Update on Mechanical Ventilation in Anesthesia

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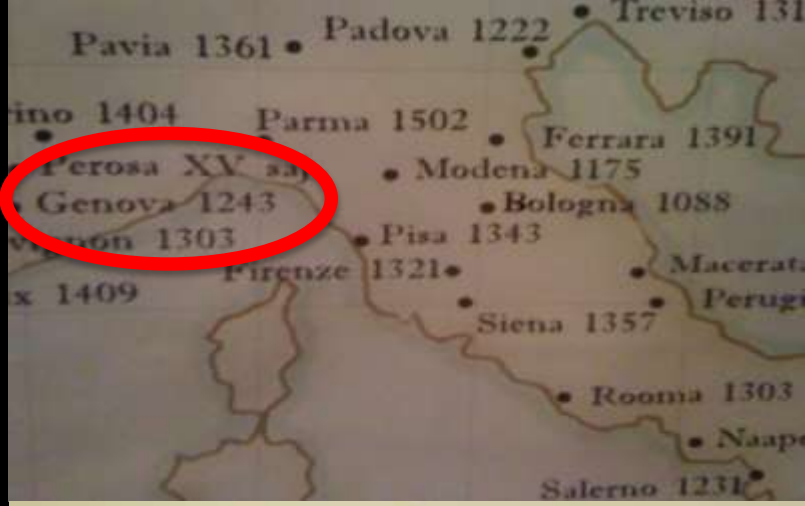
On behalf of PROVE Network Investigators and CTN ESA

Seminario Scuola di Specializzazione in Anestesia, Rianimazione e Terapia Intensiva, Brescia 11 Febbraio 2015



Conflicts of interest

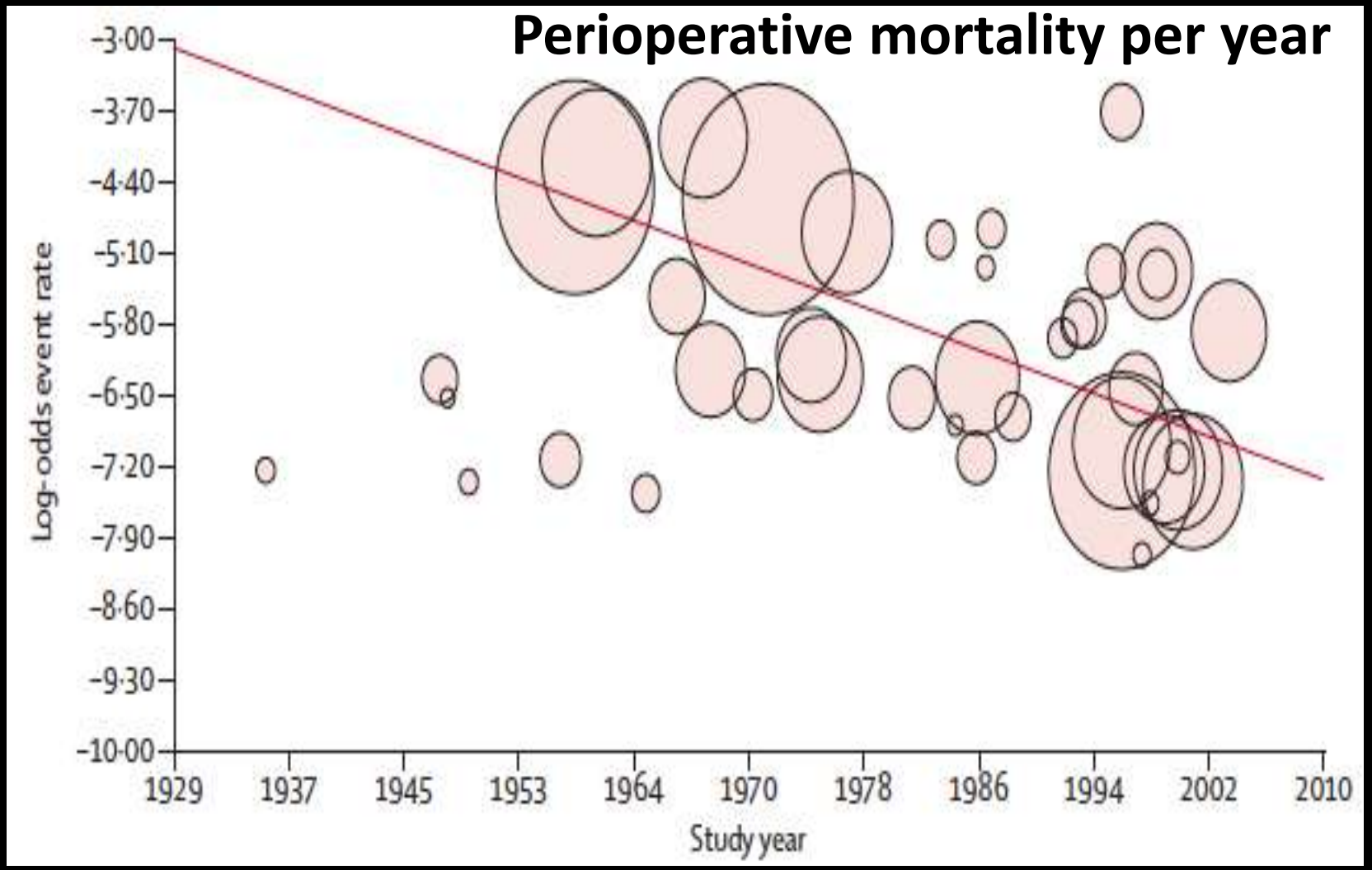
I declare

NO conflicts of interest


P.G.R.

