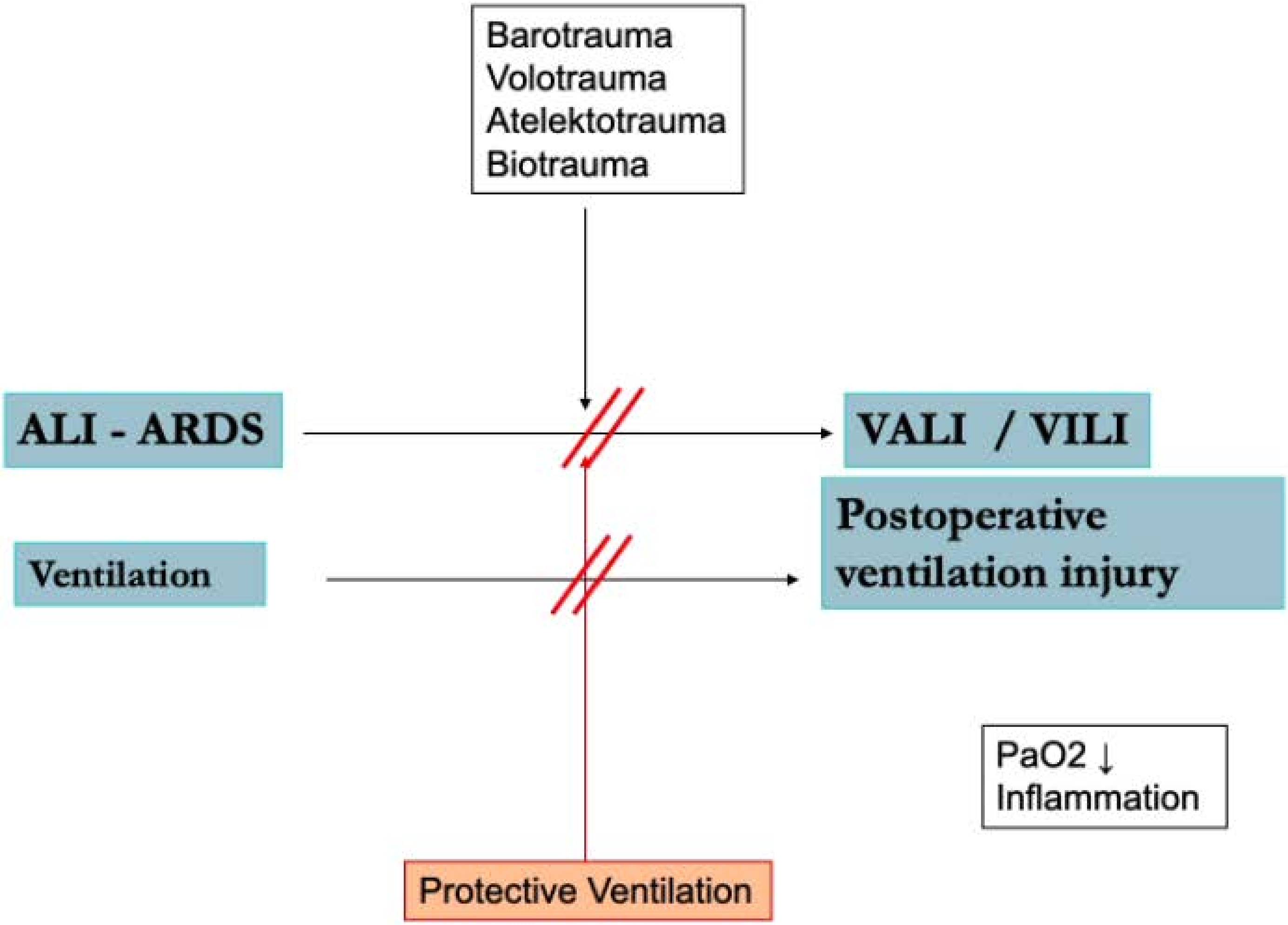
New challenge during mechanical ventilation

Treatment of ARDS

Barotrauma
Volotrauma
Atelectotrauma
Biotrauma

ALI - ARDS → **VALI / VILI**

PaO2 ↓
Inflammation


Barotrauma
Volotrauma
Atelektotrauma
Biotrauma
ALI - ARDS
VALI / VILI
Ventilation
Postoperative ventilation injury
PaO2 ↓
Inflammation
Protective Ventilation

Intraoperative hypoxia

- The first cause of neurological damage associated with general anesthesia.

- Four different origins:

  – Patient problems
  – Endotracheal tube
  – Anesthesia workstation
  – Oxygen delivery system

Intraoperative hypoxia

- The first cause of neurological damage associated with general anesthesia.

- Four different origins:

  – Patient problems
  – Endotracheal tube

CLINICAL REPORTS

Anesthesiology
V 42, No 3, Mar 1975

Intraoperative Hypoxia from an Erroneously Filled Liquid Oxygen Reservoir

DAVID H. SPRAGUE, M.D.,* AND GIRVICE W. ARCHER, JR., M.D.*

A Description of Intraoperative Ventilator Management and Ventilation Strategies in Hypoxic Patients

James M. Blum, MD,* Douglas M. Fetterman, MD,* Pauline K. Park, MD,† Michelle Morris, MS,* and Andrew L. Rosenberg, MD*

- University of Michigan Medical Center, review of all operations performed between 2005- 2009, using a general anesthetic which at least 1 arterial blood gas determination was made.
- 83,866 ABGs were obtained in 27,101 patients
- Excluding cardiac and thoracic procedures
- Four cohorts of arterial blood gases were identified with P/F > 300, P/F= 300-201, P/F = 200-101, P/F < 100.
- Positive end-expiratory pressure (PEEP), peak inspiratory pressures (PIPs), FIO2, oxygen saturation (SaO2), and tidal volume in mL/kg PBW were compared

Anesth Analg 2010; 110: 1818)1622

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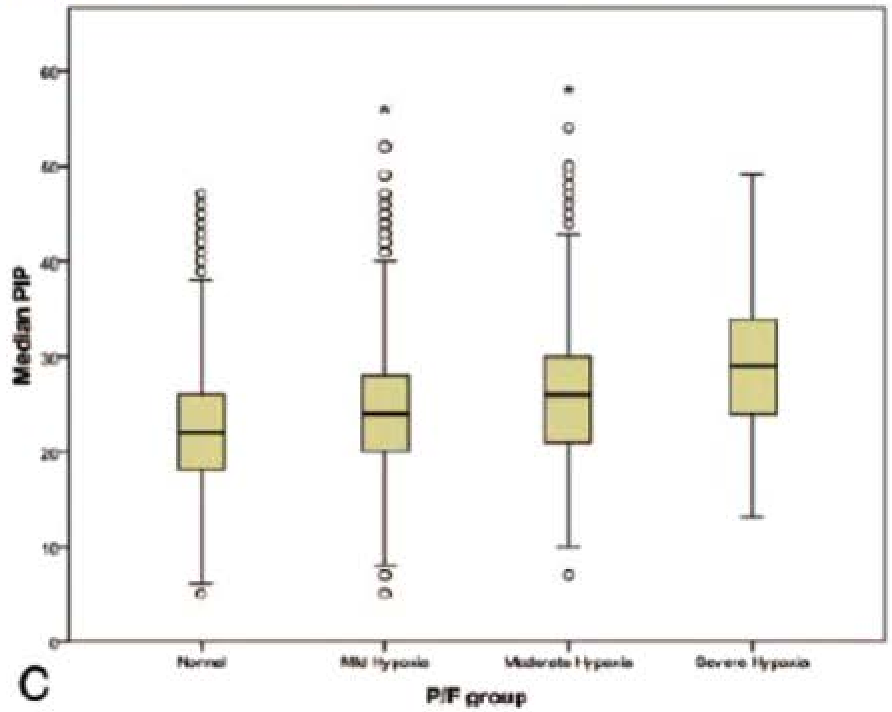

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Anesth Analg 2010; 110: 1818)1622

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Table 1-b. Demographics of Cohort and Distribution of ABGs by Surgical Service

Service	Operative cases		ABGs	
Neurosurgery	2260	19.58%	5890	20.52%
General surgery and subspecialties	1849	16.02%	4412	15.37%
Vascular	1497	12.97%	3745	13.05%
Orthopedic	1333	11.55%	2635	9.18%
Otolaryngology/maxillofacial	1321	11.45%	4011	13.97%
Urology	990	8.58%	2246	7.82%
Transplant	799	6.92%	2801	9.76%
Trauma	565	4.89%	1097	3.82%
Other/combined/unknown	428	3.71%	969	3.38%
OB/gyn	294	2.55%	515	1.79%
Plastic	205	1.78%	385	1.34%
Total	11,541	100%	28,706	100%

OR = operating room.

Anesth Analg 2010; 110: 1818)1622

EDITORIAL

A Roadmap to Optimize Intraoperative Mechanical Ventilation

Emily A. Vail, MD, MSc,*† and Avery Tung, MD, FCCM‡

See Article, page 971

GLOSSARY

ARDS = acute respiratory distress syndrome; **AUA** = Association of University Anesthesiologists; **$Etco_2$** = end-tidal carbon dioxide; **FAER** = Foundation for Anesthesia Education and Research; **GRADE** = Grading of Recommendations, Assessment, Development, and Evaluations; **I:E** = inspiratory to expiratory; **IARS** = International Anesthesia Research Society; **NHLBI** = National Heart, Lung, and Blood Institute; **NIH** = National Institutes of Health; **PEEP** = positive end-expiratory pressure; **PETAL** = prevention and treatment of acute lung injury; **PPC** = postoperative pulmonary complication

Ventilation Strategies During General Anesthesia for Noncardiac Surgery: A Systematic Review and Meta-Analysis

Maria Bolther, MD,* Jeppe Henriksen, MD,* Mathias J. Holmberg, MD, MPH, PhD,†‡§ ,et al.

Anesth Analg 2022;135:971–85

BACKGROUND: The optimal ventilation strategy during general anesthesia is unclear. This systematic review investigated the relationship between ventilation targets or strategies (eg, positive end-expiratory pressure [PEEP], tidal volume, and recruitment maneuvers) and postoperative outcomes.

Anesth Analg 2022;135:971–85

Table 1. Overview of Lung-Protective Ventilation Trials

Trial	Type of surgery	Laparoscopic (%)	n	Intervention		Comparator		Mortality	Length of stay	Postoperative complications		
				TV (mL/kg)	PEEP[a] (cm H_2O)	TV (mL/kg)	PEEP (cm H_2O)			Combined pulmonary	Atelectasis	Mechanical ventilation
Asida and Badawy 2015[19]	Urology	0	104	5–7	10 +RM	10–12	0	–	+	–	+	–
Choi et al, 2006[20]	GI, urology	30	46	6	10	12	0	+	–	–	–	+
Liu et al, 2020[21]	Gynecology	100	92	7	NR[b] +RM	9	0	–	+	+	+	+
Park et al, 2016[22]	GI	100	62	6	5	10	0	–	+	+	+	+
Pi et al, 2015[23]	GI	0	66	7	8 ±RM	9	0	+	+	+	–	+
Severgnini et al, 2013[24]	GI	0	56	7	10 +RM	9	0	+	+	+	+	–
Weingarten et al, 2010[25]	GI	0	40	6	12 +RM	10	0	+	+	+	+	+
Chugh et al, 2019[26]	GI	0	90	6	10	10	0	+	+	–	–	–
Futier et al, 2013[27]	GI	21	400	6–8	6–8 +RM	10–12	0	+	+	+	+	+
Liu et al, 2019[28]	GI	100	120	7	NR[b] +RM	10	0	+	+	–	–	–
Mølsted et al, 2020[29]	Urology	100	24	6	10	10	4	–	–	+	–	–
Soh et al, 2018[30]	Neurosurgery	0	78	6	6 +RM	10	0	–	+	+	+	+
Fu et al, 2020[31]	GI	0	100	6–8	6–8 +RM	8–10	0	–	+	+	+	+
Huang et al, 2021[32]	Urology	100	256	6	7	9	0	+	+	+	–	–

Abbreviations: GI, gastrointestinal; NR, not reported; PEEP, positive end-expiratory pressure; RM, recruitment maneuver; TV, tidal volume.

[a]Trials marked with "+RM" included recruitment maneuvers in the intervention group. One trial marked as "±RM" included 2 intervention groups: 1 with and 1 without recruitment maneuvers.

[b]Individualized PEEP based on lung compliance, range 6–14 cm H_2O. Actual mean or median PEEP not reported.

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Table 1. Overview of Lung-Protective Ventilation Trials

Trial	Type of surgery	Laparoscopic (%)	n	Intervention TV (mL/kg)	Intervention PEEP[a] (cm H_2O)	Comparator TV (mL/kg)	Comparator PEEP (cm H_2O)	Mortality	Length of stay	Postoperative complications: Combined pulmonary	Atelectasis	Mechanical ventilation
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Fu et al, 2020[31]	GI	0	100	6–8	6–8 +RM	8–10	0	–	+	+	+	+
Huang et al, 2021[32]	Urology	100	256	6	7	9	0	+	+	+	–	–

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[b]Individualized PEEP based on lung compliance, range 6–14 cm H_2O. Actual mean or median PEEP not reported.

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KEY POINTS

- **Question:** Do specific ventilatory targets or strategies improve outcomes for patients undergoing general anesthesia for noncardiac surgery?
- **Findings:** In this systematic review and meta-analysis including 63 trials, we found that evidence to support specific ventilatory strategies during general anesthesia was limited. Methodological heterogeneity among trials was large.
- **Meaning:** Evidence to guide mechanical ventilation strategies during perioperative care is limited. Larger trials with less methodological heterogeneity are needed to inform clinical care.

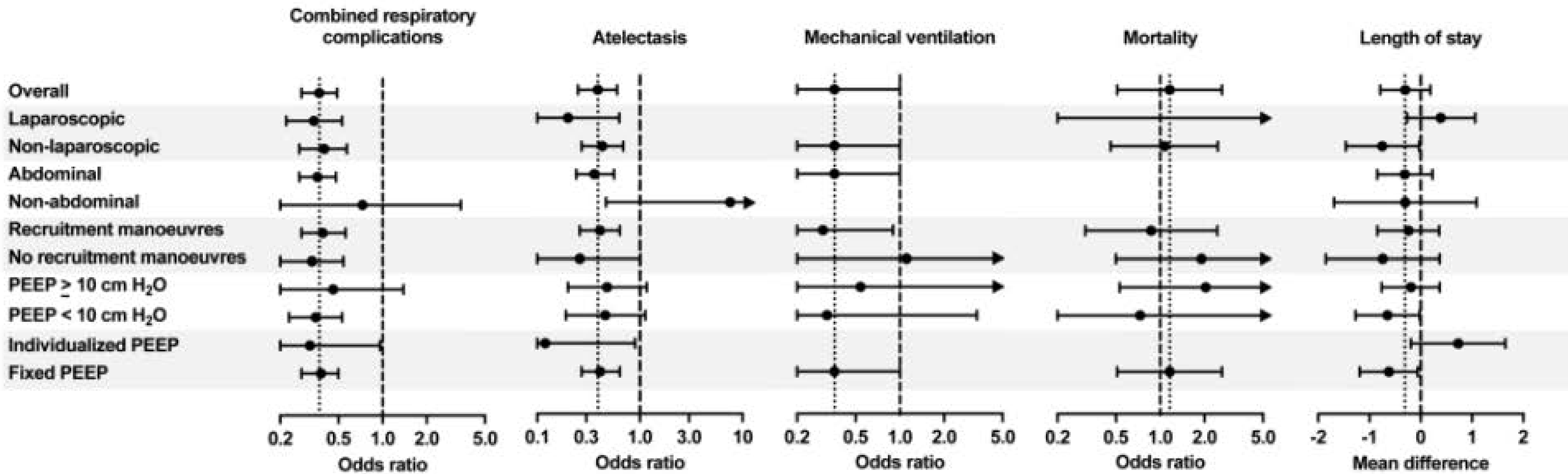
Anesth Analg 2022;135:971–85

Table 3. Overview of PEEP Trials

Trial	Type of surgery	Laparoscopic (%)	n	PEEP ($cm\ H_2O$) Intervention	PEEP ($cm\ H_2O$) Comparator	Mortality	Length of stay	Postoperative complications: Combined pulmonary	Postoperative complications: Atelectasis	Postoperative complications: Mechanical ventilation
Individualized PEEP[a]										
Pereira et al, 2018[33]	Multiple	50	40	12 (6–16)	4	–	+	–	+	–
Ruszkai et al, 2020[34]	Urology	0	39	10 (8–14)	6	+	+	–	–	–
Wetterslev et al, 2001[35]	GI	0	40	5, 8, or 10[b]	0	+	+	–	–	+
Ferrando et al, 2018[36]	Multiple	38	967	10 (8–12)	5	+	+	+	+	+
Piriyapatsom and Phetkampang, 2020[37]	Gynecology	100	44	13 (2)	5	–	+	+	–	–
Nestler et al, 2017[38]	GI	100	54	18 (5)	5	+	–	+	–	+
Elshazly et al, 2020[39]	GI	100	40	8 (2)	4	–	–	–	+	–
Yoon et al, 2021[40]	Urology	100	60	14 (12–18)	7	–	+	+	+	–
PEEP ≥5 cm versus zero PEEP										
Kim et al, 2013[42c]	Gynecology	100	100	5	0	–	–	+	–	–
Talab et al, 2009[43]	GI	100	66	5 or 10[d]	0	–	–	+	+	–
Kim et al, 2019[45]	Urology	0	68	7	0	–	–	–	–	–
Almarakbi et al, 2009[41e]	GI	100	60	10	0	+	+	+	–	+
Abd Ellatif and Mowafy, 2020[44]	GI	100	69	5[f]	0	–	·	+	+	–
Wei et al, 2018[46]	GI	100	36	8	0[f]	–	+	+	·	–
Azab et al, 2005[47]	GI	100	30	5	0	–	–	–	+	–
High versus low PEEP										
Chun et al, 2019[51]	Gynecology	100	40	8	4	–	–	+	+	–
Bluth et al, 2019[48]	Multiple	75	1976	12	4	+	–	+	+	–
Elokda and Farag, 2019[49]	GI	100	50	15	5	–	–	+	–	–
Hemmes et al, 2014[50]	Multiple	0	900	12	2	+	+	+	+	+
Whalen et al, 2006[52]	Abdominal	100	20	12	4	–	+	+	+	+
Other PEEP comparisons										
El-Sayed and Tawfeek, 2012[53]	GI	100	60	15	10	–	–	–	+	+
He et al, 2016[54g]	GI	100	50	10	8	–	–	+	+	–
Van Hecke et al, 2019[55]	GI	100	100	10 (3)	10	–	+	+	–	–

Abbreviations: GI, gastrointestinal; PEEP, positive end-expiratory pressure.
[a]PEEP values for trials with individualized PEEP are reported as the mean (standard deviation) or median (first and third quartiles).
[b]The trial used individualized PEEP but with either PEEP of 5, 8, or 10.
[c]The trial included 3 different control groups, PEEP 0 with different I:E ratios. These were combined in meta-analyses.
[d]The trial included 2 intervention groups. These were combined in meta-analyses.
[e]The trial included 3 intervention groups: PEEP 10 with no RM, 1 RM, and multiple RMs. These were combined in meta-analyses.
[f]These groups consisted of 2 groups with and without recruitment maneuvers. These were combined in meta-analyses.