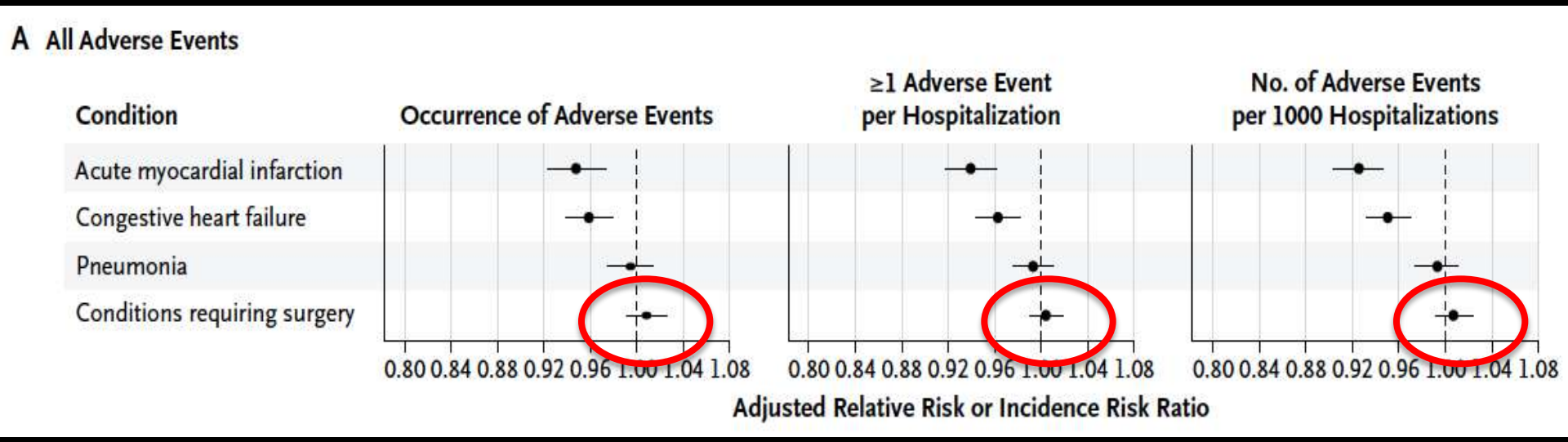
Perioperative and anaesthetic-related mortality in developed and developing countries: a systematic review and meta-analysis

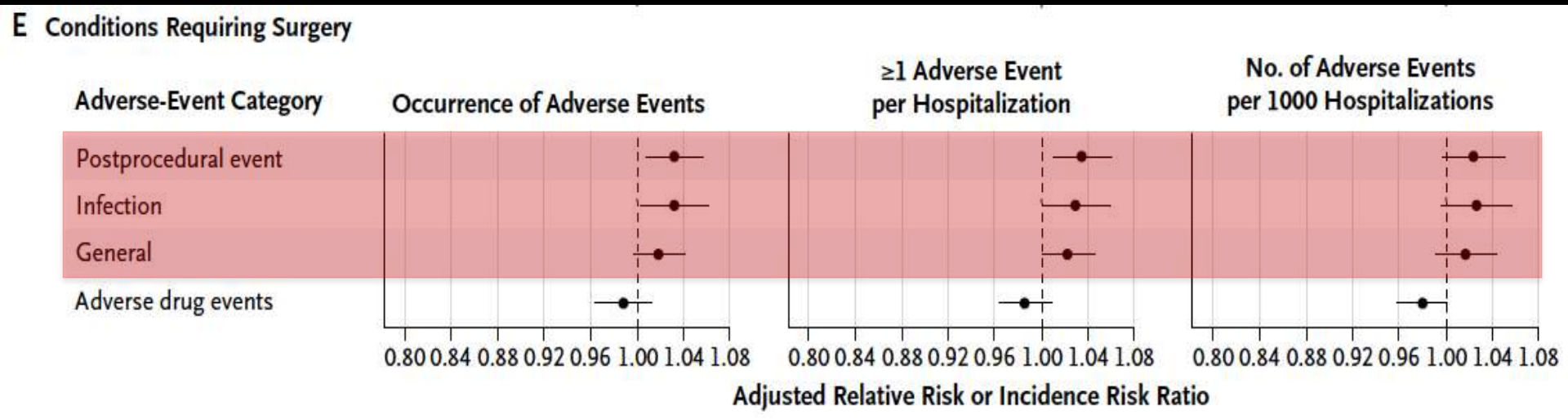
Bainbridge et al. Lancet 2012; 380: 1075–81



National Trends in Patient Safety for Four Common Conditions, 2005–2011

Wang Y et al. N Engl J Med 2014;370:341-51





EuSOS

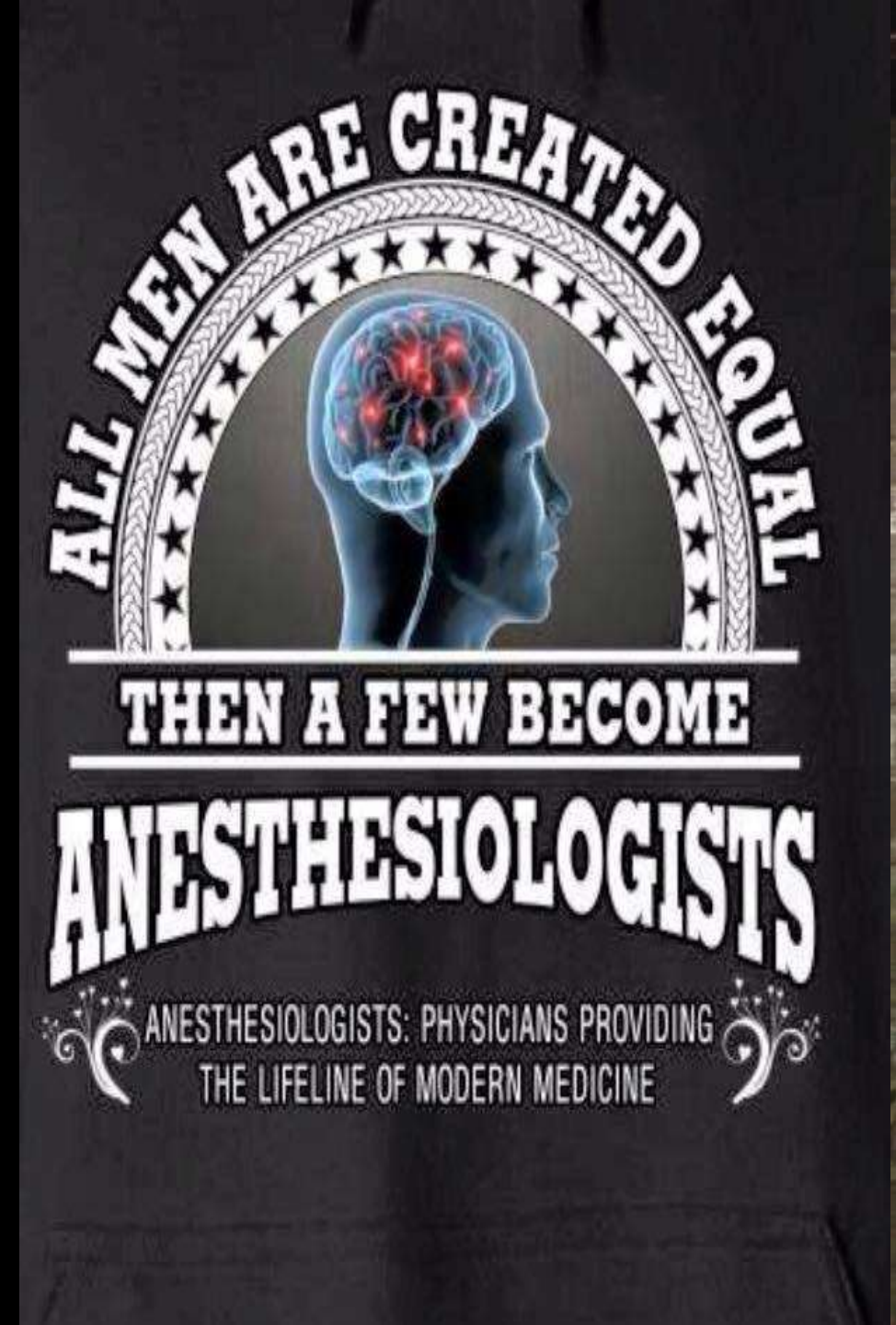
European Surgical Outcomes Study

Lancet 2012; 380:1059-1065

Mortality after surgery in Europe: a 7 day cohort study

*Rupert M Pearse, Rui P Moreno, Peter Bauer, Paolo Pelosi, Philipp Metnitz, Claudia Spies, Benoit Vallet, Jean-Louis Vincent, Andreas Hoeft, Andrew Rhodes, for the European Surgical Outcomes Study (EuSOS) group for the Trials groups of the European Society of Intensive Care Medicine and the European Society of Anaesthesiology**

- High in-hospital mortality (3 – 4 % !!)
- High mortality in the ward (10-15%)
- Low mortality in planned ICU admission
- Age, ASA (IV-V) & Cancer
- Upper abdominal, epatobiliary, vascular (*cardiac & thoracic*) surgery


ALL MEN ARE CREATED EQUAL
THEN A FEW BECOME
ANESTHESIOLOGISTS
ANESTHESIOLOGISTS: PHYSICIANS PROVIDING
THE LIFELINE OF MODERN MEDICINE

Periscope Definition of PPCs

ESA

Jammer I et al. Eur J Anaesthesiol. 2015; 32:88-105

Mazo V et al. Anesthesiology. 2014 Aug;121(2):219-31

Canet J et al. Eur J Anaesthesiol. 2015; 32:1–13 [Epub ahead of print]

- ✓ **Primary outcome (composite)**
  - Respiratory insufficiency
  - Bronchospasm
  - Pleural effusion
  - Respiratory infection
  - Atelectasis
  - Aspiration pneumonitis
  - Pneumothorax
- ✓ **Unified definitions of variables**

How to predict the risk of PPCs ?

Canet J et al. for ARISCAT, Anesthesiology. 2010; 113(6):1338-50.

Mazo V et al. Anesthesiology. 2014 Aug;121(2):219-31

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

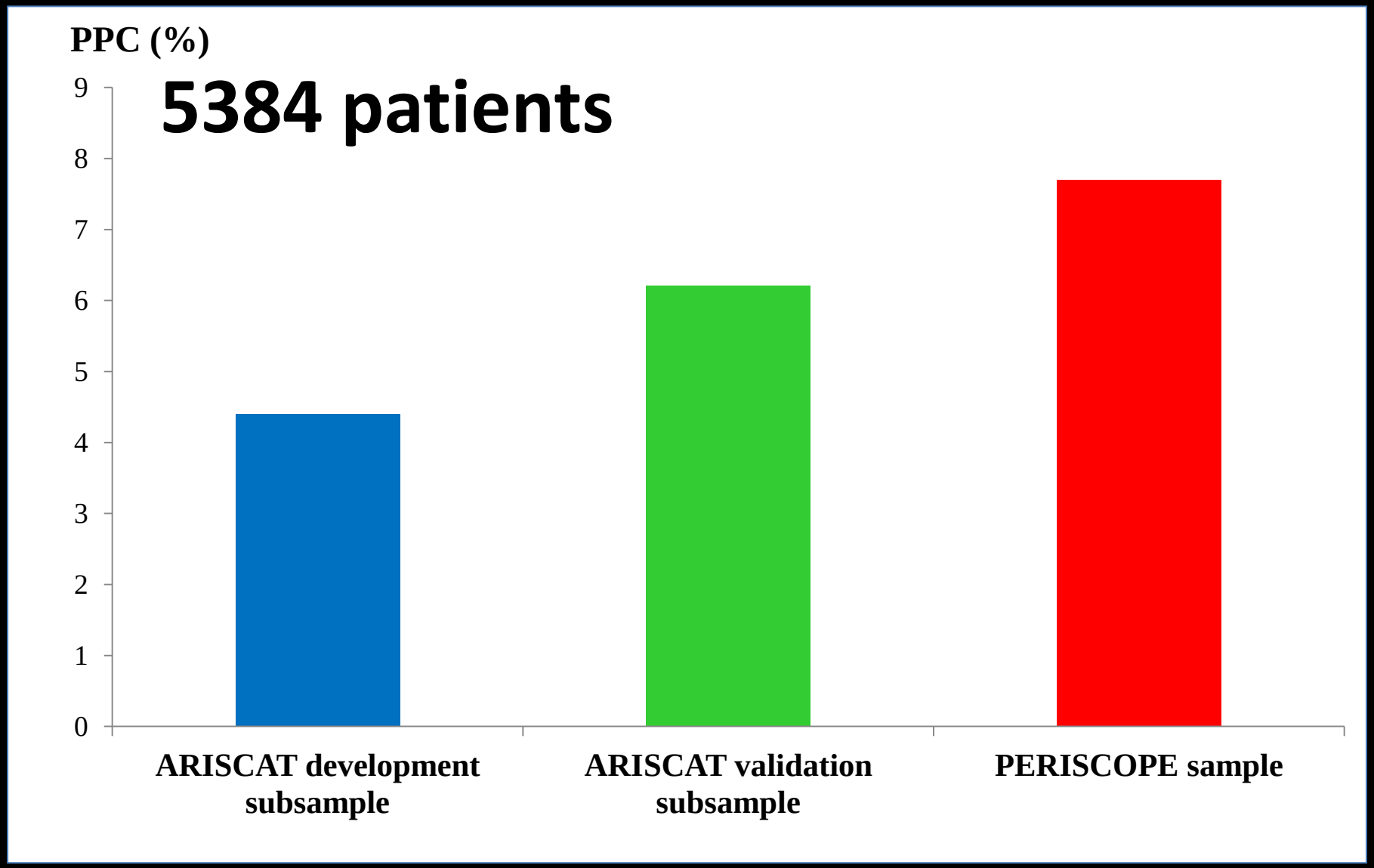
ARISCAT inclusion criteria	Criteria values						Points
Age in years	≤ 50	☐	51-80	☐	≥ 80	☐	0 - 3 - 16
Preoperative SpO2 %	≥ 96	☐	91-95	☐	≤ 90	☐	0 - 8 - 24
Respiratory infection (last month)	yes	☐	no	☐			11
Preoperative anemia (≤ 10 g/dL)	yes	☐	no	☐			10
Emergency procedure	yes	☐	no	☐			8
Surgical incision*	peripheral	☐	upper abdominal	☐	Intrathoracic		0 - 15 - 24
Duration of surgery (hrs)	≤ 2	☐	> 2 to 3	☐	> 3	☐	0 - 16 - 23