Anesth Analg 2022;135:971–85



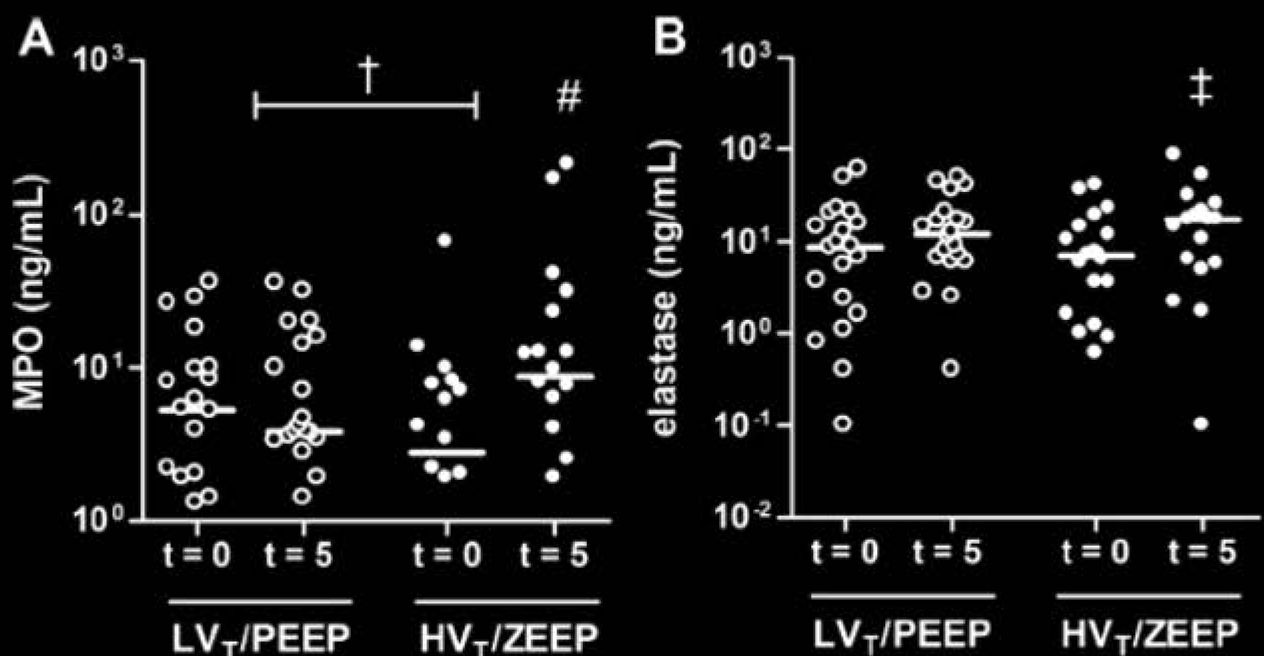
Overview of results for lung-protective ventilation. Results from meta-analyses of trials assessing lung-protective ventilation. Results are displayed as Peto's odds ratios (dot) or mean differences (dot) with 95% confidence intervals (error bars) for binary and continuous outcomes, respectively. Values below 1 for odds ratios and below 0 for mean differences indicate better outcomes with lung-protective ventilation. The x-axis is logarithmic for the binary outcomes. Some subgroups contained no trials reporting the relevant outcome, and these are, therefore, missing. Additional details are provided in Supplemental Digital Content 2, eTables 6 and 7, http://links.lww.com/AA/D970. PEEP indicates positive end-expiratory pressure.

Anesth Analg 2022;135:971–85

Anesthesiology 2008; 108:46–54

Mechanical Ventilation with Lower Tidal Volumes and Positive End-expiratory Pressure Prevents Pulmonary Inflammation in Patients without Preexisting Lung Injury

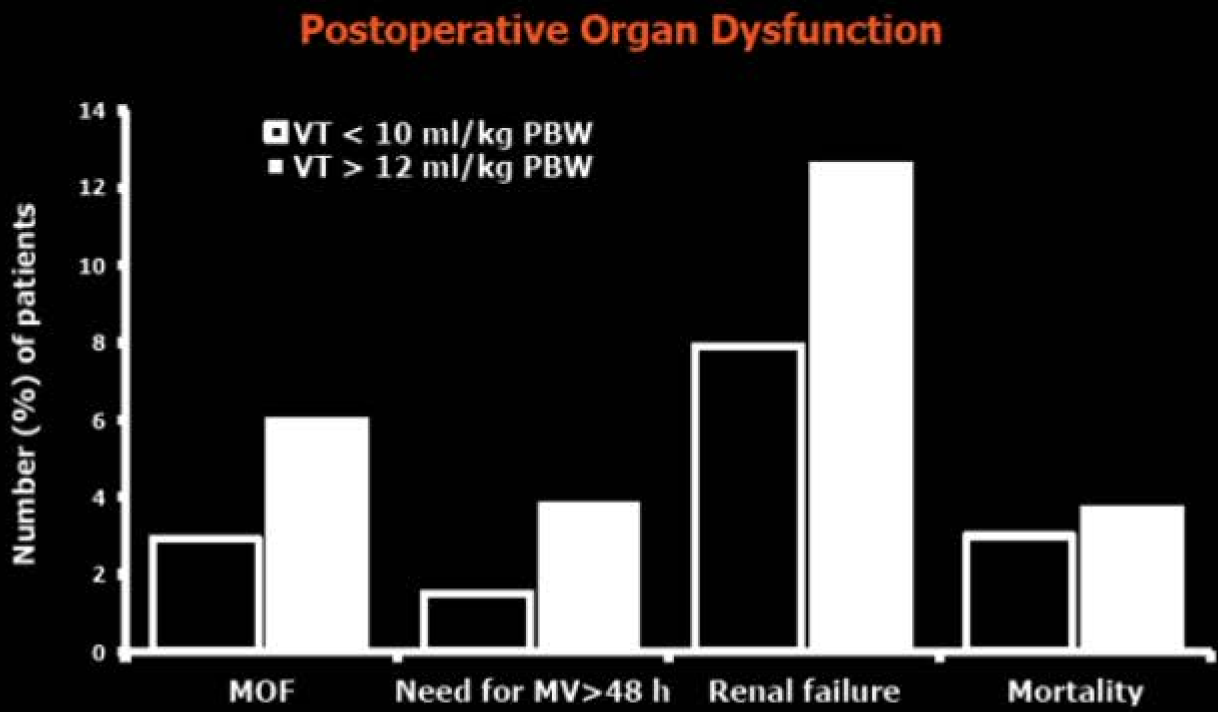
Esther K. Wolthuis, M.D., Goda Choi, M.D., Ph.D., Mark C. Dessing, Ph.D., Paul Bresser, M.D., Ph.D., Rene Lutter, Ph.D., Misa Dzoljic, M.D., Ph.D., Tom van der Poll, M.D., Ph.D., Margreeth B. Vroom, M.D., Ph.D.,Markus Hollmann, M.D., Ph.D., Marcus J. Schultz, M.D., Ph.D.



High Tidal Volumes in Mechanically Ventilated Patients Increase Organ Dysfunction after Cardiac Surgery

Francois Lellouche, M.D., Ph.D., Stephanie Dionne, Serge Simard, M.Sc., Jean Bussieres, M.D., Francois Dagenais, M.D.

N = 3434 patients from Janvier 2004 to Mars 2006



Lellouche F et al. **Anesthesiology** 2012 116:1072-82

CARING FOR THE CRITICALLY ILL PATIENT

Ary Serpa Neto, MD, MSc
Sergio Oliveira Cardoso, MD
José Antônio Manetta, MD
Victor Galvão Moura Pereira, MD
Daniel Crepaldi Espósito, MD
Manoela de Oliveira Prado Pasqualucci, MD
Maria Cecília Toledo Damasceno, MD, PhD
Marcus J. Schultz, MD, PhD

Association Between Use of Lung-Protective Ventilation With Lower Tidal Volumes and Clinical Outcomes Among Patients Without Acute Respiratory Distress Syndrome

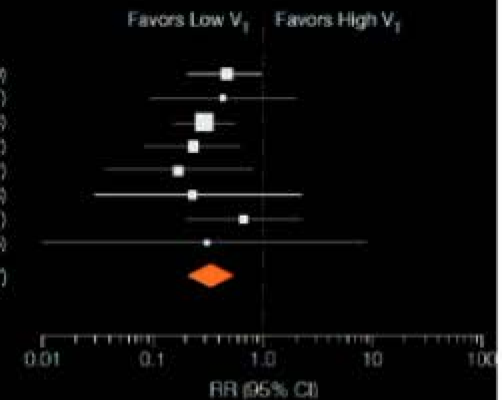
A Meta-analysis

JAMA 2012; 308(16):1651-1659

Lung injury

	High V_T, No.		Low V_T, No.			
	Events	Total	Events	Total	Weight, %	RR (95% CI)
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,[21] 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,[22] 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			

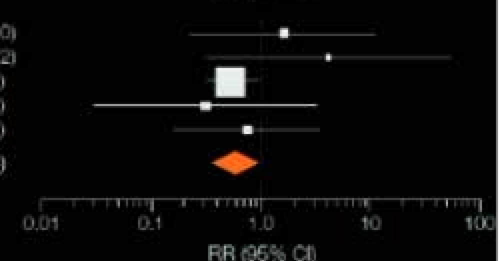
Heterogeneity: $\chi^2_7 = 3.74$; $P = .81$; $I^2 = 0\%$
Test for overall effect: $z = 6.06$; $P < .001$



Atelectasis

	High V_T, No.		Low V_T, No.			
	Events	Total	Events	Total	Weight, %	RR (95% CI)
Lin et al,[25] 2008	2	20	3	20	3.1	1.59 (0.24-10.70)
Cai et al,[24] 2007	5	8	7	8	1.1	4.20 (0.33-53.12)
Licker et al,[26] 2009	47	533	28	558	83.1	0.55 (0.34-0.89)
Yang et al,[21] 2011	3	50	1	50	5.4	0.32 (0.03-3.18)
Weingarten et al,[22] 2012	5	20	4	20	7.3	0.75 (0.17-3.33)
Subtotal (95% CI)		631		656	100.0	0.62 (0.41-0.95)
Total events	62		43			

Heterogeneity: $\chi^2_4 = 3.76$; $P = .44$; $I^2 = 0\%$
Test for overall effect: $z = 2.18$; $P = .03$



EDITORIAL

Editorials represent the opinions
of the authors and *JAMA* and
not those of the American Medical Association.

Low Tidal Volumes for All?

Niall D. Ferguson, MD, MSc

Why do we not simply move to implement lung protective ventilation in the OR?

Low Tidal Volume Ventilation

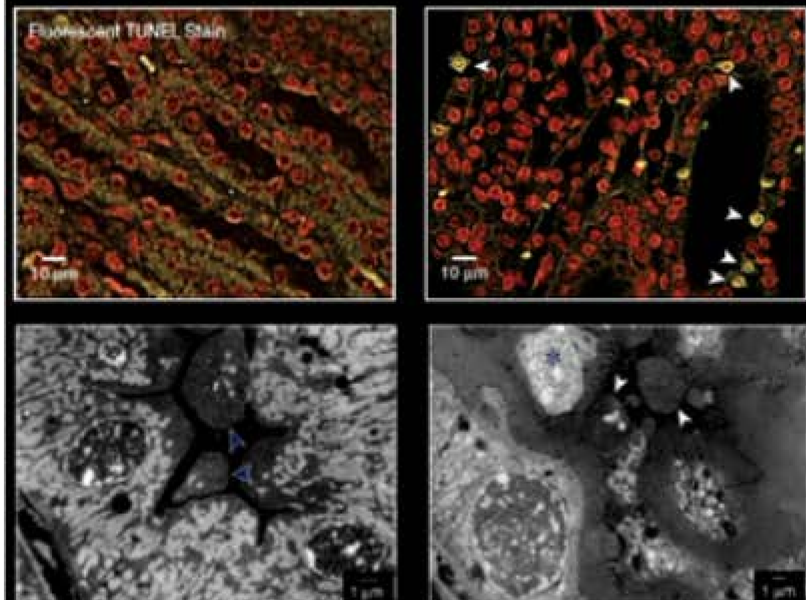
Main differences between ICU and OR patients

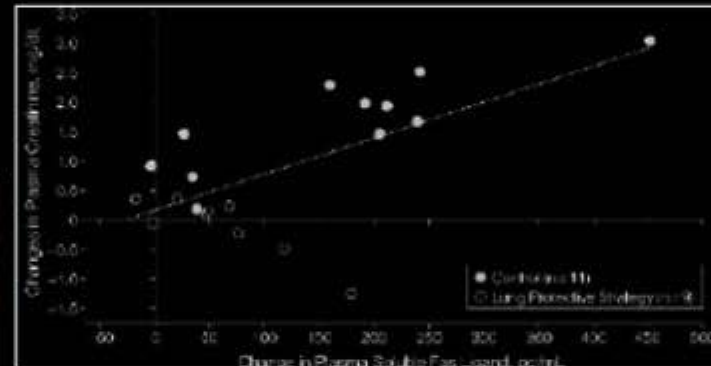
In ICU patients		In OR patients
Prolonged (≥24h)	Duration of MV	Short-term (<6-8h)
Sometimes difficult	weaning from MV	Easy in most patients

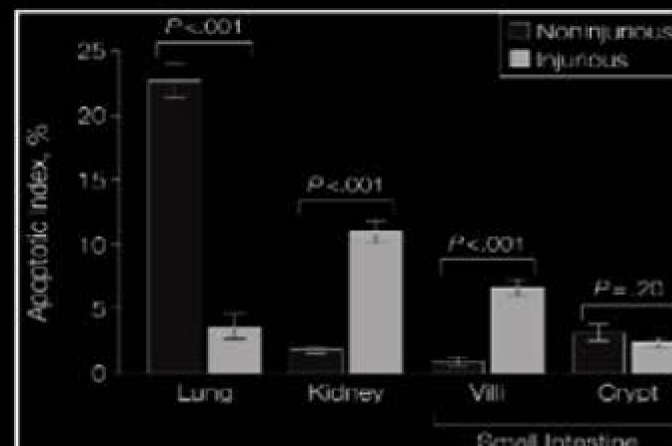
Injurious mechanical ventilation and end-organ epithelial cell apoptosis and organ dysfunction in an experimental model of acute respiratory distress syndrome.

Non-Injurious Ventilation – 8 hours
TV 5-7 ml/kg, PEEP 9-12 cmH$_2$O

Injurious Ventilation – 8 hours
TV 15-17 ml/kg, PEEP 0-3 cmH$_2$O





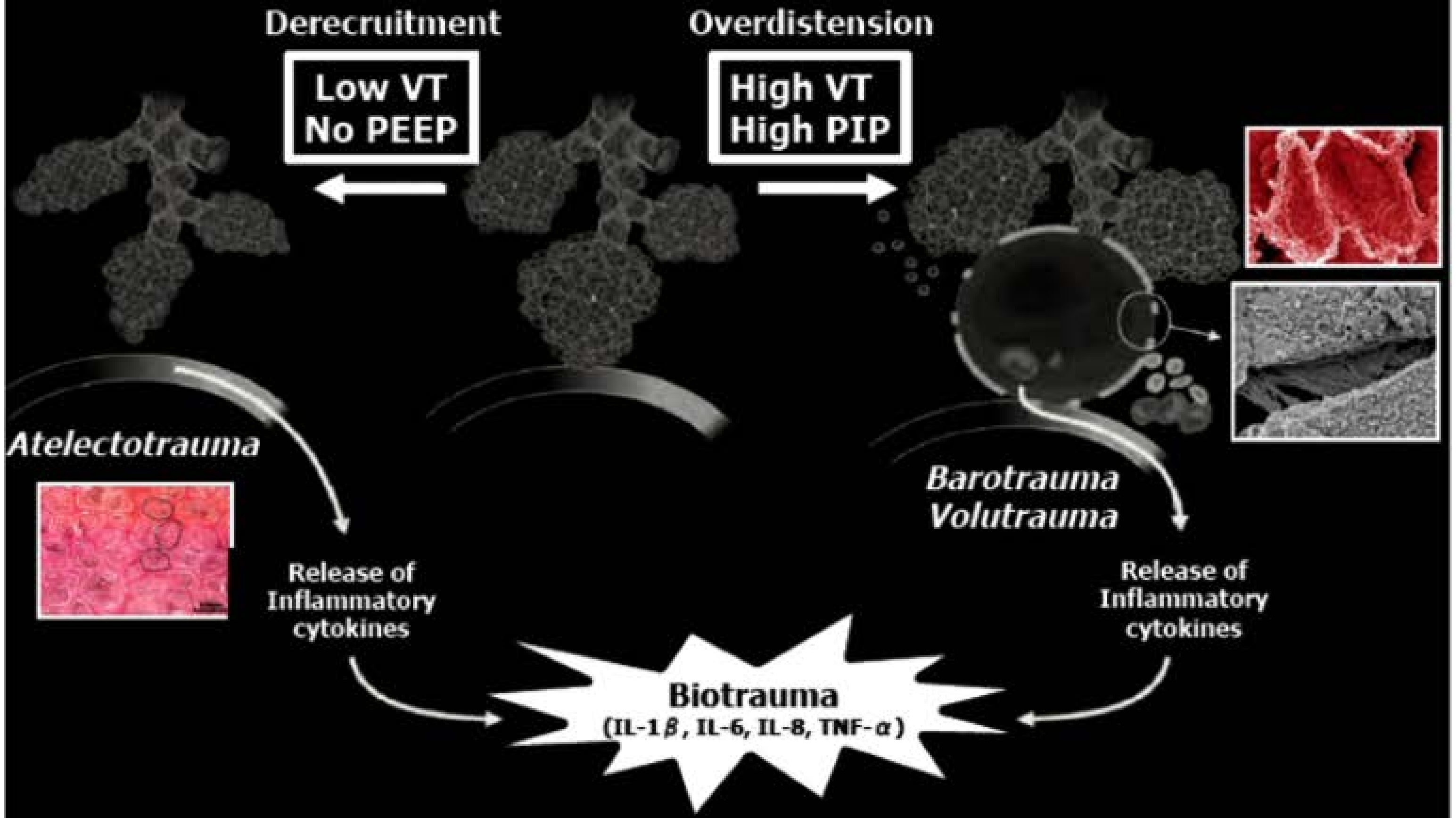


- Even short-term injurious ventilation can produce lung damage
- Injurious mechanical ventilation can lead to epithelial cell apoptosis (kidney, small intestine)
- This effect could be mediated by solube factors (Fas-Fas ligand system)

Imai Y et al. Jama 2003

Mechanical ventilation during major trauma

DO NOT MAKE MORE HARM!



Ventilator-associated lung injury (VALI)

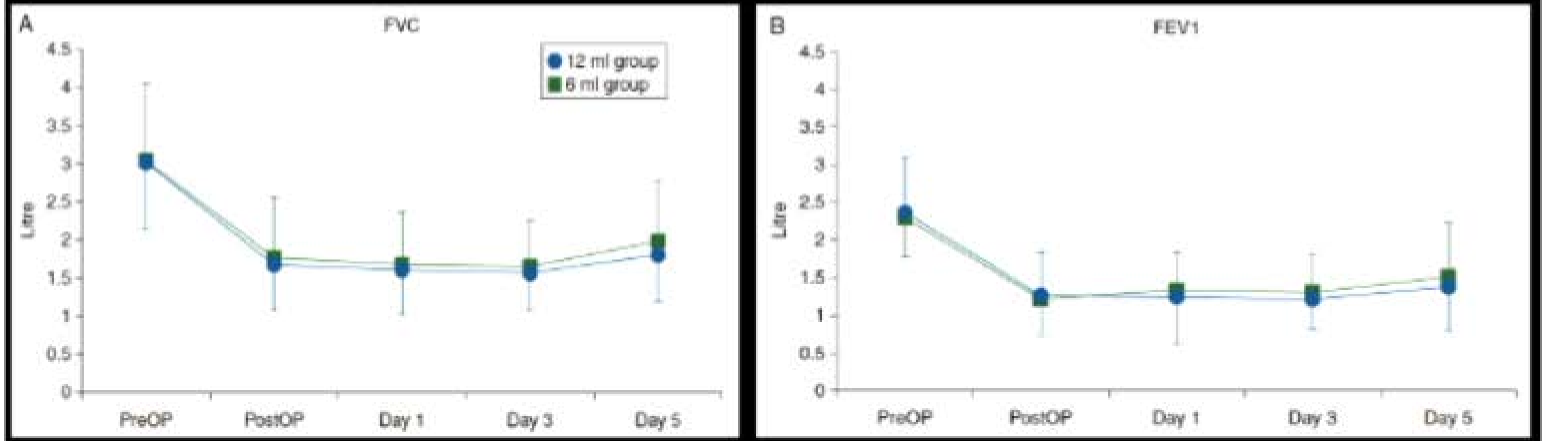
Tusman G et al. Curr Opin Anesthesiol 2012

Lung Protective Ventilation is NOT JUST LOWER VT !

Ventilation with low tidal volumes during upper abdominal surgery does not improve postoperative lung function

T. A. Treschan, W. Kaisers, M. S. Schaefer, B. Bastin, U. Schmalz, V. Wania, C. F. Eisenberger, A. Saleh, M. Weiss, A. Schmitz, P. Kienbaum, D. I. Sessler, B. Pannen and M. Beiderlinden

101 undergoing elective upper abdominal surgery lasting at least 3 h with combined general and epidural anaesthesia



	High TV group (n = 51)	Low TV group (n = 50)
TV, ml/kg PBW	12.0 ± 2.3	6.7 ± 1.1
PEEP, cmH_2O	5	5
Recruitment maneuver	0	0
Minute ventilation, l	6.2 ± 1.9	7.8 ± 2.1
Duration of surgery, h	6.1 ± 2.1	6.1 ± 2.7

Treschan TA et al. **Br J Anaesth** 2012

Lung Protective Ventilation in surgical patients should ideally be a combination of:

- Low Tidal Volume (<10 ml/kg PBW)

- Positive End Expiratory Pressure (>5 cmH_2O)

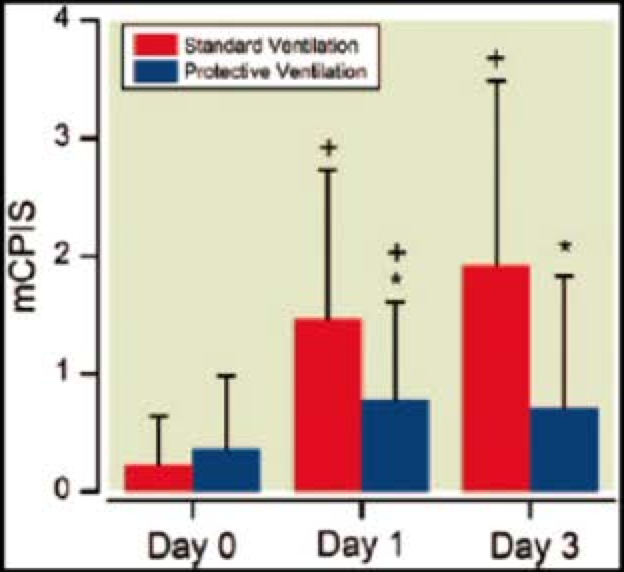
- Alveolar Recruitment Maneuver (early and repeated)

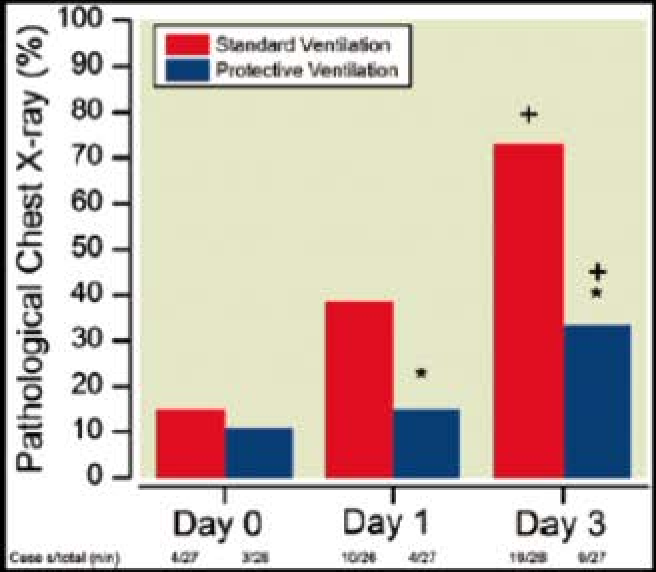
Protective Mechanical Ventilation during General Anesthesia for Open Abdominal Surgery Improves Postoperative Pulmonary Function

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

56 Patients undergoing elective open abdominal surgery

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





Severgnini P. et al. Anesthesiology 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*

The *IMPROVE* study

N Engl J Med 2013, 369:428-37

- **Intraoperative Protective Ventilation in Abdominal Surgery (IMPROVE Study)**

Control group	Intervention group
VT 10-12 ml/kg IBW	VT 6-8 ml/kg IBW
No PEEP	PEEP 6-8 cmH2O
No Recruitment maneuver	Recruitment maneuvers : 1. After intubation 2. Repeated every 30-40 min

A pragmatic multicenter, double-blinded, randomized controlled trial

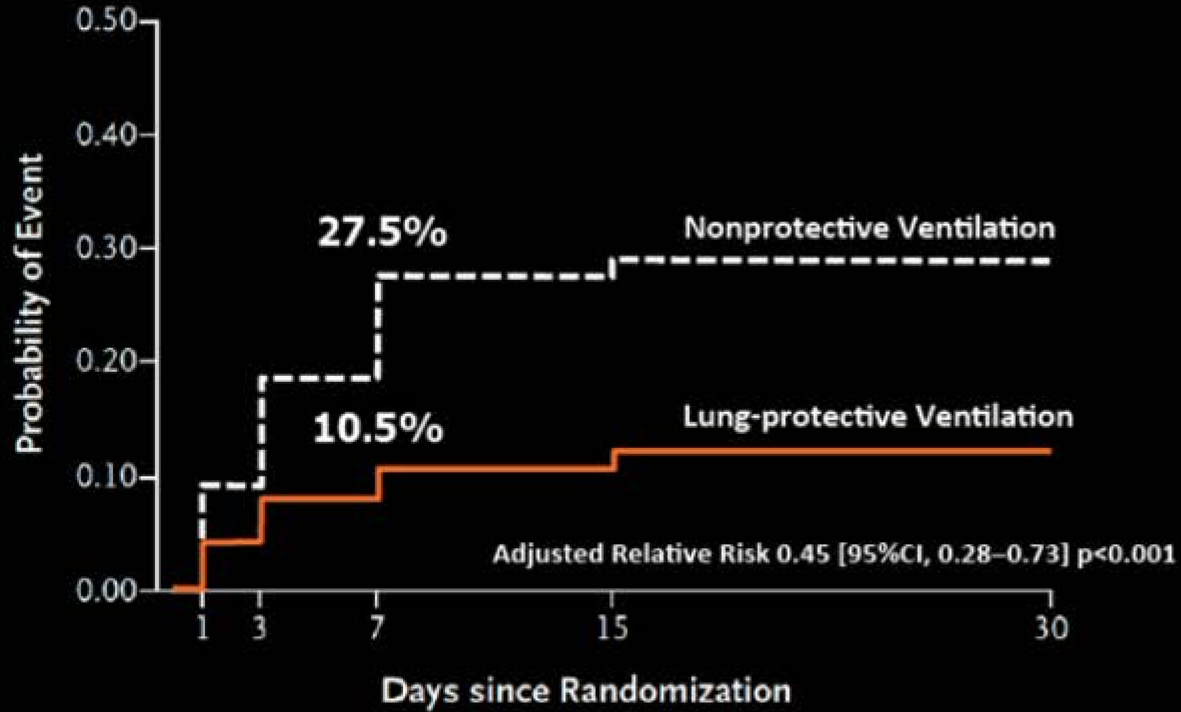
Lung-Protective Ventilation N=200	VS.	Non-Protective Ventilation N=200
V_T 6 to 8 ml/kg PBW PEEP 6 to 8 cmH_2O Recruitment Maneuver		V_T 10 to 12 ml/kg PBW No PEEP No Recruitment Maneuver

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

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

The *IMPROVE* study

Kaplan–Meier Estimates of the Probability of severe pulmonary and extra-pulmonary complications



No. at Risk

Nonprotective ventilation	200	182	163	145	142	142
Lung-protective ventilation	200	192	184	179	176	175

The *IMPROVE* study

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

Control group	Intervention group
VT 8 ml/kg IBW	VT 8 ml/kg IBW
PEEP ≤ 2 cmH2O	PEEP 12 cmH2O
No Recruitment maneuver	Recruitment maneuvers :
	1. After intubation
	2. After any disconnection from the vent
	3. Before detubation

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

The Lancet, Volume 384, Issue 9942, 495 - 50

PROVHILO trial

- Postoperative pulmonary complicarions
- 174/445 (40%) in high PEEP group
- 172/449 (39%) in low PEEP group

- Group high PEEP – intraoperative hypotension with vasoactive drugs

Anesthesiology 2009; 111:979–87

Prevention of Atelectasis in Morbidly Obese Patients during General Anesthesia and Paralysis

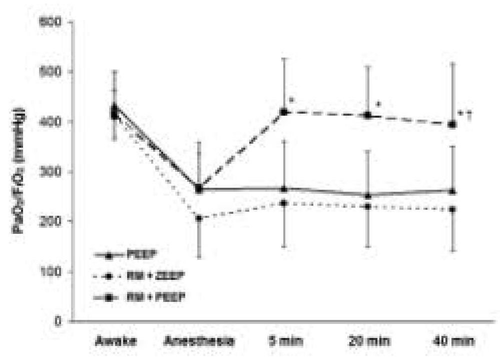
A Computerized Tomography Study

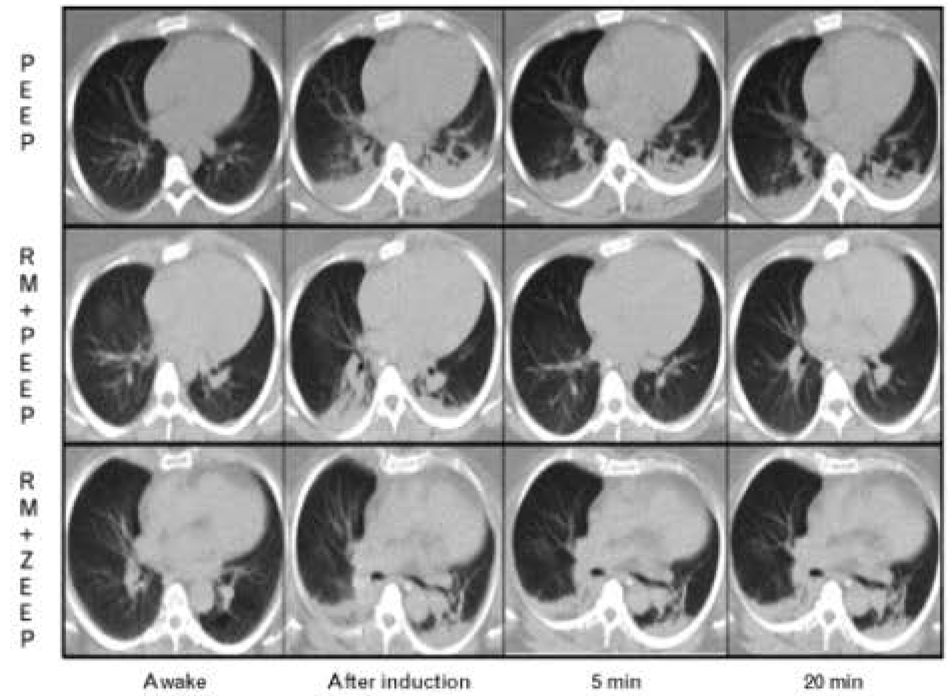
Henrik Reinius, M.D.,* Lennart Jonsson, M.D.,* Sven Gustafsson, M.D., Ph.D.,† Magnus Sundbom, M.D., Ph.D.,†
Olov Duvernoy, M.D., Ph.D.,|| Paolo Pelosi, M.D., Ph.D.,‡ Göran Hedenstierna, M.D., Ph.D.,§ Filip Fredén, M.D., Ph.D.*

BMI: 45 ± 4

RM (55 cmH_20; 10 s)

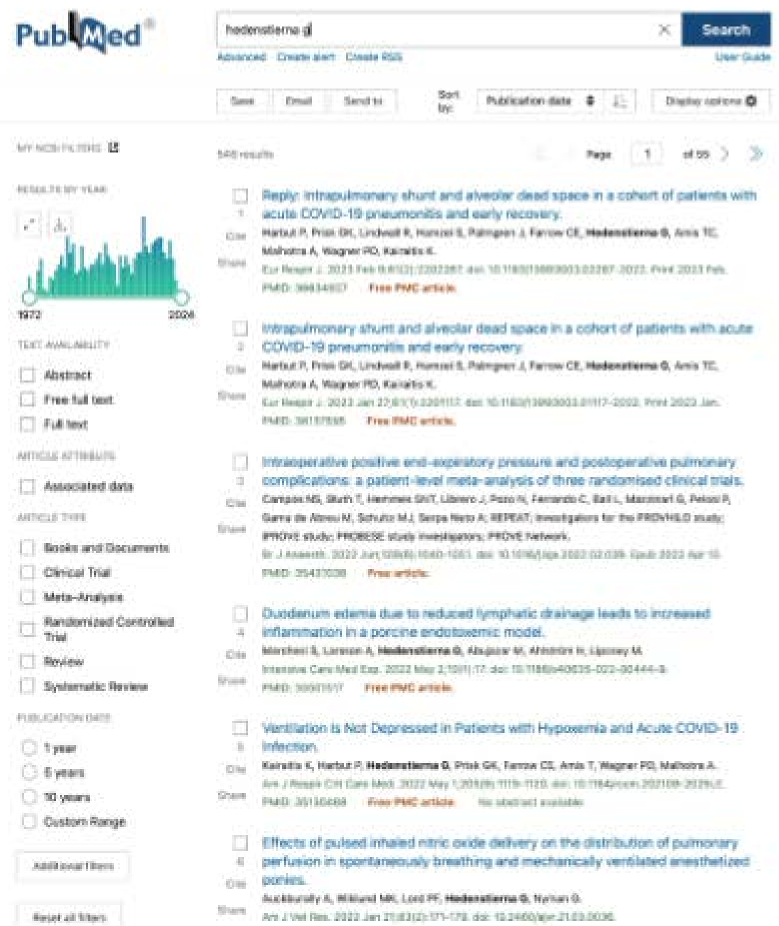
PEEP: 10 cm H_2O





WHO Surgical Site Infection Prevention Guidelines Web Appendix 13
Summary of systematic review on perioperative oxygenation

Overall, a moderate quality of evidence shows that increased perioperative FiO2 (80%) is beneficial in reducing SSI when compared to standard perioperative FiO2 (30-35%) in patients undergoing surgical procedures under general anaesthesia with endotracheal intubation



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Books and Documents
Clinical Trial
Meta-Analysis
Randomized Controlled Trial
Review
Systematic Review
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10 years
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1
Reply: Intrapulmonary shunt and alveolar dead space in a cohort of patients with acute COVID-19 pneumonitis and early recovery.
Harbut P, Prisk GK, Lindwall R, Hamzei S, Palmgren J, Farrow CE, Hedenstierna G, Amis TC, Malhotra A, Wagner PD, Kairaitis K.
Free PMC article.
Intrapulmonary shunt and alveolar dead space in a cohort of patients with acute COVID-19 pneumonitis and early recovery.
Harbut P, Prisk GK, Lindwall R, Hamzei S, Palmgren J, Farrow CE, Hedenstierna G, Amis TC, Malhotra A, Wagner PD, Kairaitis K.
Free PMC article.
Intraoperative positive end-expiratory pressure and postoperative pulmonary complications: a patient-level meta-analysis of three randomised clinical trials.
Free article.
Duodenum edema due to reduced lymphatic drainage leads to increased inflammation in a porcine endotoxemic model.
Free PMC article.
Ventilation is Not Depressed in Patients with Hypoxemia and Acute COVID-19 Infection.
Kairaitis K, Harbut P, Hedenstierna G, Prisk GK, Farrow CS, Amis T, Wagner PD, Malhotra A.
Free PMC article.
Effects of pulsed inhaled nitric oxide delivery on the distribution of pulmonary perfusion in spontaneously breathing and mechanically ventilated anesthetized ponies.
Cite
Share