*any procedure for open abdominal surgery requiring an incision up umbilicus, totally or in part. It includes either mid-line, subcostal, lumbothomy or any other.

Total risk score ☐ High or intermediate risk: ≥ 26

Periscope PPCs Incidence

Mazo V et a.l Anesthesiology. 2014 Aug;121(2):219-31



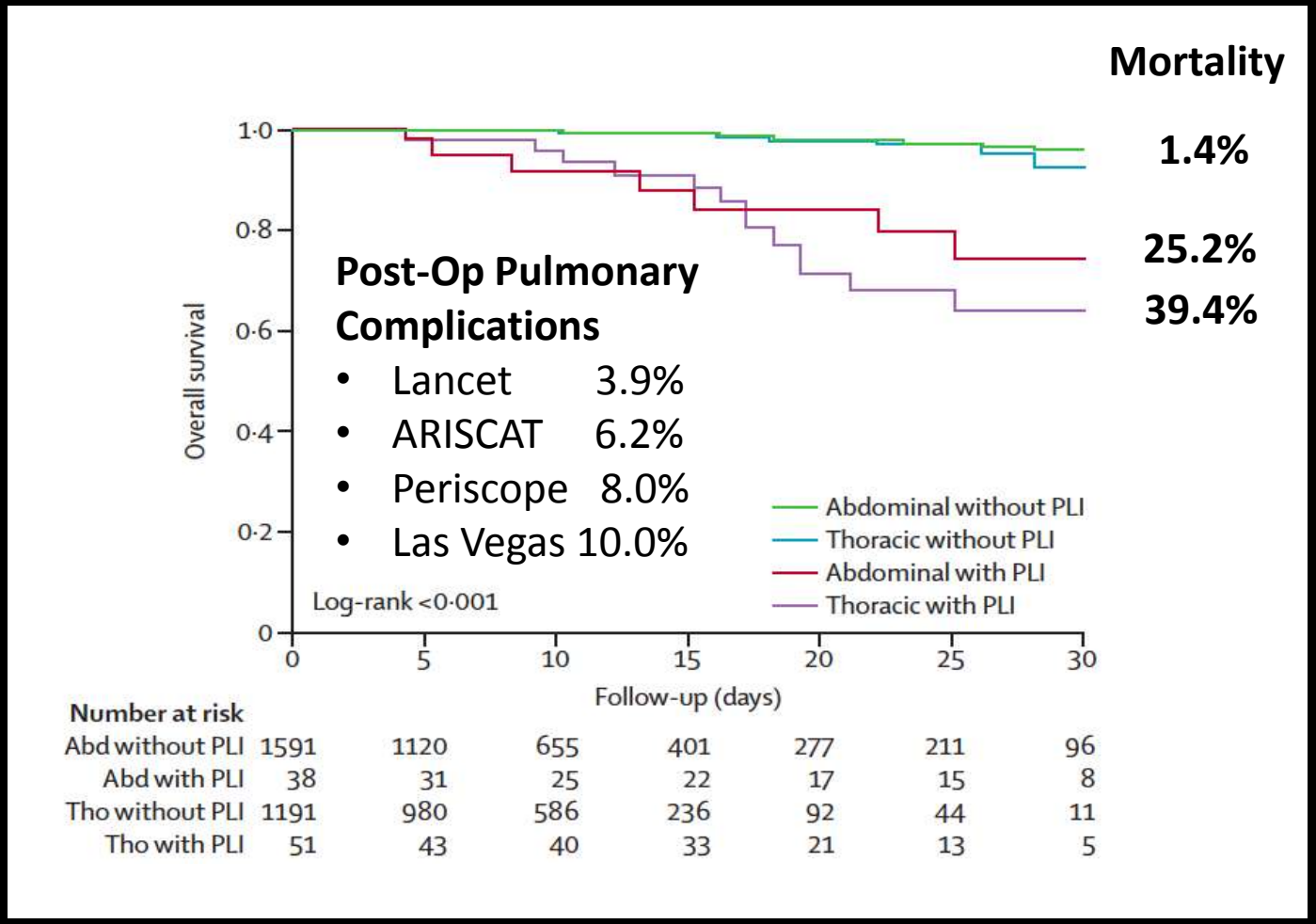
PLOS and In–Hospital Mortality & PPCs

Mazo V et al. Anesthesiology. 2014 Aug;121(2):219-31

	No. of PPCs				
	0	1	2-3	≥4	Total No. of patients
No. (%) of patients	4960 (92.1)	156 (2.9)	183 (3.4)	85 (1.6)	5384
PLOS. median (10^{th} - 90th percentile). d[a]	3 (1 – 10.2)	8 (2.9 – 18.2)	9 (4 – 37)	14 (5.6 – 51.6)	4 (1 – 12)
In-hospital mortality. n (%)[b]	11 (0.2)	3 (1.9)	12 (6.6)	20 (23.5)	46 (0.9)

Incidence of mortality and morbidity related to postoperative lung injury in patients who have undergone abdominal or thoracic surgery

Serpa Neto A. et al. Lancet Respir Med. 2014 Dec;2(12):1007-15.



Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort

Canet J et al. Eur J Anaesthesio.l 2015; 32:1–13 [Epub ahead of print]

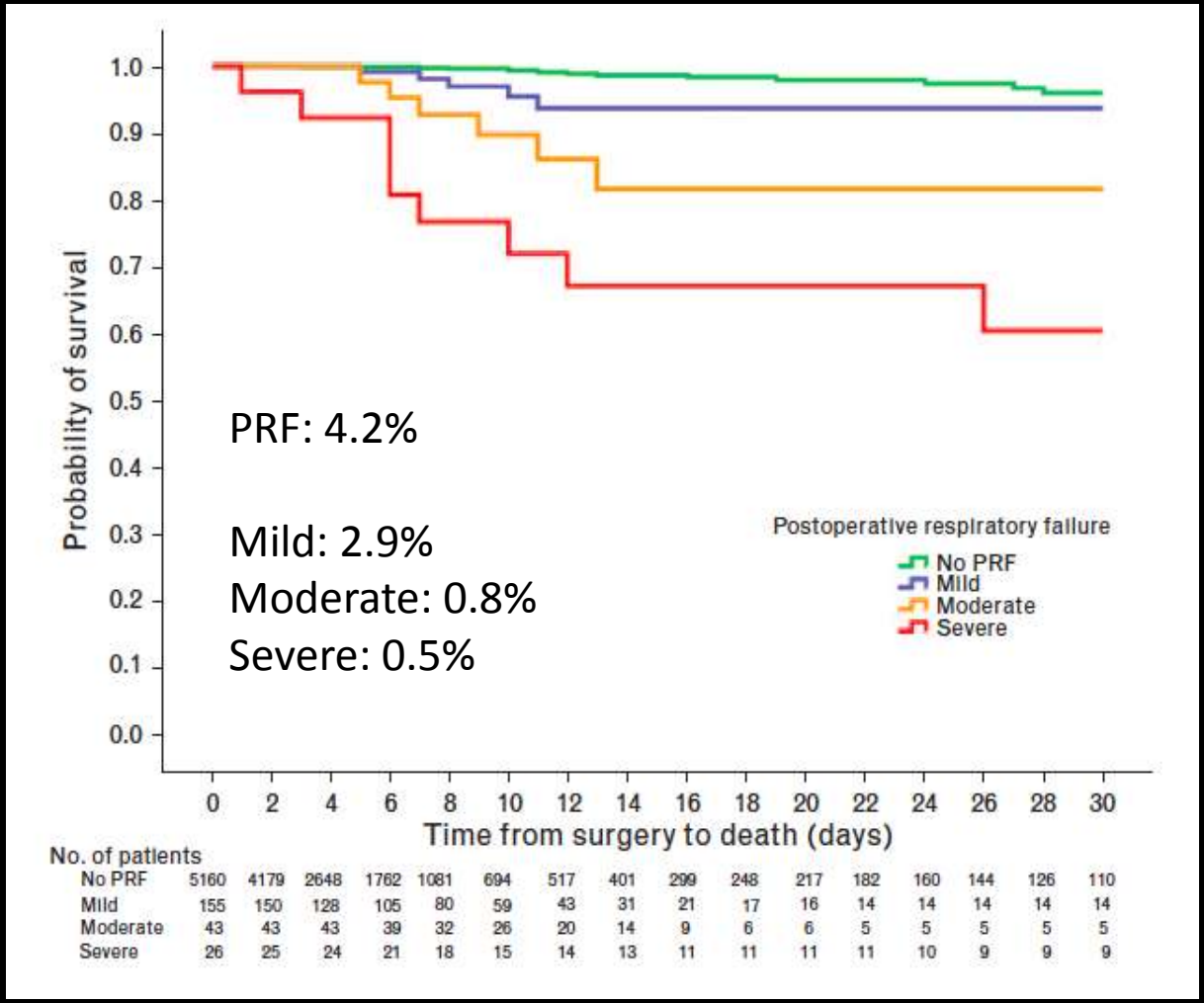
POST-OPERATIVE RESPIRATORY FAILURE

New-onset hypoxaemia appearing within 5 postoperative days at three levels of severity:

- Mild (PaO_2 < 60 mmHg or SpO_2 < 90% on room air but responding to mask/nasal supplemental oxygen);
- Moderate (noninvasive or invasive mechanical ventilation to treat a PaO_2 < 60 mmHg or SpO_2 < 90%);
- Severe (invasive MV to manage a PaO_2 /FiO_2 200 mmHg regardless of the level of PEEP

Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort

Canet J et al. Eur J Anaesthesiol. 2015; 32:1–13 [Epub ahead of print]



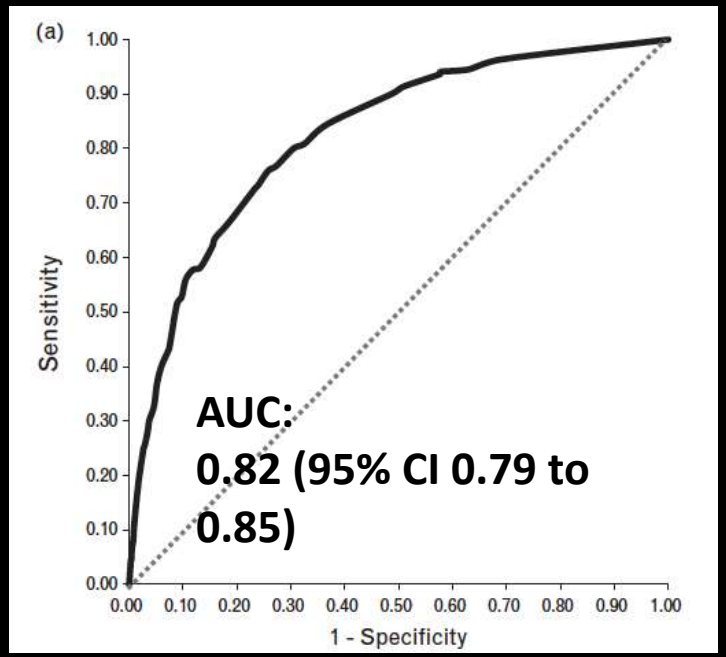
Development and validation of a score to predict postoperative respiratory failure in a multicentre European cohort