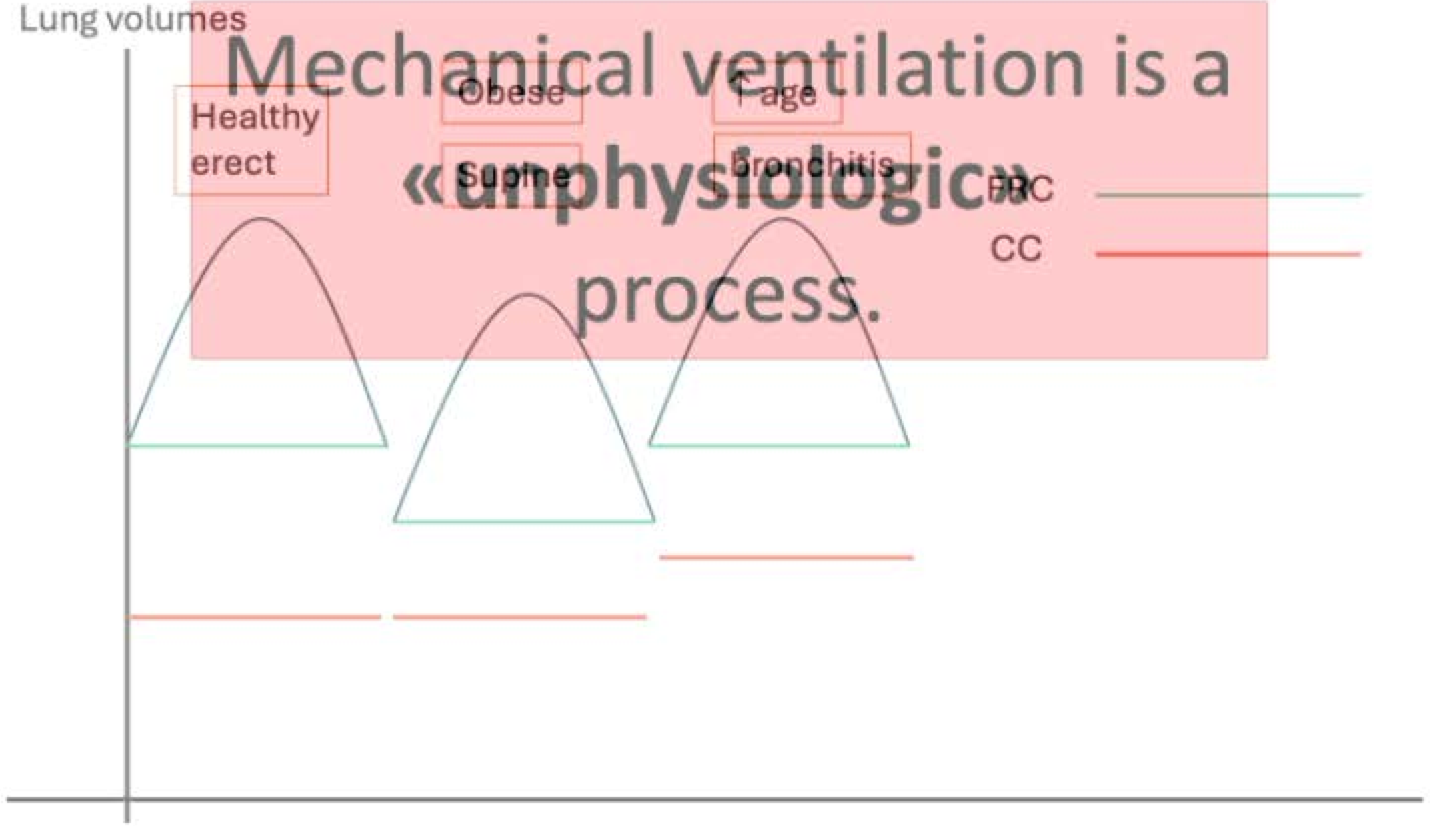
FiO$_2$

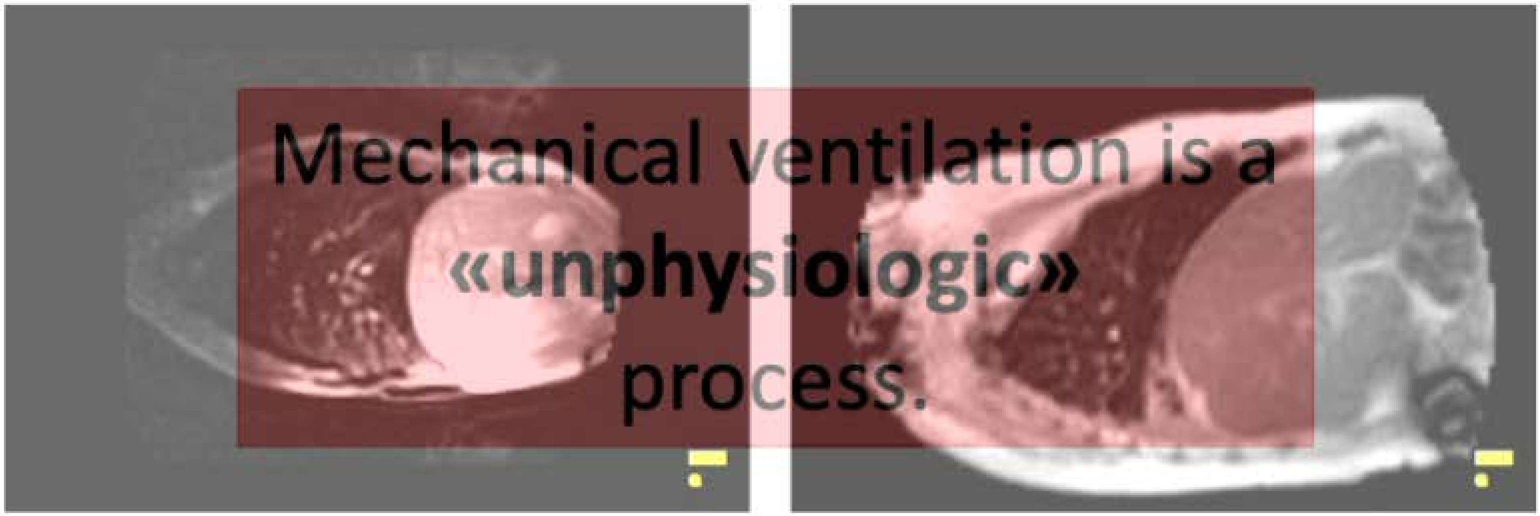
Mechanisms of atelectasis in the perioperative period

Göran Hedenstierna [1], Lennart Edmark

Hedenstierna G, Edmark L. Mechanisms of atelectasis in the perioperative period. Best Pract Res Clin Anaesthesiol. 2010 Jun;24(2):157-69.

Mechanical ventilation is a **«unphysiologic»** process.



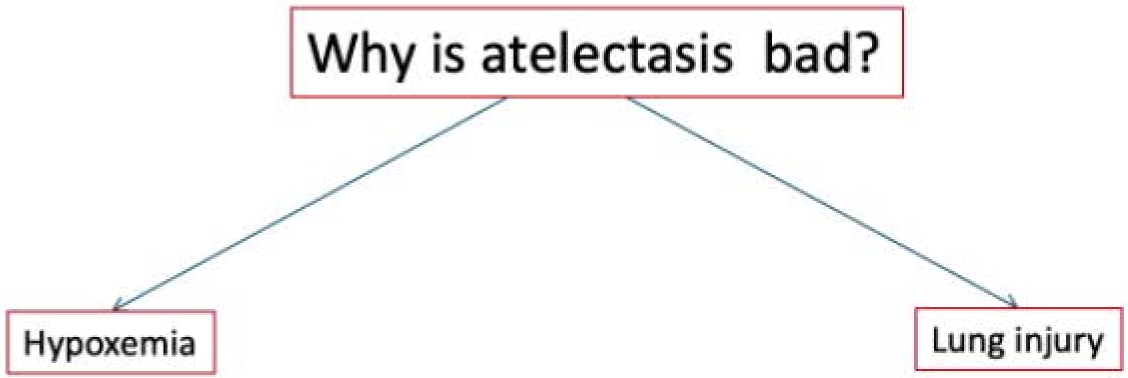


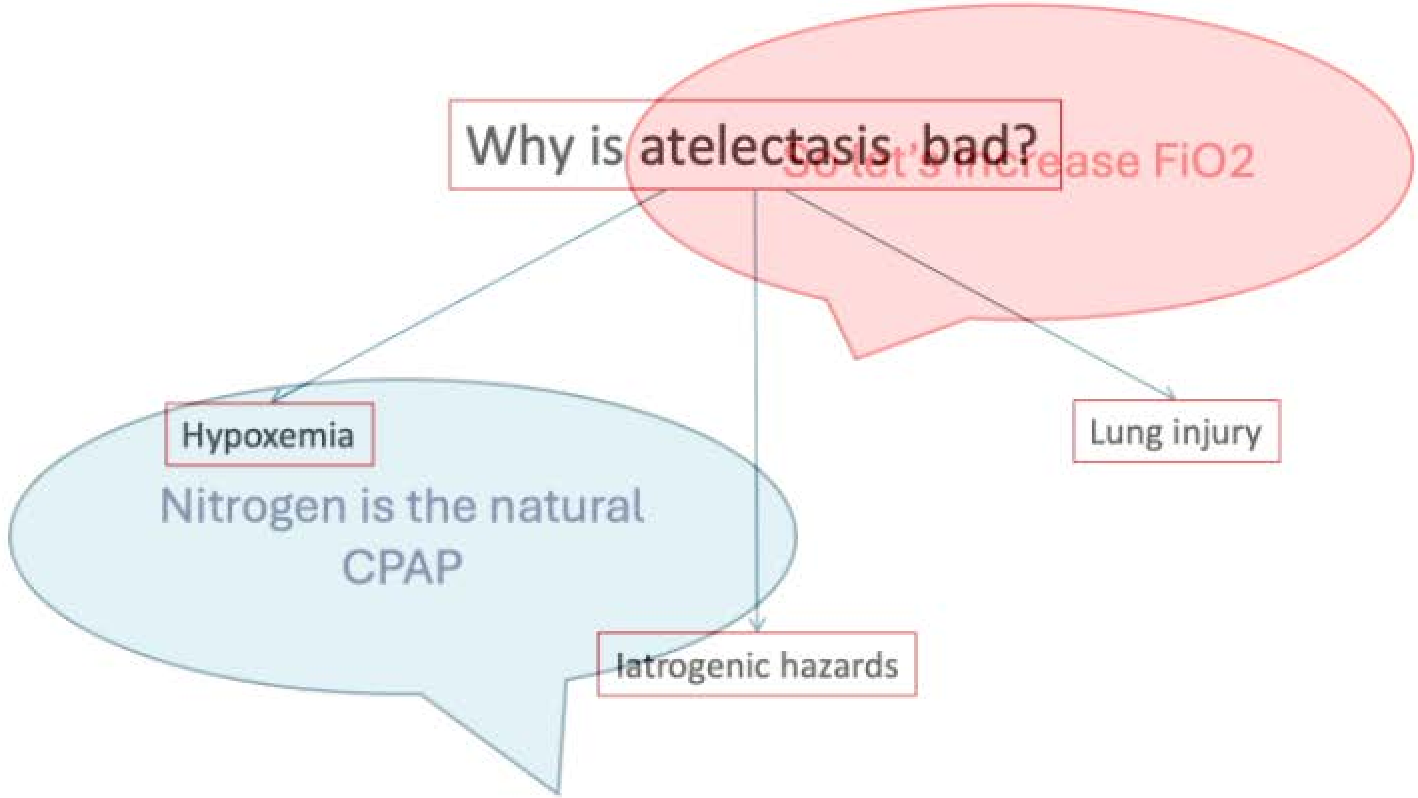
Mechanical ventilation is a
«unphysiologic»
process.

Positive pressure

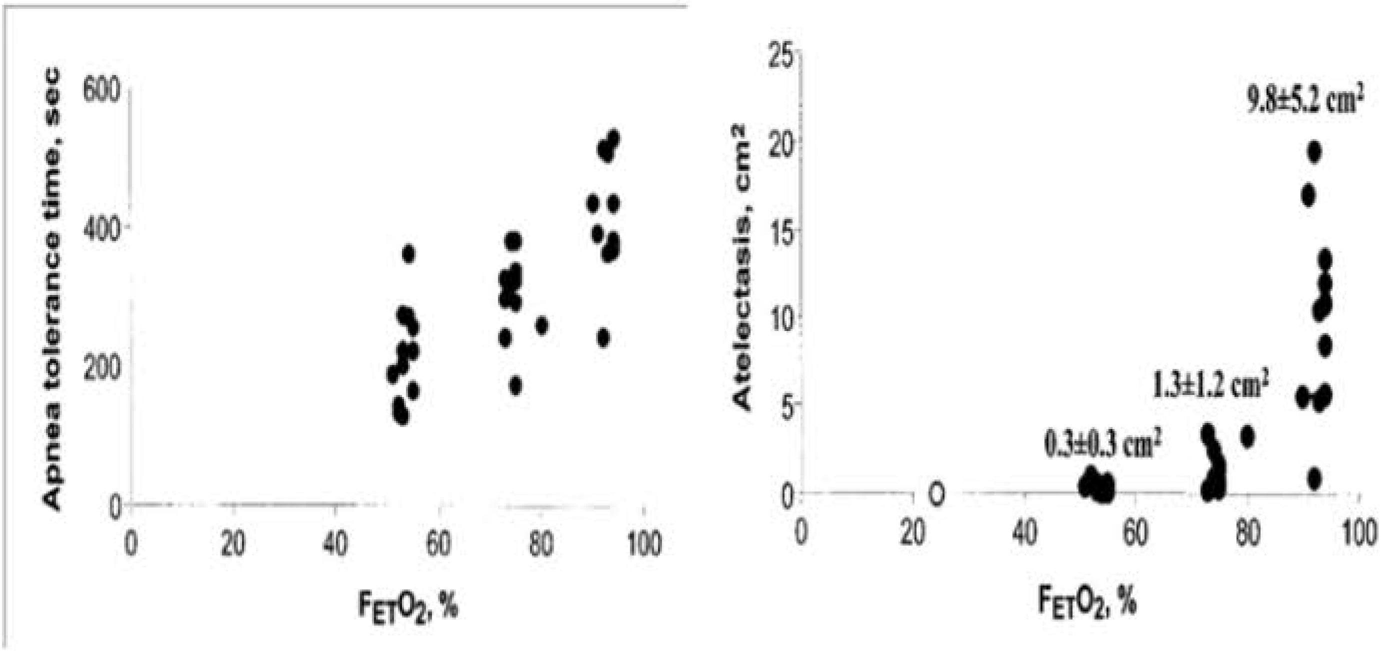
Gas mixture

Drugs

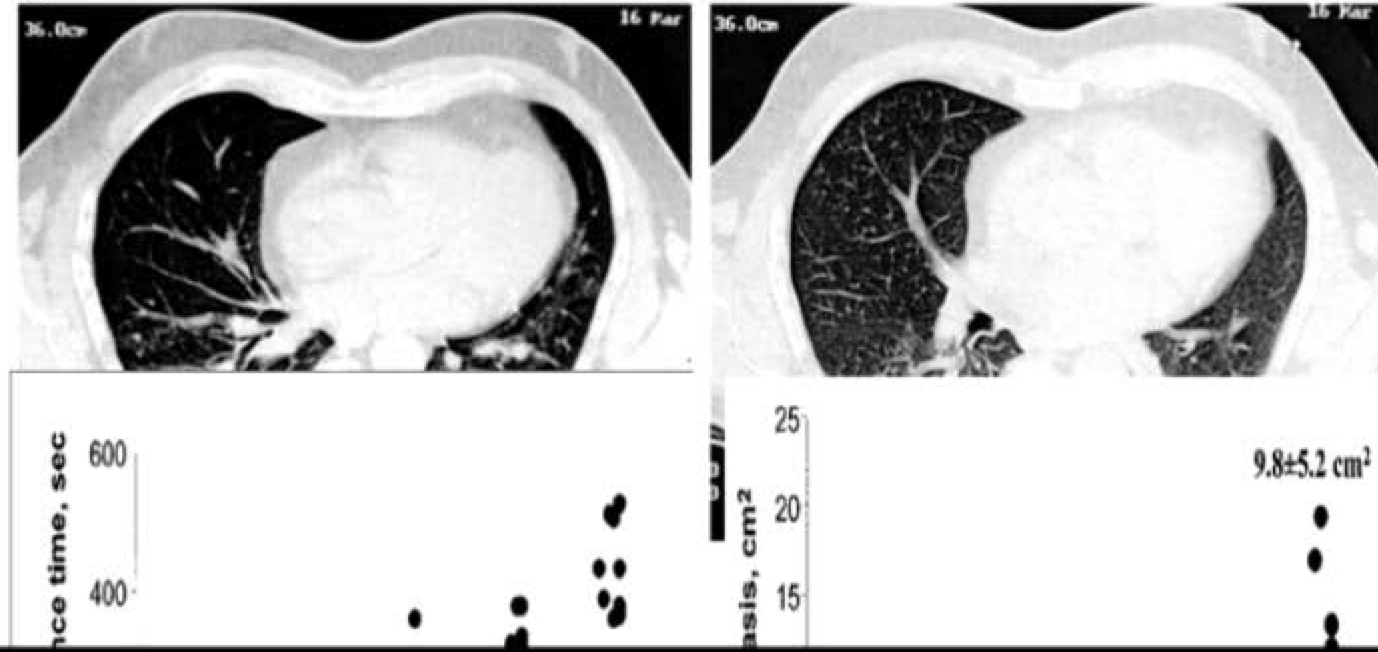

Why is atelectasis bad?
Hypoxemia
Lung injury



Why is atelectasis bad?
So let's increase FiO2
Hypoxemia
Nitrogen is the natural CPAP
Iatrogenic hazards
Lung injury


Apnea tolerance time, sec
600
400
200
0
0 20 40 60 80 100
$F_{ET}O_2$, %
Atelectasis, cm²
25
20
15
10
5
0
0 20 40 60 80 100
9.8±5.2 cm²
1.3±1.2 cm²
0.3±0.3 cm²
$F_{ET}O_2$, %

A

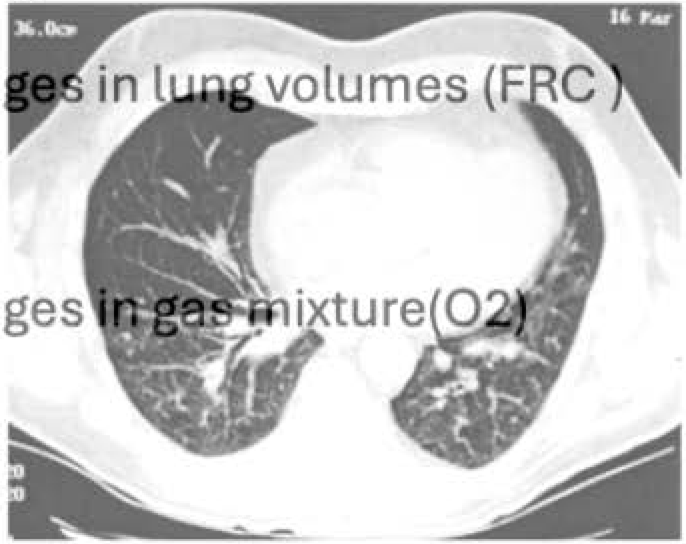

36.0cm
16 Mar
36.0cm
nce time, sec
600
400
asis, cm²
25
20
15
9.8±5.2 cm²

Atelectasis- How?

A

- Changes in lung volumes (FRC)

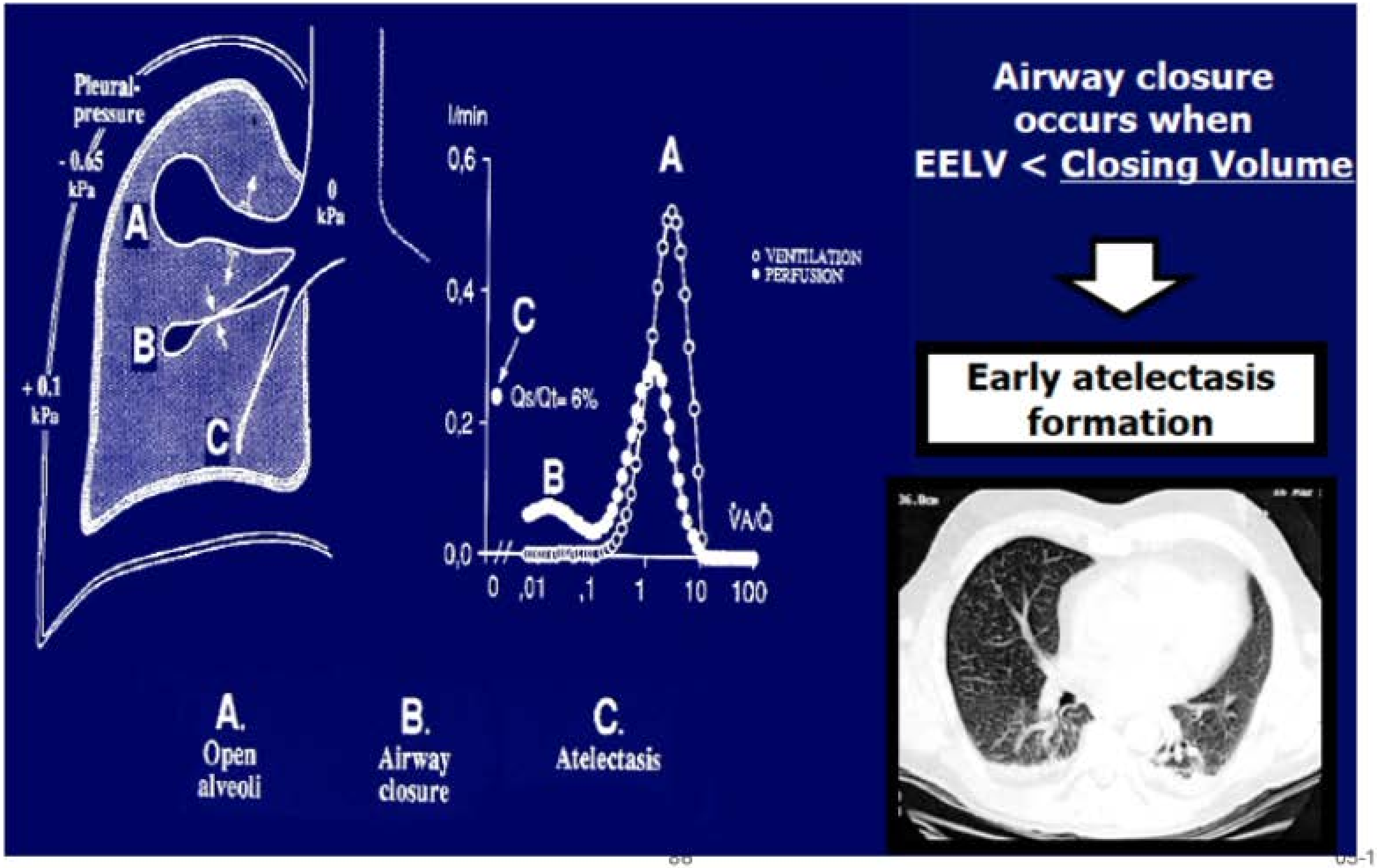
- Changes in gas mixture(O2)



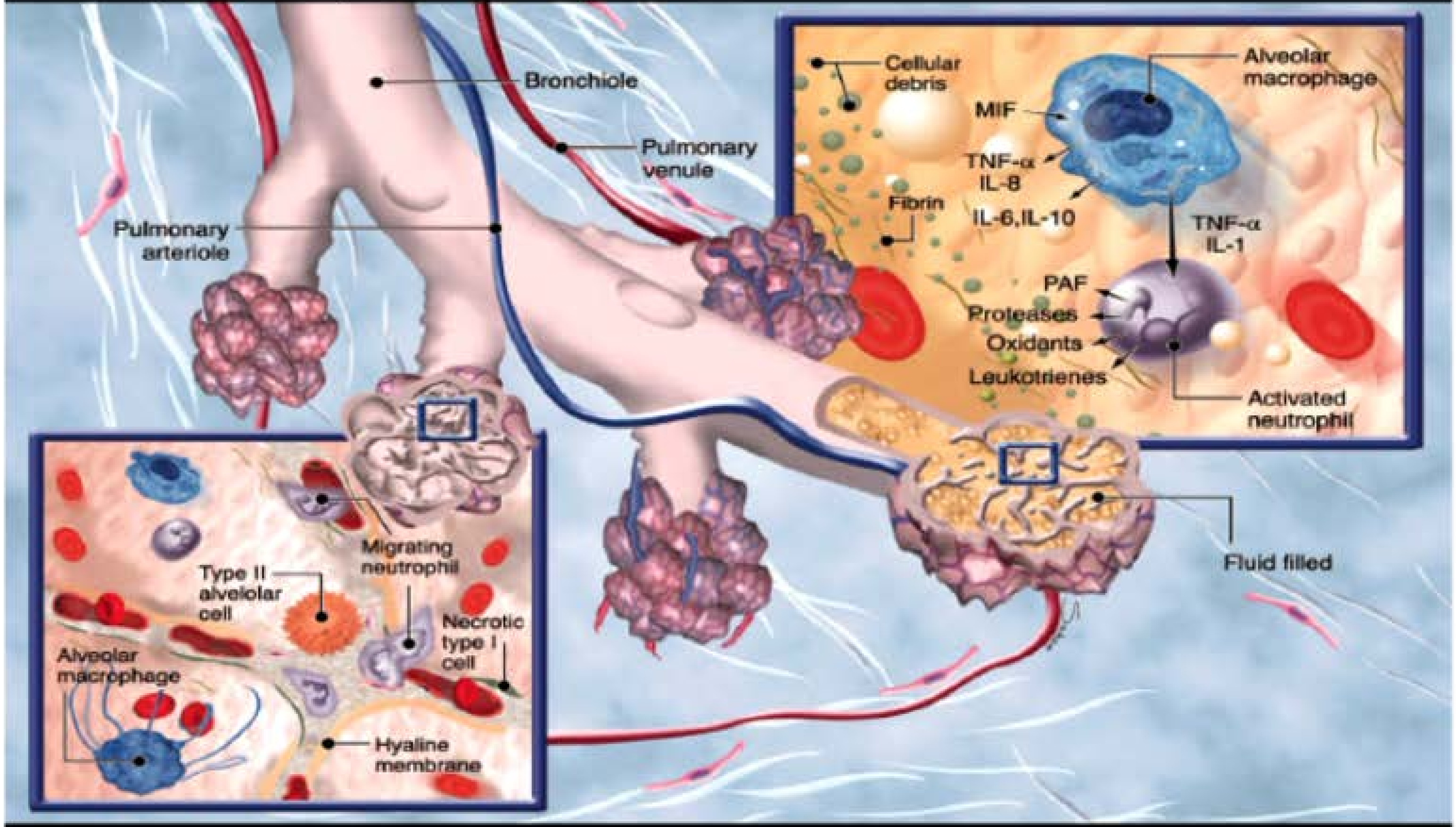
Before induction

After intubation

Airway Closure: the silent killer of peripheral airways



Pulmonary Atelectasis:
A Pathogenic Perioperative Entity



Initial injury is simple collapse of alveoli. However, with time, this leads to an inflammatory reaction. The derecruited lungs cause **epithelial injury** and **loss of epithelial integrity**

Duggan M. **Anesthesiology** 2005

Atelectasis

- Atelectasis in 90% of all patients who are anesthetized
- Up to 15-20% of the lungs is regularly collapsed prior to surgery
- Atelectasis can persist several days
- Likely to be a focus of infection and contributes to PPC

Hedenstierna G, Edmark L. Mechanisms of atelectasis in the perioperative period. Best Pract Res Clin Anaesthesiol. 2010 Jun;24(2):157-69.

Atelectasis

- RM followed by use of 40 O2/Air will result in reappearence of atelectasis

- Surgical manipulation and positioning favorise atelectasis

- Airway suctioning produce atelectasis

Hedenstierna G, Edmark L. Mechanisms of atelectasis in the perioperative period. Best Pract Res Clin Anaesthesiol. 2010 Jun;24(2):157-69.

APNEIC OXYGENATION IN MAN

M. Jack Frumin, M.D., Robert M. Epstein, M.D., Gerald Cohen, Ph.D.

Following denitrogenation, the endotracheal tube was left connected to the circle apparatus filled with 100 per cent oxygen and intermittent compression of the reservoir bag stopped.

Anesthesiology
Nov.–Dec. 1959

APNEIC OXYGENATION IN MAN

M. JACK FRUMIN, M.D., ROBERT M. EPSTEIN, M.D., GERALD COHEN, PH.D.

TABLE 1

APNEIC OXYGENATION IN MAN

Subject Number	Duration of Apnea (minutes)	Lowest Arterial Saturation (per cent)	Lowest Arterial pH	Highest $PaCO_2$ (mm. Hg)	Average Rate of Rise of $PaCO_2$ (mm. Hg/minute)
1	30	100	—	—	—
2	45	100	—	—	—
3	55	100	—	—	—
4	45	100	6.88	160	3.0
5	18	99	6.97	130	4.9
6	45	98	6.87	160	3.0
.7	53	98	6.72	250	3.5
8	38	100	6.96	130	2.7

Anesthesiology
Nov.–Dec. 1959

Anesthesiology
Nov.-Dec. 1959

Apneic oxygenation was carried out in 8 human subjects for periods between 15 and 55 minutes. The mechanism by which oxygenation was maintained during the period of increasing respiratory acidosis was described. A moderate to severe arterial hypertension usually developed followed by a mild hypotension when artificial respiration was resumed. The increases in plasma sodium, potassium, epinephrine and norepinephrine concentrations during the apnea were described and their relationship to the hypertension and the electrocardigraphic changes were discussed. The electrocardiographic patterns were usually unchanged during the production of profound acidosis with arrhythmias noted only twice, once after 7 minutes and once after 53 minutes of apnea. In the latter instance, ventricular tachycardia lasting one minute accompanied the institution of artificial respiration and carbon dioxide elimination. A severe metabolic acidosis accompanied the respiratory acidosis.

This study was supported by a grant from The National Foundation.

Joseph Priestley, (one of) the discoverer(s) of oxygen, has quoted: "… though pure dephlogistated air might be very useful as a medicine, it might not be so proper for us in the usual healthy state of the body; for, as a candle burns out much faster in dephlogistated than in common air, so we might live out too fast, and the animal powers be too soon exhausted in the pure king of air. A moralist would say that the air which nature has provided for us is as good as we deserve…".

WHO Needs High FIO_2?

Ozan Akca[1], Lorenzo Ball[2], F. Javier Belda[3], Peter Biro[4], Andrea Cortegiani[5], Arieh Eden[6], Carlos Ferrando[3], Luciano Gattinoni[7], Zeev Goldik[6], Cesare Gregoretti[5], Thomas Hachenberg[8], Göran Hedenstierna[9], Harriet W. Hopf[10], Thomas K. Hunt[11], Paolo Pelosi[2], Motaz Qadan[12], Daniel I. Sessler[13], Marina Soro[3], Mert Şentürk[14]

[1]*Department of Anesthesiology and Perioperative Medicine, Neuroscience ICU, University of Louisville, Kentucky, USA*

[2]*IRCCS AOU San Martino-IST, Department of Surgical Sciences and Integrated Diagnostics, University of Genoa, Genoa, Italy*

[3]*Department of Anesthesiology and Critical Care, Hospital Clinico Universitario, University of Valencia, Valencia, Spain*

[4]*Institute of Anesthesiology, University Hospital Zurich, Switzerland*

[5]*Department of Biopathology and Medical Biotechnologies (DIBIMED), Section of Anesthesia, Analgesia, Intensive Care and Emergency, Policlinico Paolo Giaccone. University of Palermo, Italy*

[6]*Department of Anesthesiology, Critical Care and Pain Medicine, Lady Davis Carmel Medical Center, Haifa, Israel*

[7]*Department of Anesthesiology Emergency & Intensive Care Medicine, Gottingen University, Gottingen, Germany*

[8]*Department of Anaesthesiology and Intensive Care Medicine, Otto-von-Guericke-University Magdeburg, Magdeburg, Germany*

[9]*Clinical Physiology, Uppsala University, Sweden*

[10]*Department of Anesthesiology, University of Utah, Salt Lake City, UT, USA*

[11]*Division of General Surgery, University of California, San Francisco, USA*

[12]*Massachusetts General Hospital, Department of Surgery, Harvard University, Massachusetts, USA*

[13]*Department of Outcomes Research, Anesthesiology Institute, Cleveland Clinic, Cleveland, Ohio, USA*

[14]*Department of Anaesthesiology and Reanimation, İstanbul University İstanbul School of Medicine, İstanbul, Turkey*

Listed according to the surnames.

Cite this article as: Akca O, Ball L, Belda FJ, Biro P, Cortegiani A, Eden A, et al. WHO Needs High FIO2? Turk J Anaesthesiol Reanim 2017; 45: 181-92.

World Health Organization and the *United States Center for Disease Control* have recently recommended the use of 0.8 FIO_2 in all adult surgical patients undergoing general anaesthesia, to prevent surgical site infections. This recommendation has arisen several discussions: As a matter of fact, there are numerous studies with different results about the effect of FIO_2 on surgical site infection. Moreover, the clinical effects of FIO_2 are not limited to infection control.

Multiple confounders for VILI

- Surgical intervention
- Fluid balance
- Oxygen toxicity
- Interaction of variables

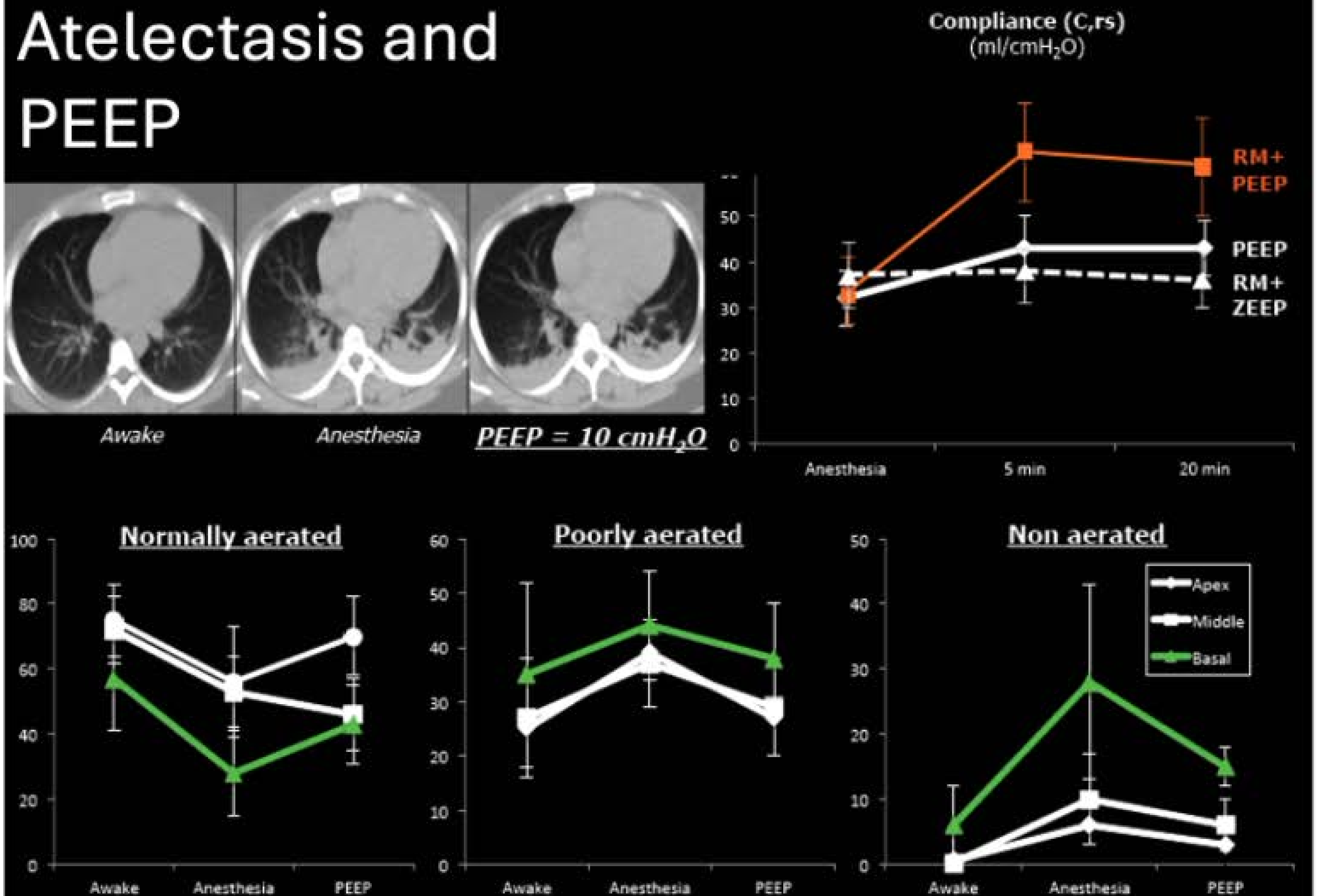
Ventilator induced lung injury

An evidence/physiological-based approach

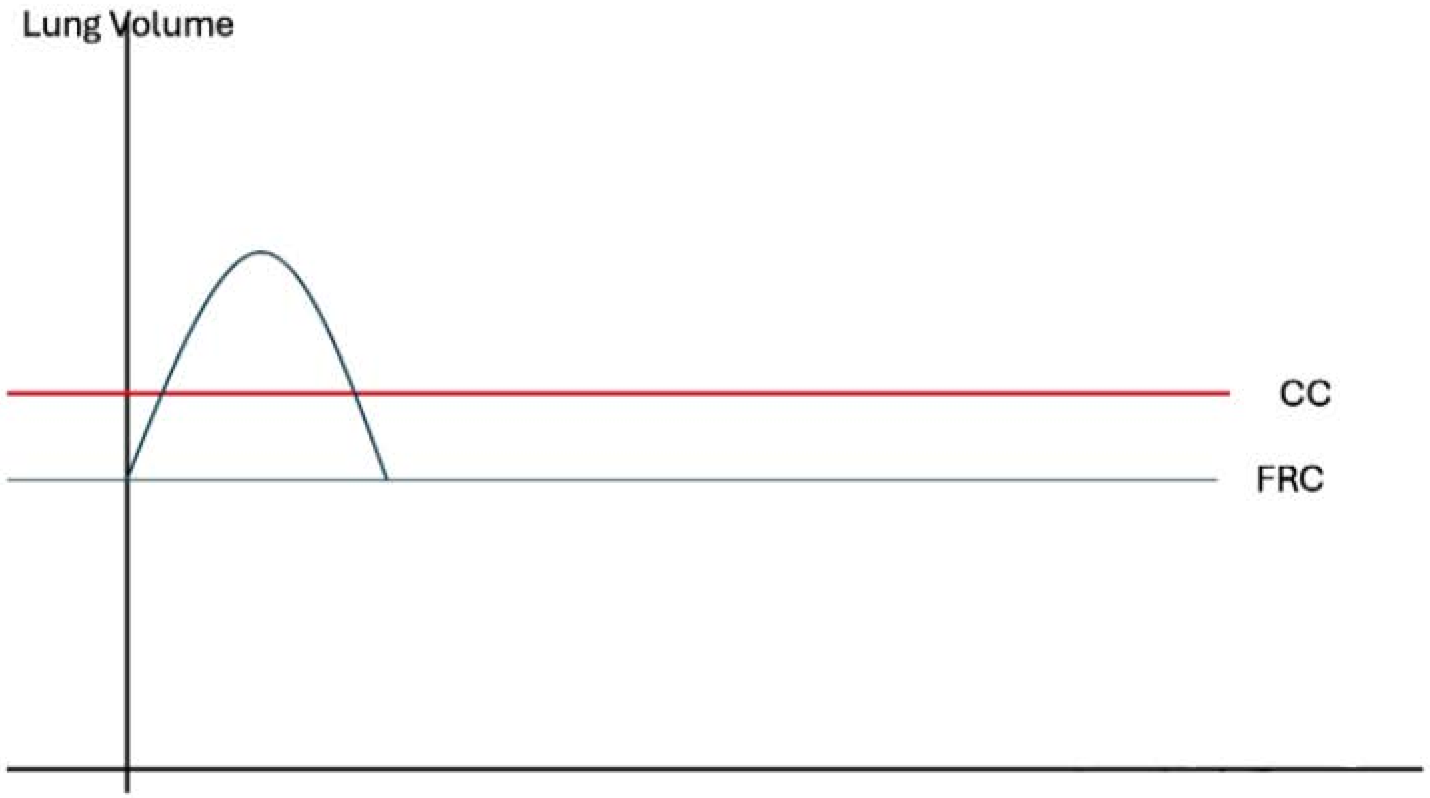
- Pressure or volume controlled ventilation
- Tidal volume of 4 - 5 - 6 -7 ml/kg
- Driving pressure < 15 cmH2O, avoid increase
- PEEP 5 to 10 cmH2O
- Recruitement manoeuvers, followed by PEEP titration