Canet J et al. Eur J Anaesthesiol. 2015; 32:1–13 [Epub ahead of print]

	Risk score[c]
Patient health related factors	
Preoperative SpO_2 (%)	
≥96	
91 to 95	7
≤90	10
Respiratory symptoms (at least 1)	10
History of congestive heart failure	
No	
NYHA I	3
NYHA ≥II	8
History of chronic liver disease	7
Procedure related factors	
Emergency procedure	12
Surgical incision	
Peripheral	
Closed intrathoracic/closed upper abdominal	3
Open upper abdominal	7
Intrathoracic open	12
Duration of surgery (h)	
≤ 2	
>2 to 3	5
>3	10

The incidences (95% CIs) of PRF:

- **Score < 12: 1.1% (0.7 to 1.5)**
- **Score 12-22: 4.6% (3.4 to 5.6)**
- **Score >=23: 18.8% (15.8 to 21.8)**



Strategies to prevent postoperative pulmonary complications

Guldner A, Pelosi P, de Abreu GM Curr Opin Anesthesiol 2013, 26:141–151

Preoperatively

- Assess general physical status and identify risk factors
  - Risk Scores
  - Preoperative SpO_2
- Preoperative "optimization"
  - Cessation of smoking
  - Treat pre-op infection and/or bronchospasm
  - Alleviate anemia (< 10 g/dL) (?)
- Education regarding physiotherapy

Strategies to prevent postoperative pulmonary complications

Guldner A, Pelosi P, de Abreu GM Curr Opin Anesthesiol 2013, 26:141–151

Intraoperatively

- Anaesthetic/surgical plan
  - Consider regional anesthesia for pain control
  - Choose short-acting drugs/avoid PORC (monitoring)
  - Limit duration of surgery and fluids - GDT
  - If feasible, use laparoscopic techniques
  - Reduce emergent surgery
- Ventilatory strategies
  - Protective ventilation (Low tidal volume 6-8 ml/kg IBW)
  - Limit high oxygen concentrations (< 70%)
  - Maintain $PaCO_2$

Strategies to prevent postoperative pulmonary complications

Guldner A, Pelosi P, de Abreu GM Curr Opin Anesthesiol 2013, 26:141–151

Postoperatively

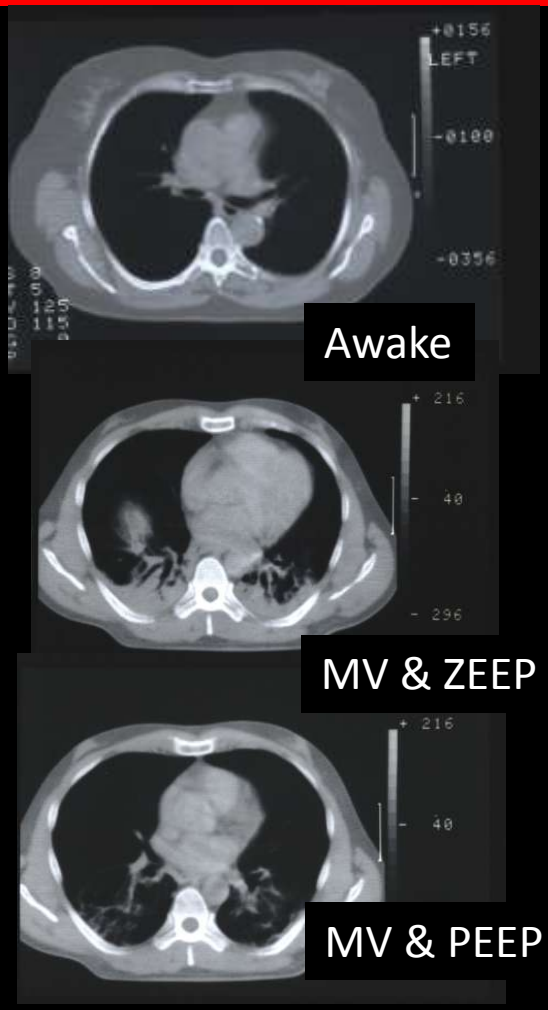
- Selective use of nasogastric tube
  - If PONV
  - Inability to oral feeding
  - Abdominal distension
- Effective pain management and minimize respiratory depression
- Post-op Physiotherapy and/or NRS
  - Early ambulation
  - Mobilization of secretions
  - Deep breathing (Incentive spirometry?)
  - CPAP/NPPV

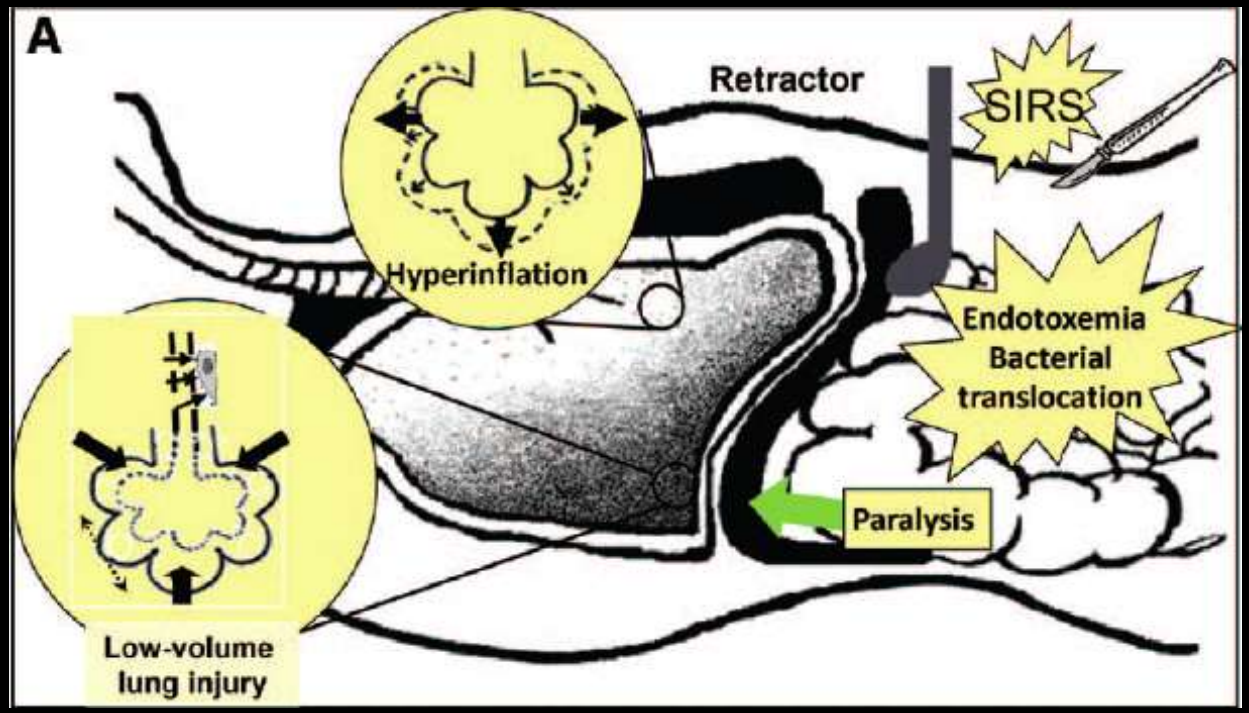
Protect the Lungs during Abdominal Surgery