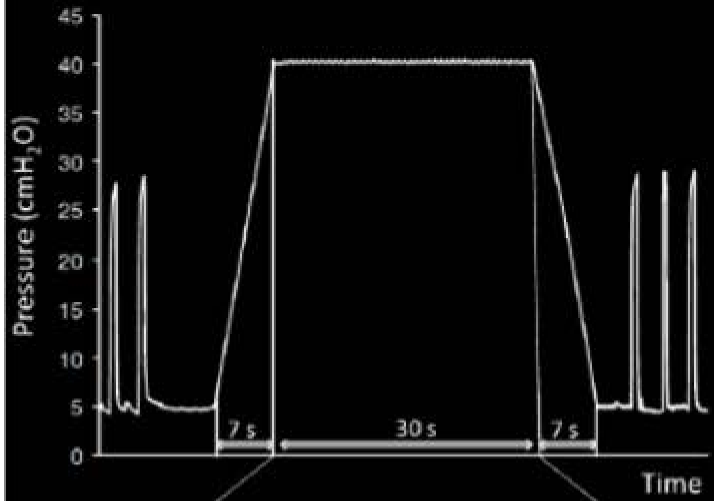
Hôpital Erasme ULB

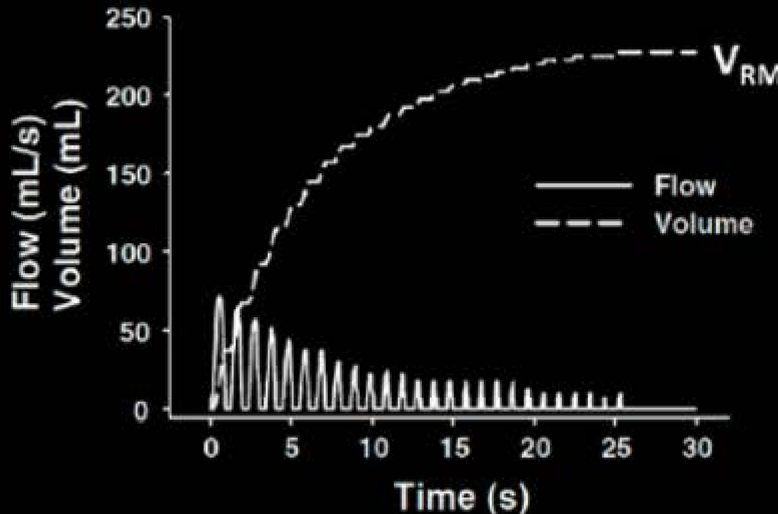
Atelectasis and PEEP



Reinius H et al. **Anesthesiology** 2009

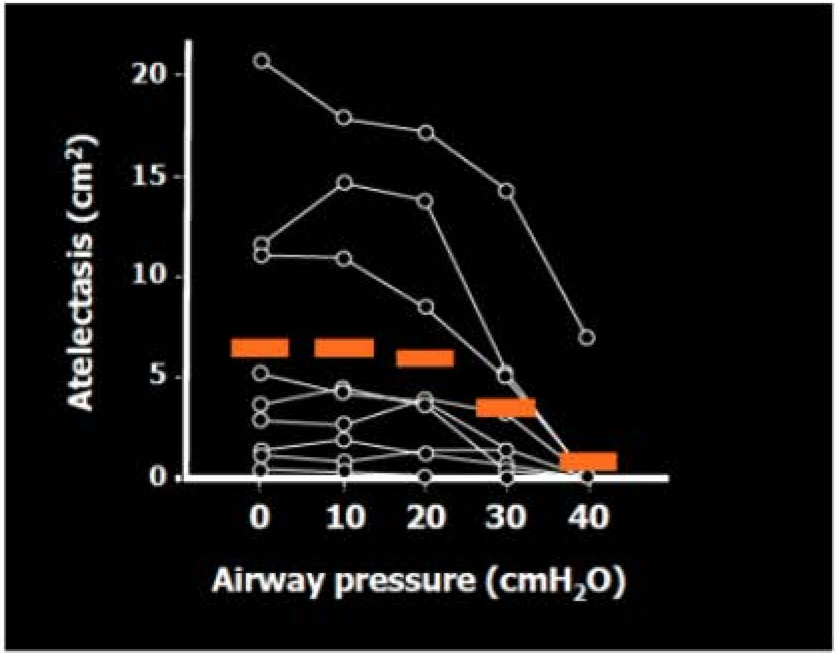

Lung Volume
CC
FRC





Recruitment is a pressure-dependent and time-dependent phenomenon

Arnal JM et al. **Intensive Care Med** 2011


Atelectasis (cm^2)
20
15
10
5
0
0
10
20
30
40
Airway pressure (cmH_2O)

1.CPAP or sustained insufflation:

- **40 cmH_2O / 40 seconds**
- **NEVER in children (bradycardia), nowadays neither in adults.**

Intensive Care Med (2007) 33:1778–1786
DOI 10.1007/s00134-007-0764-2

PEDIATRIC ORIGINAL

Jonathan P. Duff
Rhonda J. Rosychuk
Ari R. Joffe

The safety and efficacy of sustained inflations as a lung recruitment maneuver in pediatric intensive care unit patients

- From 11 days up to 14 years
- SI 30-40 cmH_2O, 15-20 seconds
- 93 RM in 32 patients
- 7 RM cancelled: 2 bradycardia and 5 fighting the ventilator
- Results: reduction on FiO_2 within 6 hours latter

Intensive Care Med (2007) 33:1778–1786
DOI 10.1007/s00134-007-0764-2

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titel

108

05-10-2024

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Rules of lung recruitment

The main objective is to re-open every single collapsed alveoli, so when all the possible alveoli has been opened, the tidal volume would be homogeneously distributed between the maximum alveoli possible of the lungs, decreasing the final driving pressure that each alveolus receive in each breath

- Collapse is an expiratory and instantaneous process.

- Re-open the lung is a maximum inspiratory pressure (PIP) and time depending process

- PEEP don´t recruit alveoli only prevent the re-collapse of the alveoli

In which patients and when?

Which patients?

Radiological criteria: x-ray not valid, only CT

When?

As soon as the patient need it BUT before it is indispensable:

- Hemodynamic stability with good preload
- NEVER in a hypovolemic patient
- Not recommendable just after the induction
- Anesthesia, preferably before surgery starts (laparoscopy) and after any disconnection.
- Critical care, every morning and after any disconnection (the less the better).

European Journal of Anaesthesiology

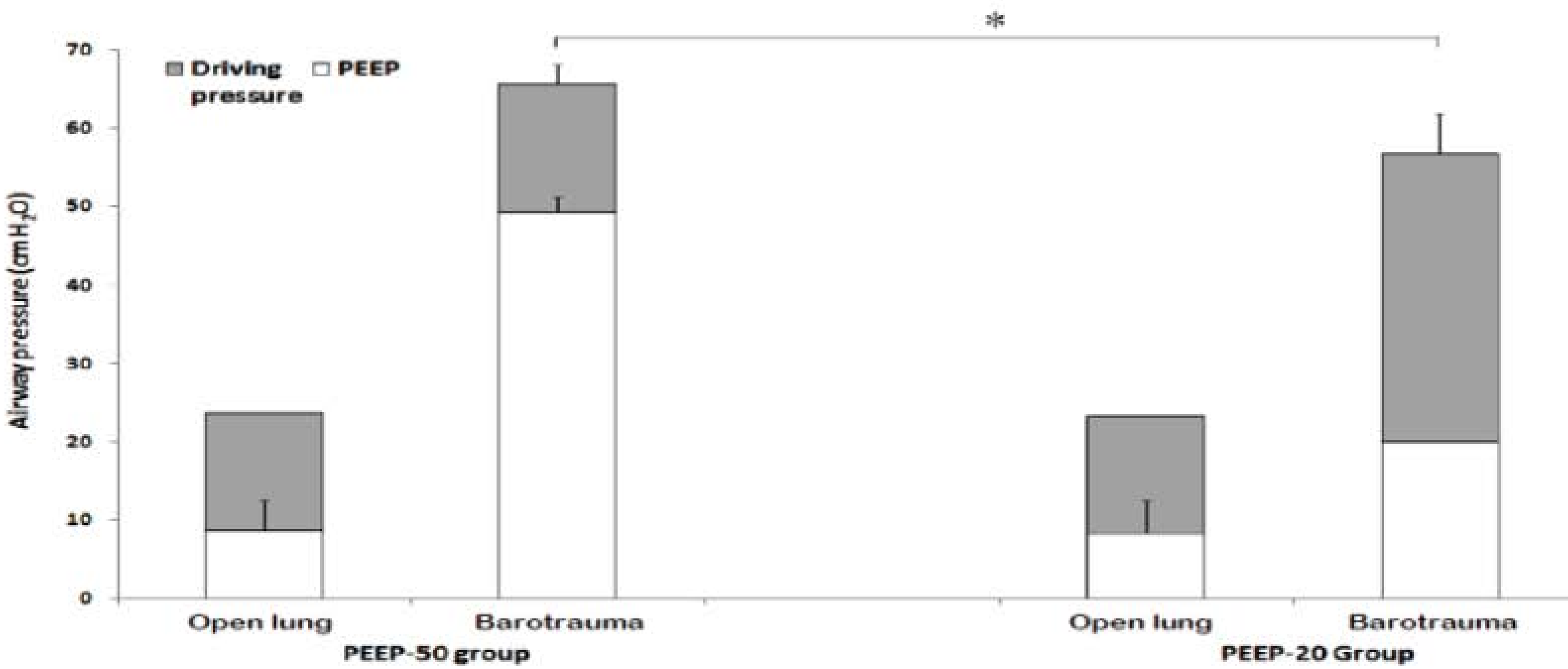
Pressure safety range of barotrauma with lung recruitment manoeuvres: a randomized experimental study in a healthy animal model

J Garcia Fernandez et al. EJA 2013.

	PEEP-20 group	PEEP-50 group
Anatomic open lung MIP (cmH_2O)	22,0 ± 2,7	21,0 ± 2,2
Overdistended threshold MIP (cmH_2O)	33,0 ± 2,7	34,0 ± 2,2
Barotrauma MIP (cmH_2O)	55,0 ± 3,5	67,0 ± 2,7 *
Safety range (cmH_2O)	22,0 ± 5,7	33,0 ± 2,7 *

* P < 0,01

Garcia Fernandez J. et al. EJA 2011; 28: 78-79



Garcia Fernandez J. et al. EJA 2011; 28: 78-79

Respiratory Physiology & Neurobiology 169 (2009) 271–281

Contents lists available at ScienceDirect

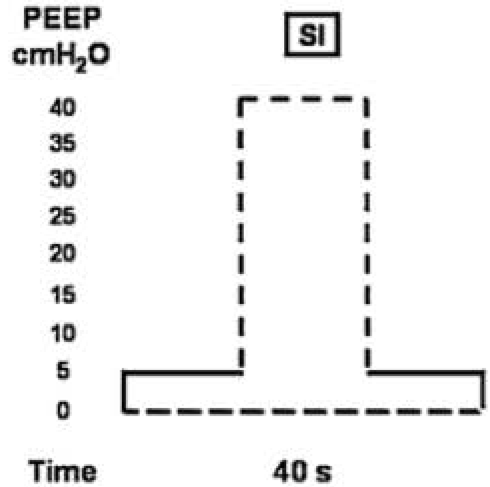
Respiratory Physiology & Neurobiology

journal homepage: www.elsevier.com/locate/resphysiol

ELSEVIER

Prolonged recruitment manoeuvre improves lung function with less ultrastructural damage in experimental mild acute lung injury

Andréia F. Rzezinski[a], Gisele P. Oliveira[a], Viviane R. Santiago[a], Raquel S. Santos[a], Debora S. Ornellas[a], Marcelo M. Morales[b], Vera L. Capelozzi[c], Marcelo B.P. Amato[d], Marcus B. Conde[e], Paolo Pelosi[f], Patricia R.M. Rocco[a,*]



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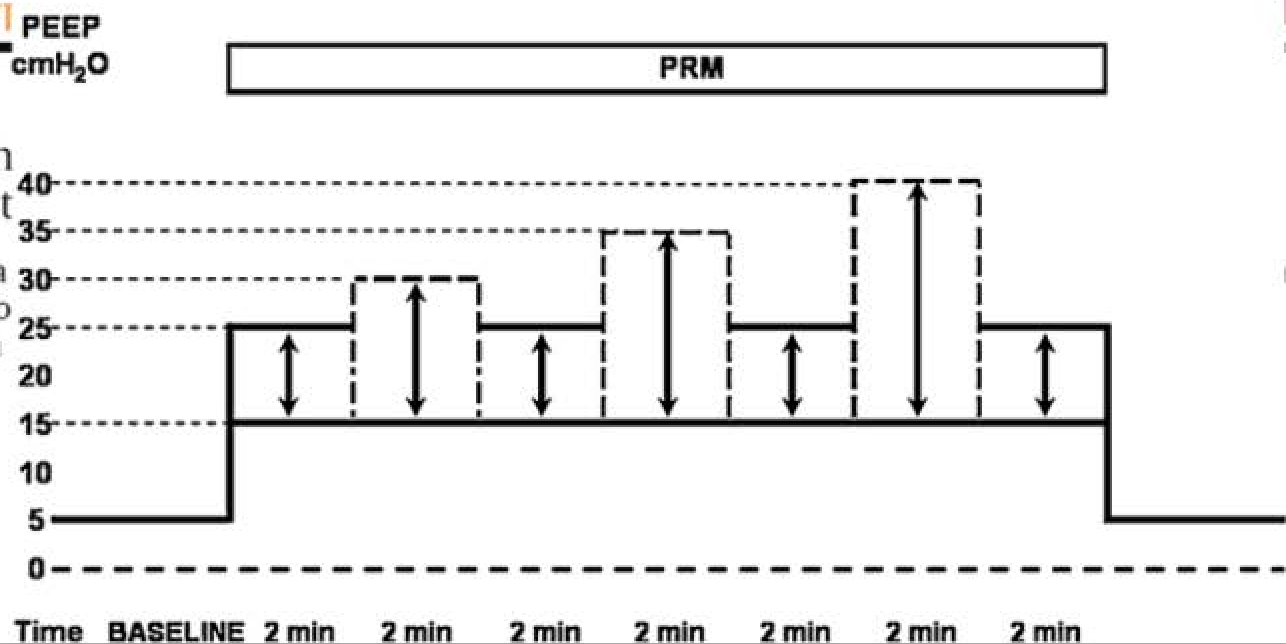

Prolon
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Andréia
Marcelo
Patricia

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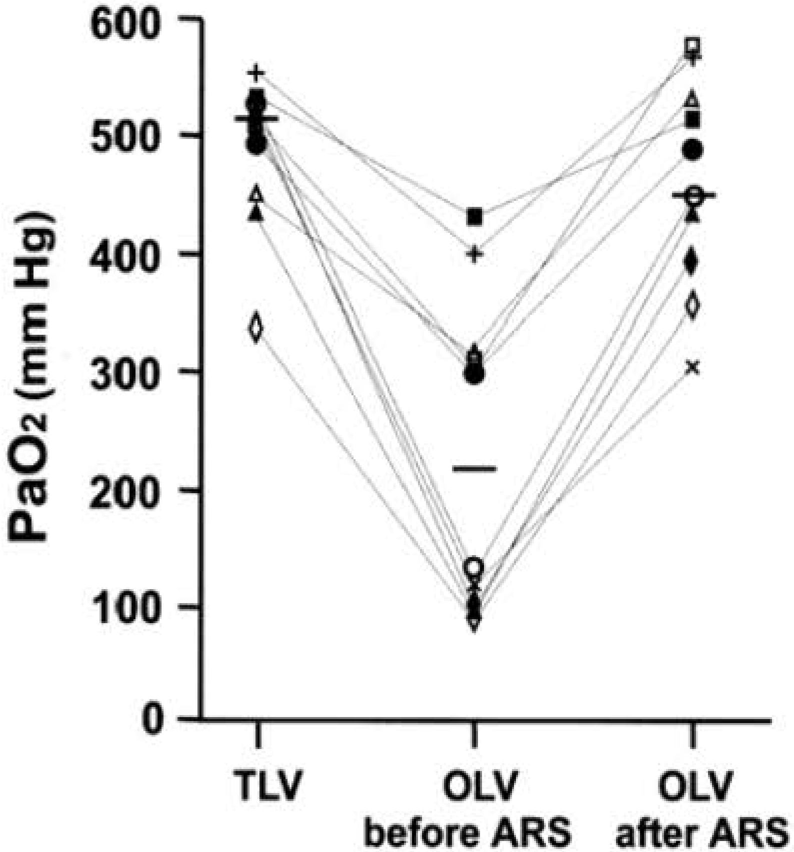
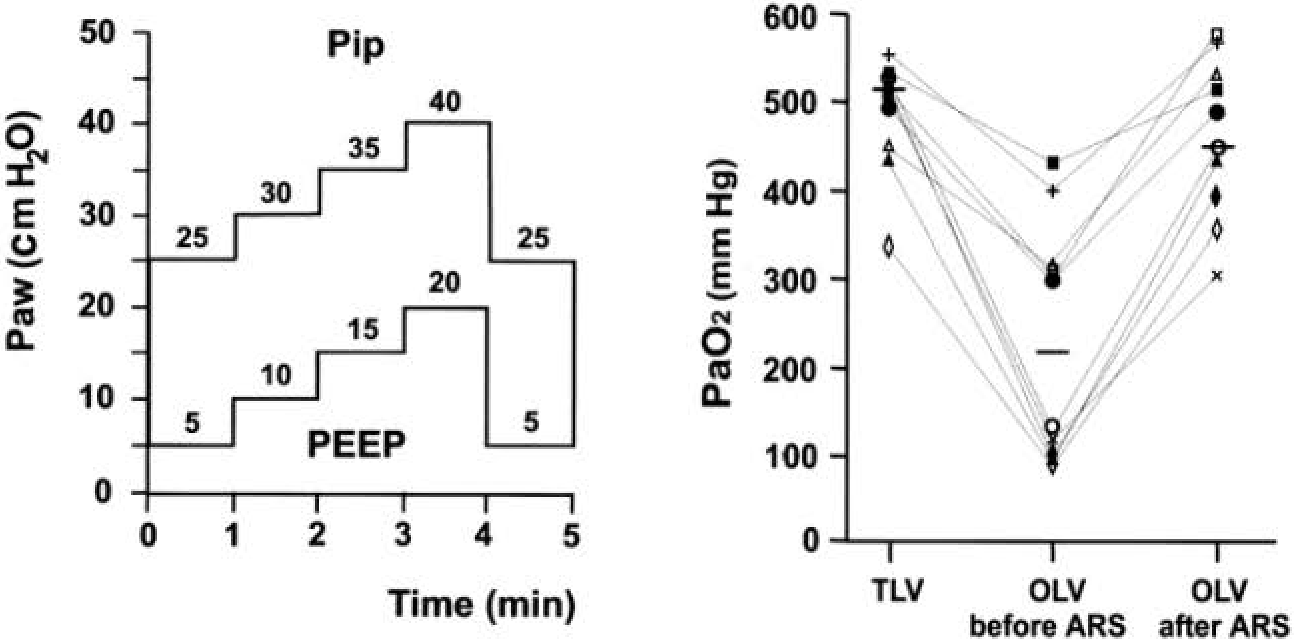
Recrutment pendant OLV

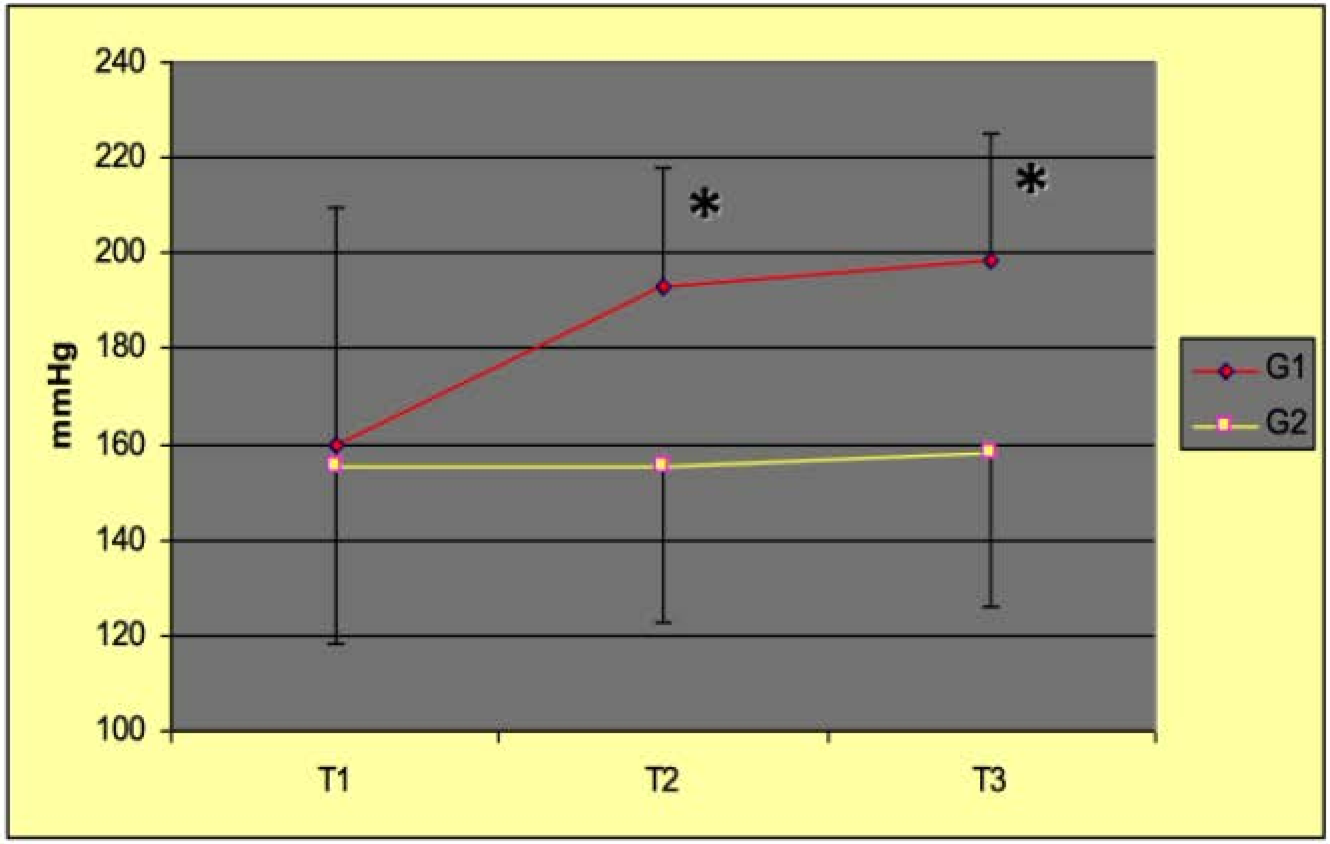


Tusman G et al. Ann tor Surg 2002; 73: 1204-9;

Recruitment

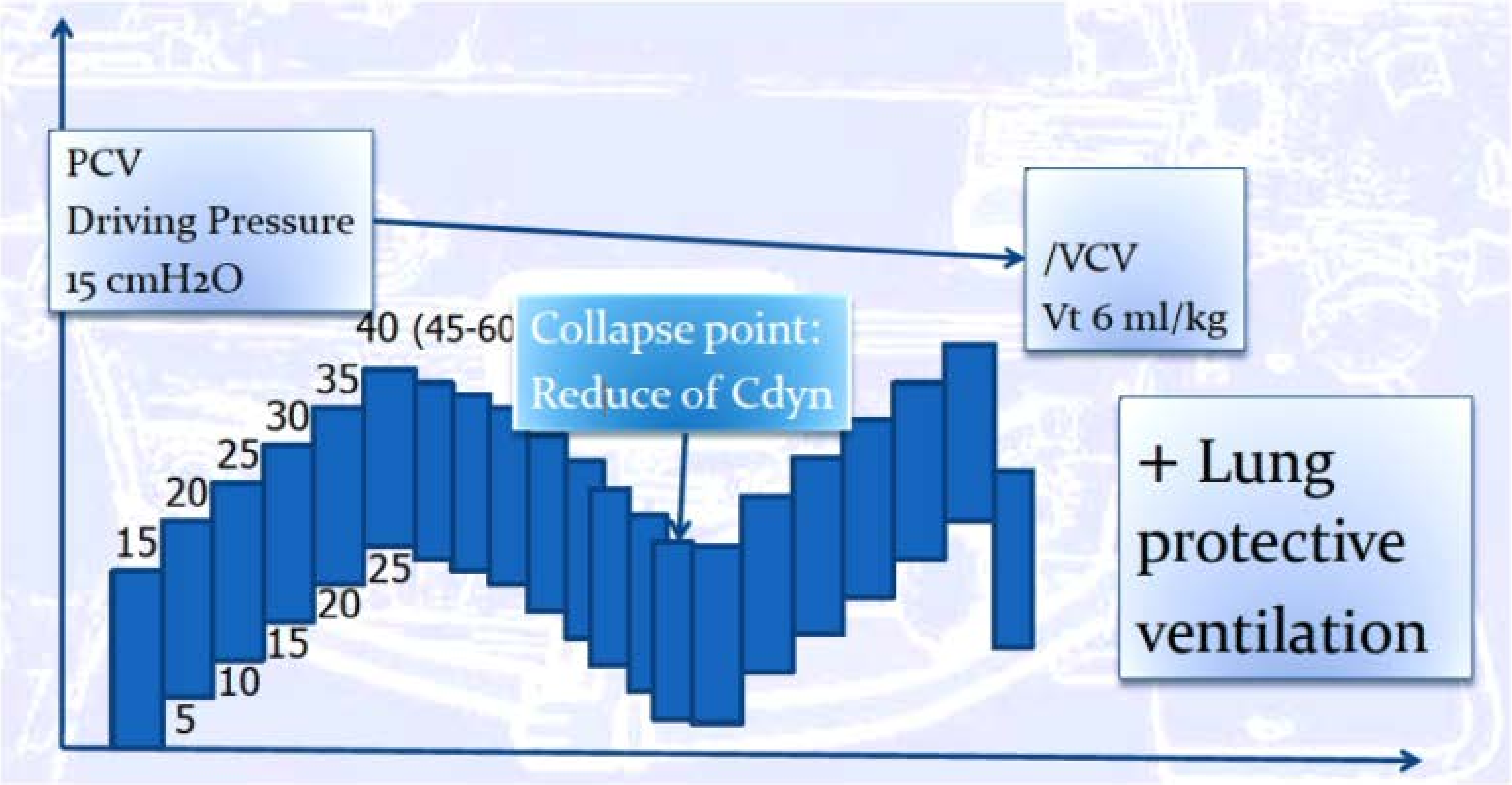


Tusman G et al. Ann Thorac Surg 2002;73:1204-9



*: $p<0.05$ vs T1

PCV with driving pressure of 15 cm H_2O



Standard Ventilator Settings

- The "best" mode and settings depends on the patient

- AND

- The physician - the mode that you best know and master

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

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

Protective Ventilation: <u>Vent. pressures ↓</u>

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  n de f , C 11: 4; 1

Protective Ventilation: Vent. pressures ↓

- "…. with a peak pressure of ≤ 30 cm H_2O"

Jordan, Eur Respir J 2000; 15: 790-799

- "…. Higher AWP's during surgery"

Van der Werff , Chest 111:1278-84; 1997

Protective Ventilation:

Pressure controlled ventilation

PRO

1. Also the plateau pressure ↓
2. Better oxygenation
3. More effective in "worse" respiratory functions

CON

1. Only the peak pressure ↓
2. No improvement in oxygenation
3. No advantage in "worse" respiratory functions
4. Actually also not that effective in ALI/ARDS/VILI

Dembinski R et al. AnesthAnalg 2004;98:211-19

OBES SURG
DOI 10.1007/s11695-007-9376-8

RESEARCH ARTICLE

Comparison of Volume-controlled and Pressure-controlled Ventilation during Laparoscopic Gastric Banding in Morbidly Obese Patients

L. E. C. De Baerdemaeker · C. Van der Herten · J. M. Gillardin · P. Pattyn · E. P. Mortier · L. L. Szegedi

PCV = VCV

Comparison of Volume-controlled and Pressure-controlled Ventilation during Laparoscopic Gastric Banding in Morbidly Obese Patients

L. E. C. De Baerdemaeker, C. Van der Herten, J. M. Gillardin, P. Pattyn, E. P. Mortier, L. L. Szegedi

Obes Surg. 2008 Jun;18(6):680-5.

Table 1 Patient characteristics and arterial blood gases while breathing room air

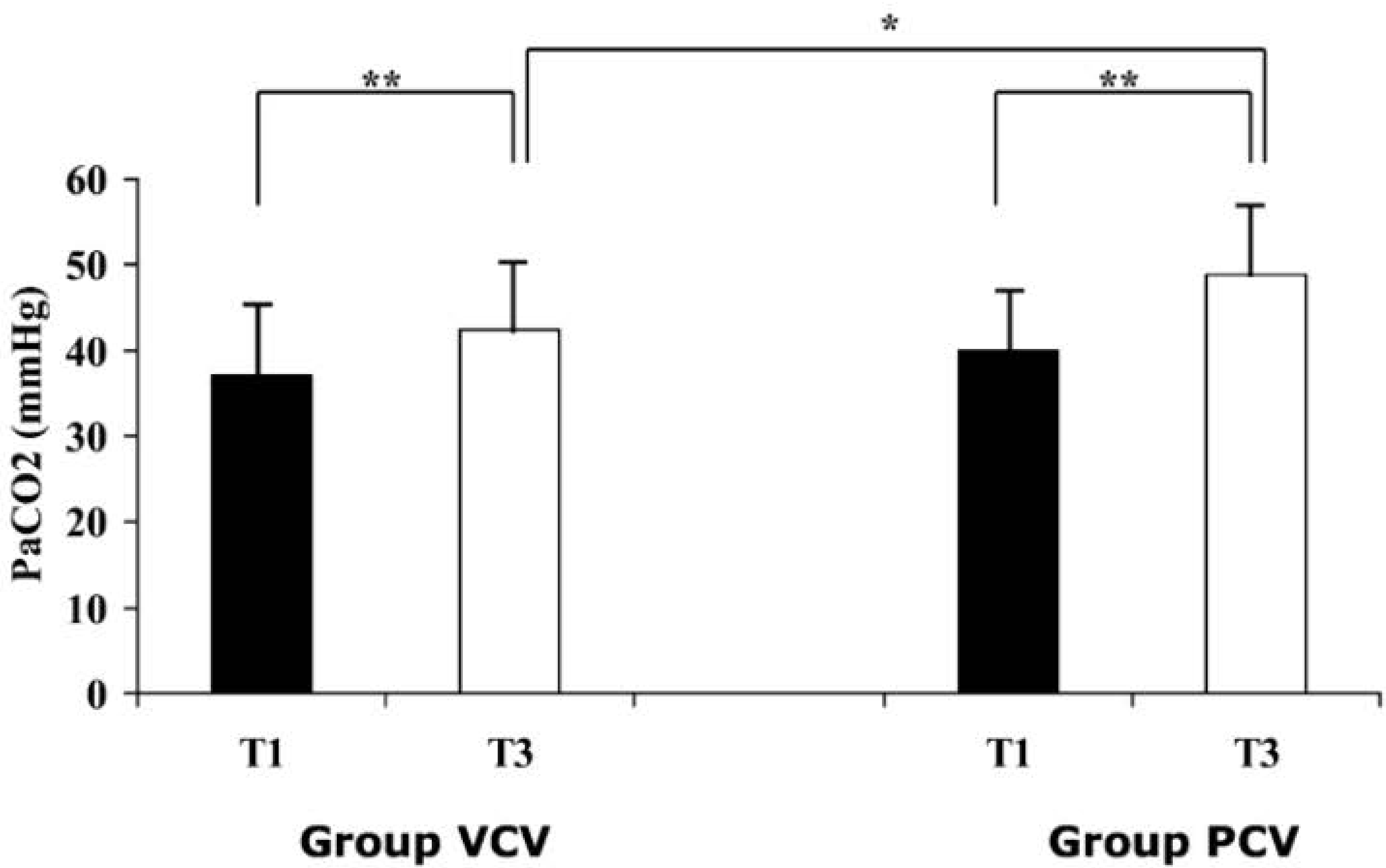
	Group VCV (n=12)	Group PCV (n=12)
Age (yrs)	34 (20–54)	40(32–57)
Male/female	9/3	8/4
Bodyweight (kg)	117.4 (22.3)	111.7 (19.2)
Height (m)	1.68 (0.10)	1.70 (0.12)
BMI (kg m^{-2})	41.4 (4.5)	38.6 (3.6)
pH room air	7.36 (0.04)	7.35 (0.04)
Pa_{O2} (mmHg) room air	79.3 (9.6)	81.9 (7.3)
Pa_{CO2} (mmHg) room air	40.5 (3.2)	40.4 (3.0)

Data are median (range), means (SD) or number of patients.
BMI=body mass index, Pa_{O2}=partial pressure of oxygen in the arterial blood, Pa_{CO2}=partial pressure of carbon dioxide in the arterial blood, VCV=volume-controlled ventilation, PCV=pressure-controlled ventilation

Table 2 Cardiovascular responses at different time points

Time point	T1		T2		T3	
Group (n=12)	VCV	PCV	VCV	PCV	VCV	PCV
Heart rate (bpm)	60(9)	61(10)	71(12)	70(9)	71(16)	71(12)
Systolic blood pressure (mmHg)	97(10)	104(9)	124(17)[a]	130(9)[a]	115(13)	120(13)[a]
Diastolic blood pressure (mmHg)	57(12)	60(9)	71(14)[a]	80(8)[a]	73(12)	74(9)
Mean arterial pressure (mmHg)	70(11)	74(9)	95(15)[a]	97(8)[a]	89(13)[a]	91(12)[a]

Data are mean (SD).
T1=baseline after positioning, T2=15 min after insufflation, T3=15 min after group allocation, VCV=volume controlled ventilation, PCV=pressure controlled ventilation
[a] $p<0.05$ compared to T1 value within group



** p<0.01 with ANOVA
* p<0.05 with ANOVA

High VT ventilation

British Journal of Anaesthesia 88 (1): 56–60 (2002)

Intrinsic positive end-expiratory pressure during one-lung ventilation of patients with pulmonary hyperinflation. Influence of low respiratory rate with unchanged minute volume†

L. L. Szegedi[1*], L. Barvais[2], Y. Sokolow[2], J. C. Yernault[2] and A. A. d'Hollander[3]

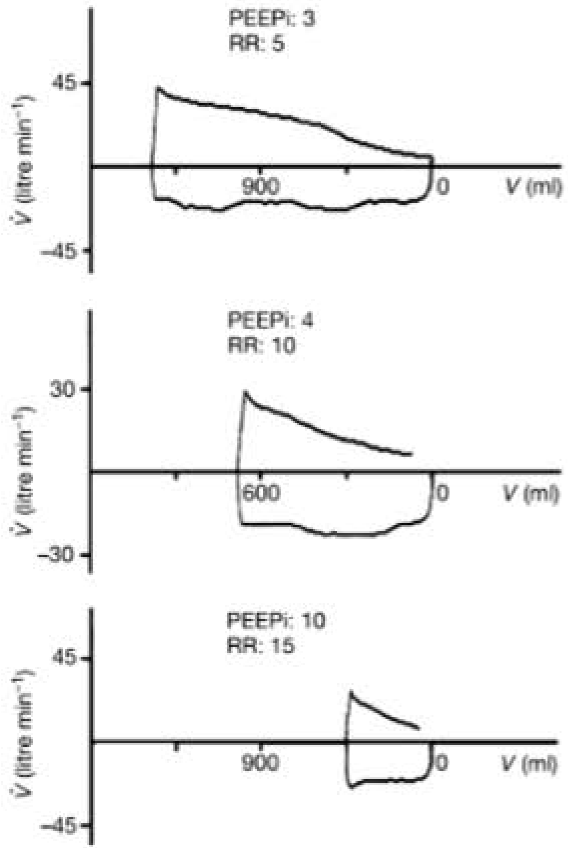


Fig 1 Flow-volume loop measured with the Datex Ultima SV Capnometer (Datex Instrumentarium, Helsinki, Finland) of one patient when changing the respiratory rate.

Hypoxic problems

- Increase PEEP
- High PEEP and high VT increases inthratoracic pressure and thus decreases preload
- Cave: hypovolemia, acute right heart failure (PE, MI)
- PEEP may reduce afterload too – helpful in patients with CHF

JAMA Network

QUESTION Does a high level of positive end-expiratory pressure (PEEP) with recruitment maneuvers (stepwise increasing tidal volume and if necessary PEEP) decrease postoperative pulmonary complications in obese patients undergoing surgery vs a low level of PEEP?

CONCLUSION This randomized clinical trial found that an intraoperative mechanical ventilation strategy with a higher level of PEEP and recruitment maneuvers did not reduce postoperative pulmonary complications in obese patients.

POPULATION

1381 Women **595** Men

Adults with BMI ≥35 undergoing noncardiac, nonneurological surgery under general anesthesia

Mean age: **49** years

INTERVENTION

2013 Patients randomized
1976 Patients analyzed

989

High level of PEEP with recruitment maneuvers

PEEP level of 12 cm H_2O plus transient increase in airway pressure designed to open a collapsed lung

987

Low level of PEEP without recruitment maneuvers

PEEP level of 4 cm H_2O

FINDINGS

Pulmonary complications

High level of PEEP with recruitment maneuvers

211 of 989 patients

Low level of PEEP without recruitment maneuvers

233 of 987 patients

LOCATIONS

77
International sites

PRIMARY OUTCOME

Composite of pulmonary complications within 5 postoperative days

Between-group mean difference:

−2.3%

(95% CI, −5.9% to 1.4%), *P* = .23

The Writing Committee for the PROBESE Collaborative Group. Effect of intraoperative high positive end-expiratory pressure (PEEP) with recruitment maneuvers vs low PEEP on postoperative pulmonary complications in obese patients: a randomized clinical trial [published online June 3, 2019]. *JAMA*. doi:10.1001/jama.2019.7505

ORIGINAL ARTICLE

Effects of different tidal volumes for one-lung ventilation on oxygenation with open chest condition and surgical manipulation: a randomised cross-over trial

T. VÉGH [1, 6], M. JUHÁSZ [1], S. SZATMÁRI [1], A. ENYEDI [2]
D. I. SESSLER [3, 4, 6], L. L. SZEGEDI [5], B. FÜLESDI [1, 6]

Conclusion. Low TV (5 mL/kg^{-1}) accompanied by 5 cmH_2O PEEP provides comparable arterial oxygenation and intrapulmonary shunt fraction during one-lung ventilation as higher TV (10 mL/kg^{-1}) without PEEP.
(Minerva Anestesiol 2013;79:24-32)

J Anesth
DOI 10.1007/s00540-012-1348-z

ORIGINAL ARTICLE

One Lung Ventilation: TV ↑

TV of 2 lungs into one lung

Effects of tidal volume and PEEP on arterial blood gases and pulmonary mechanics during one-lung ventilation

Sang Hun Kim · Ki Tae Jung · Tae Hun An

British Journal of Anaesthesia Page 1 of 6
doi:10.1093/bja/aes090

BJA

Reducing tidal volume and increasing positive end-expiratory pressure with constant plateau pressure during one-lung ventilation: effect on oxygenation

H. Rozé[1*], M. Lafargue[1], P. Perez[2], N. Tafer[1], H. Batoz[1], C. Germain[2], G. Janvier[1,3] and A. Ouattara[1,3]

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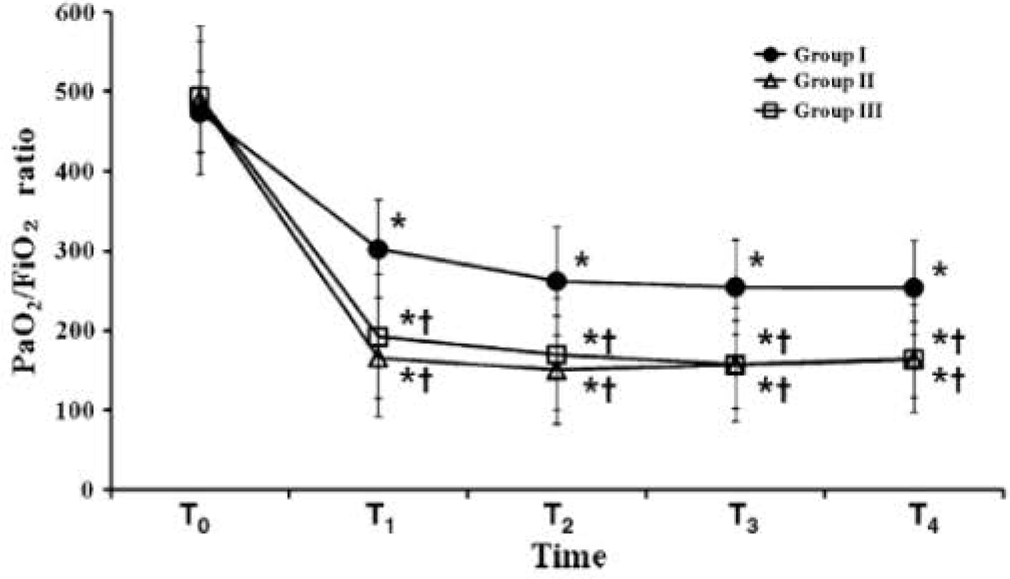


THE PRO THOR TRIAL

PROtective ventilation with high versus low PEEP during one-lung ventilation for THORacic surgery

PROTHOR: A randomized controlled trial

Kiss et al. Trials (2019) 20:213
https://doi.org/10.1186/s13063-019-3208-8

Trials

STUDY PROTOCOL Open Access

Check for updates

Protective ventilation with high versus low positive end-expiratory pressure during one-lung ventilation for thoracic surgery (PROTHOR): study protocol for a randomized controlled trial

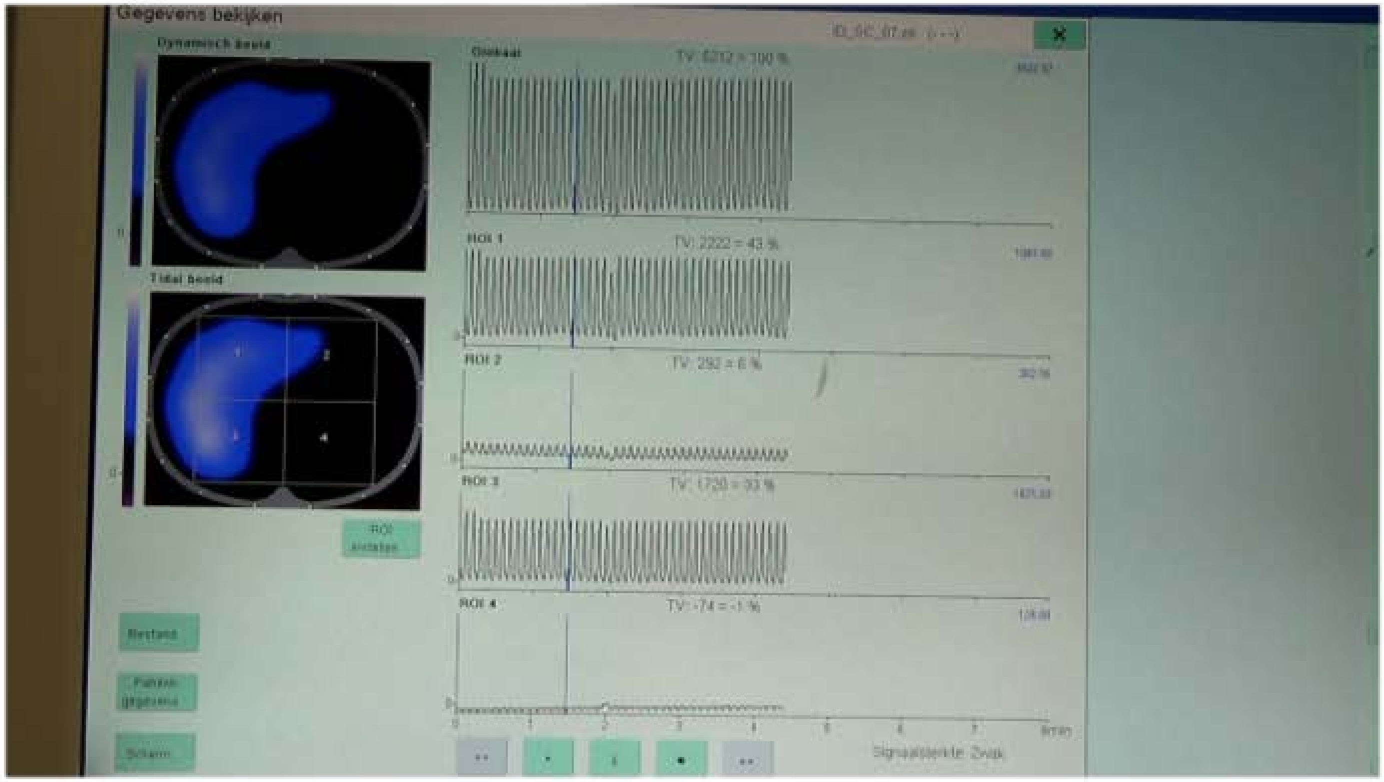
T. Kiss[1*†], J. Wittenstein[1†], C. Becker[1], K. Birr[1], G. Cinnella[2], E. Cohen[3], M. R. El Tahan[4], L. F. Falcão[5], C. Gregoretti[6], M. Granell[7], T. Hachenberg[8], M. W. Hollmann[9], R. Jankovic[10], W. Karzai[11], J. Krassler[12], T. Loop[13], M. J. Licker[14], N. Marczin[15,16,17], G. H. Mills[18], M. T. Murrell[19], V. Neskovic[20], Z. Nisnevitch-Savarese[21], P. Pelosi[22,23], R. Rossaint[24], M. J. Schultz[25,26], A. Serpa Neto[27], P. Severgnini[28], L. Szegedi[29], T. Vegh[30,31], G. Voyagis[32,33], J. Zhong[34,35], M. Gama de Abreu[1], M. Senturk[36], for the PROTHOR investigators and the Research Workgroup PROtective VEntilation Network (PROVEnet) of the European Society of Anaesthesiology (ESA)

Pulmovista 500®, Dräger , Lübeck, Germany

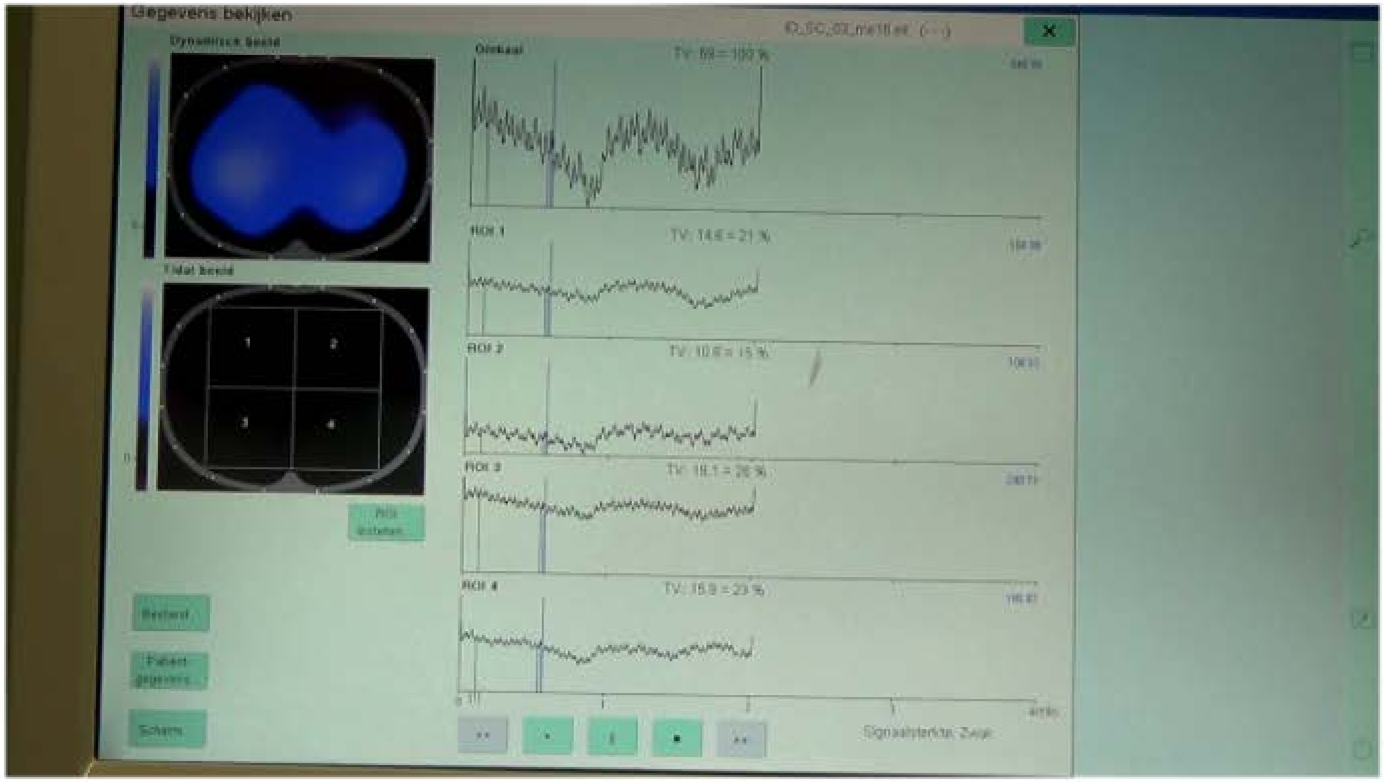
Pulmovista 500®, Dräger , Lübeck, Germany

Induction of GA and intubation

One-lung ventilation

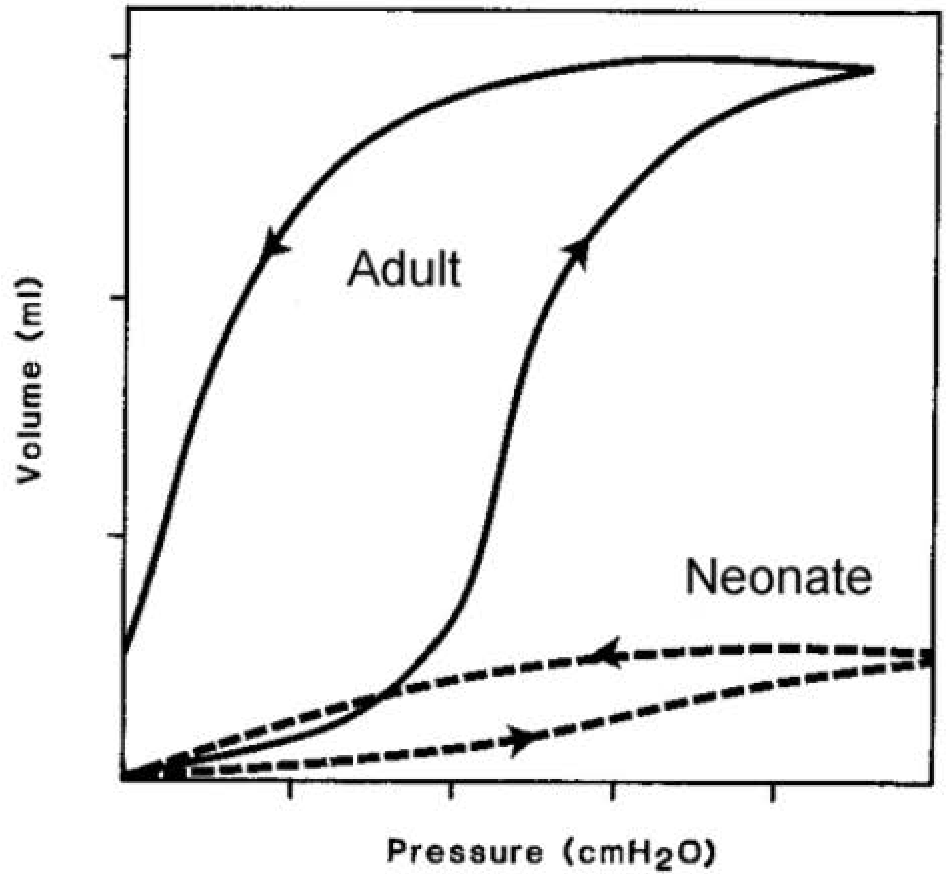


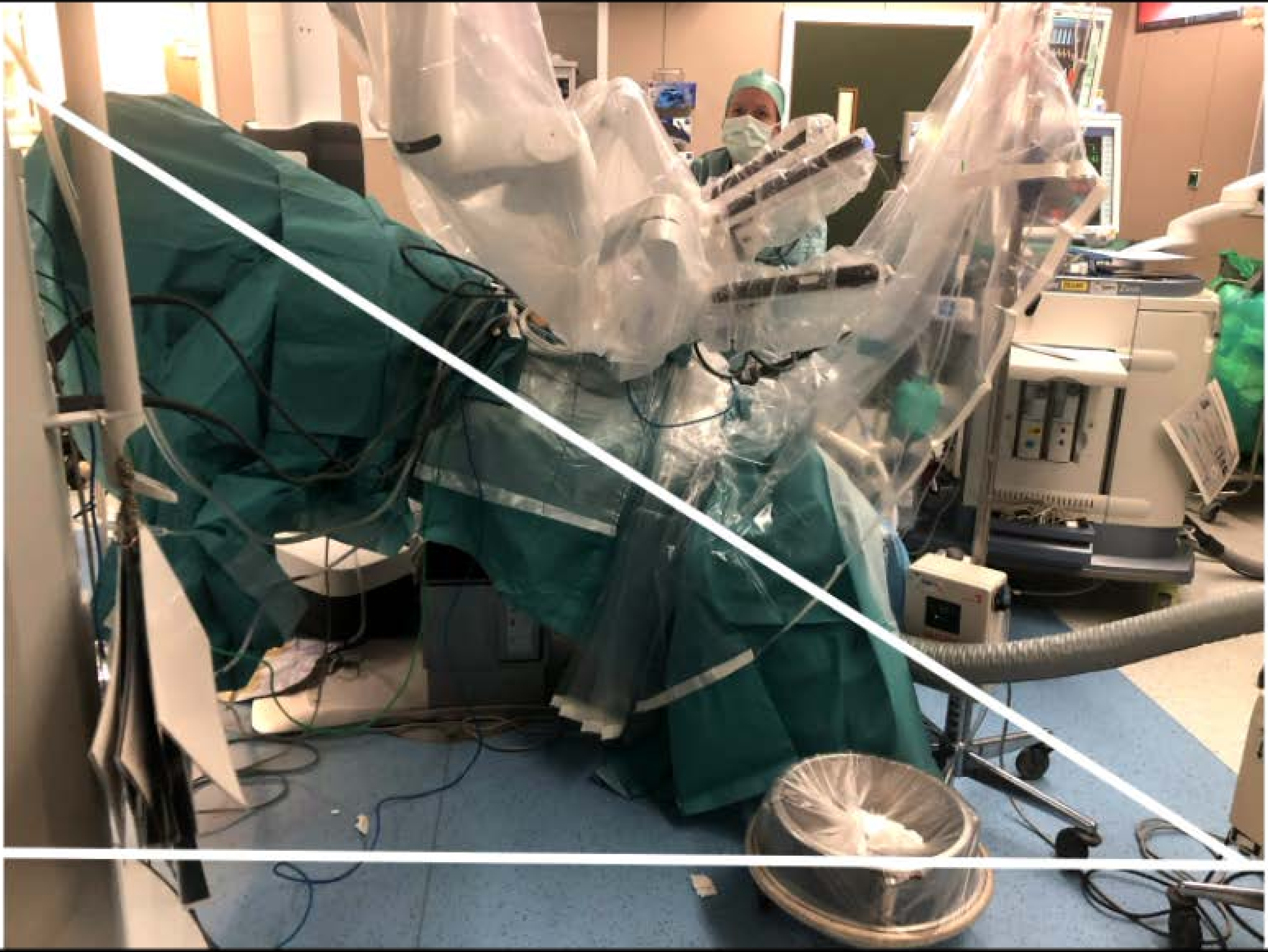
Jet ventilation



Increasing PEEP for recruitment

Recruitment in adults vs neonates: PV curve





Adulte Adulte
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Circuit fermé
Conso. O2 36 mL.min
O2 Air Sev
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Sev% N2O% xMAC O2
2.7 0 50
1.8 0 0.9 46
BIS
SQI
EMG
BSR
SEF
NMT
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TOF
SEV
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DGF-AIOC
O2+Air
xMAC → 0.9
100% O2
Volume Contrôlé - VC - AF
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2 ULTIV
BASIC
BASIC
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340
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xMAC
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0.8
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BIS
NMT
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DGF-AIOC
O2+Air
xMAC → 0.9
Pression Contrôlée - VC
1.0 2.0
1 PROP1
2 ULTIV
BASIC
BASIC
40
FiO2
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etSEV
21
Pinsp
0
13
FR
6
PEP

Conclusion

Le Remède Miracle Fait Maison

Erreur - La page n'existe pas

What is new in protective ventilation?

- Mechanical ventilation should no longer be considered only as a way to supply gas exchange during surgery
- Inadequate ventilatory settings can produce lung damage even in patients with healthy lungs both in ICU and the OR

What is new in protective ventilation?

- Standard of care in most ARDS patients
- In surgical patients scheduled for abdominal surgery, a lung protective mechanical ventilation strategy using:
  - VT of 6 to 8 ml/kg PBW
  - PEEP level of 6 to 8 cmH2O
  - Early and Repeated recruitment maneuver

improves outcome in patients with intermediate to high risk of PPCs (IMPROVE study)