It May Change the Postoperative Outcome

Vidal Melo M.F., Eikermann M. Anesthesiology 2013; 118:1254-7

Brismar B. et al. Anesthesiology. 1985 Apr;62(4):422-8

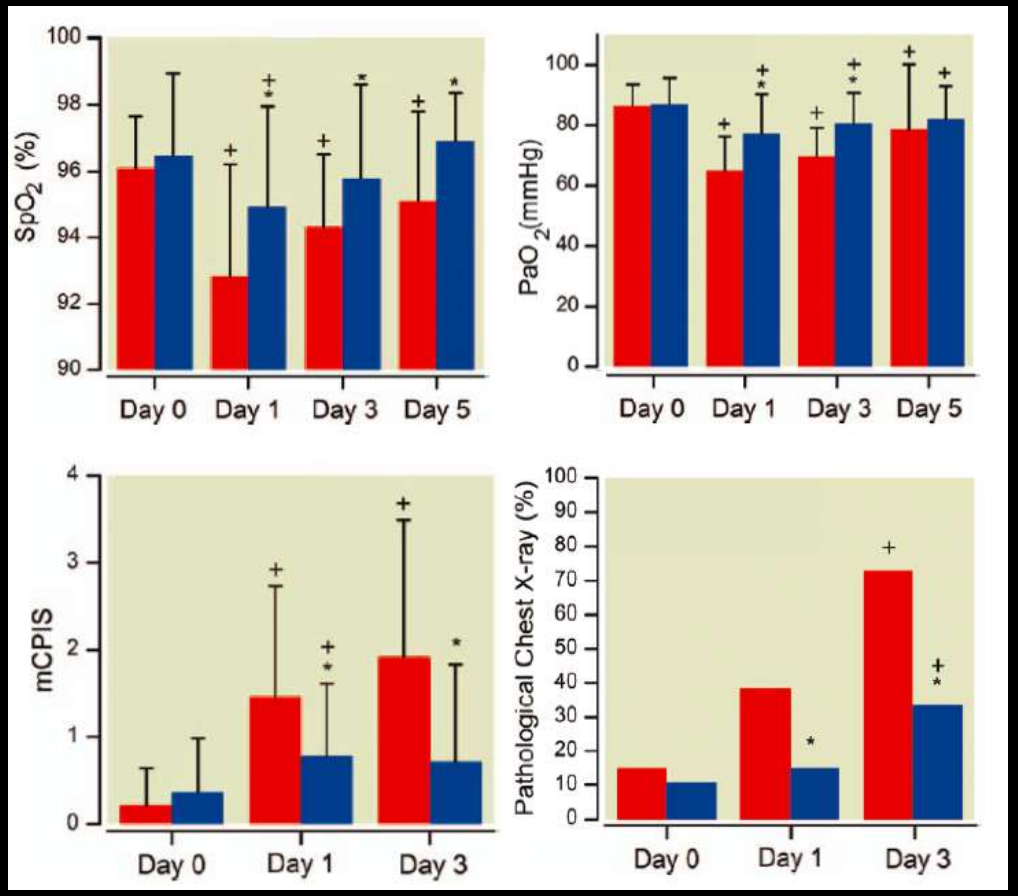




Lower V_T with PEEP and RM Protects Against Pulmonary Complications

Severgnini P. et al. Anesthesiology. 2013 Jun;118(6):1307-21

- 56 patients
- Single Center
- RCT
- Open abdominal Surgery
- Italy



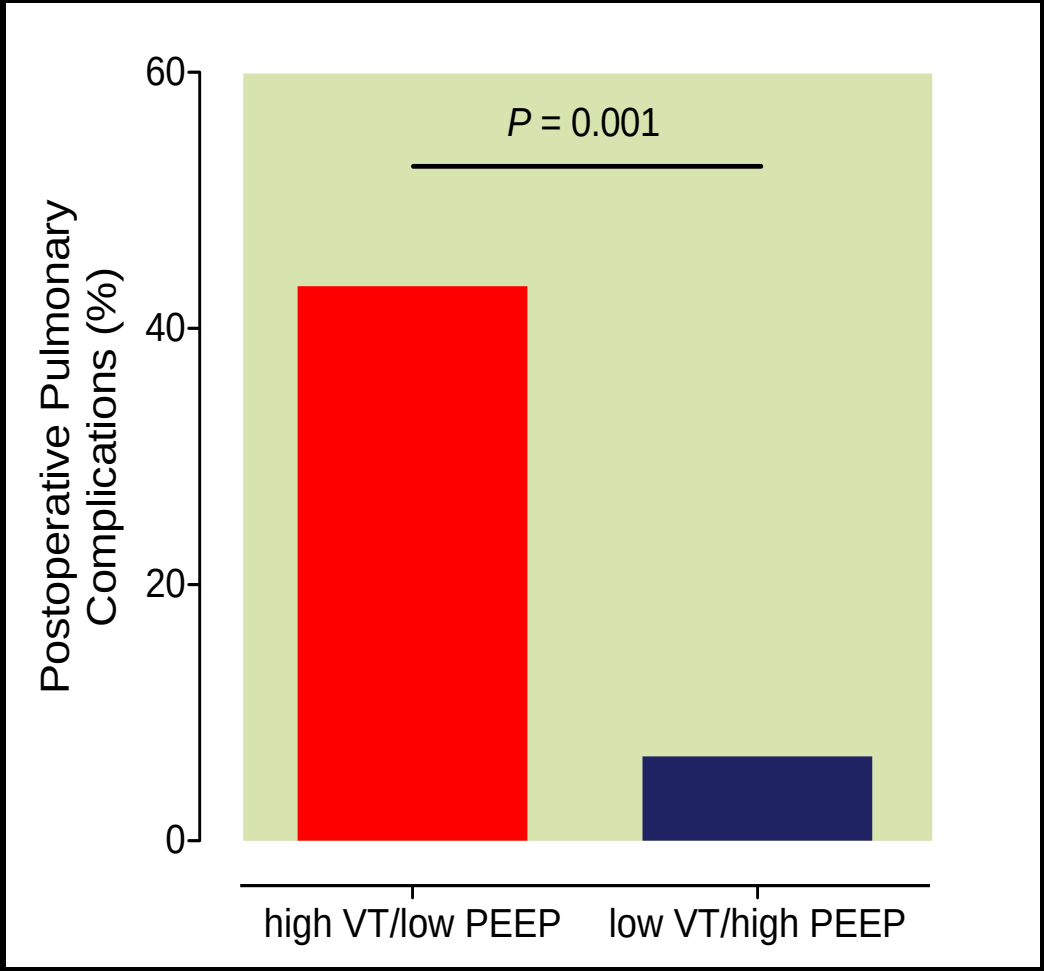
- V_T 9 ml/Kg PBW-PEEP 0 cmH_2O
- V_T 6 ml/Kg PBW- PEEP 10 cmH_2O+ RM

Lower V_T with High PEEP Prevents Postoperative Complications

Ge Y. et al. J Cent South Univ (Med Sci) 2013; **38**:81

- 60 patients
- China
- Spinal fusion surgery
- China

- V_T 10-12 ml/Kg PBW-PEEP 0 cmH_2O
- V_T 6 ml/Kg PBW- PEEP 10 cmH_2O+ RM



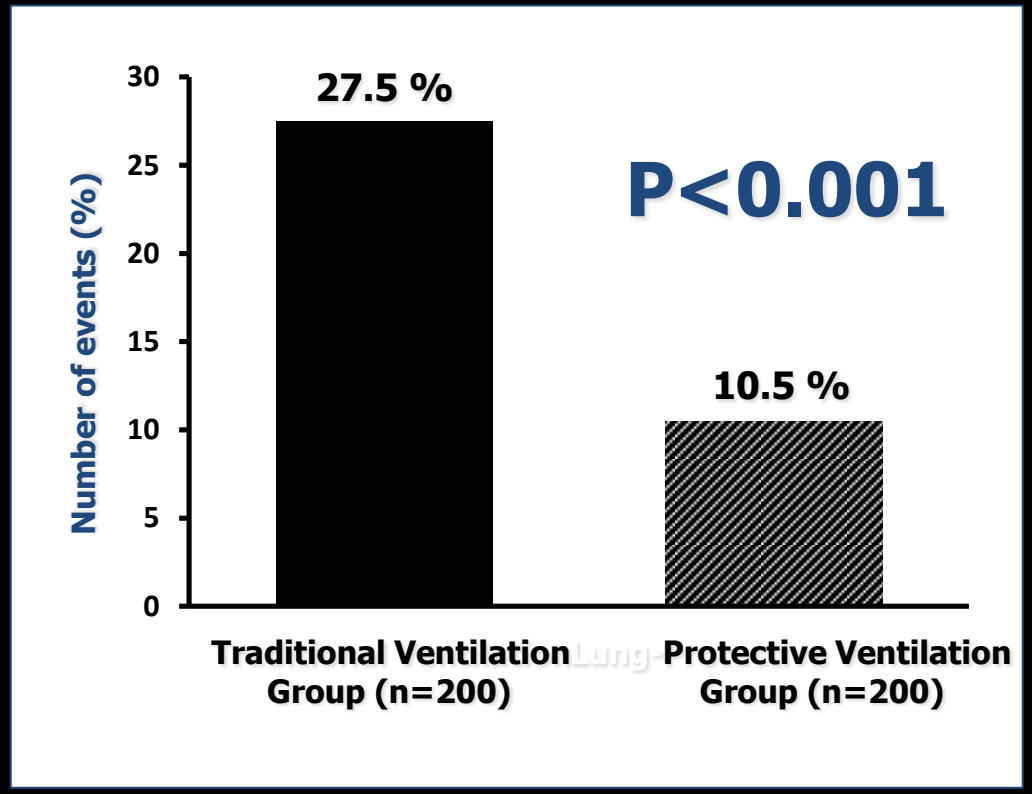
Lower V_T with PEEPand RM Protects Against Post-Operative Complications

Futier E. et al. N Engl J Med 2013;369:428-37.

- 400 patients
- Multicenter
- RCT
- Major abdominal surgery
- France

- V_T 10/12 ml/Kg PBW-PEEP 0 cmH_2O
- V_T 6 ml/Kg PBW-PEEP 6/8 cmH_2O+ RM

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



Incidence of mortality and morbidity related to postoperative lung injury in patients who have undergone abdominal or thoracic surgery

Serpa Neto A. et al. Lancet Respir Med. 2014 Dec;2(12):1007-15.

Outcomes in patients with postoperative lung injury

	HR for in-hospital mortality (95% CI)	HR for ICU discharge (95% CI)
All patients	9·58 (5·32–17·34)	0·45 (0·33–0·66)
Ventilation		
Conventional	14·22 (5·91–34·26)	0·39 (0·25–0·58)
Protective	6·07 (2·47–14·55)	0·71 (0·42–1·19)

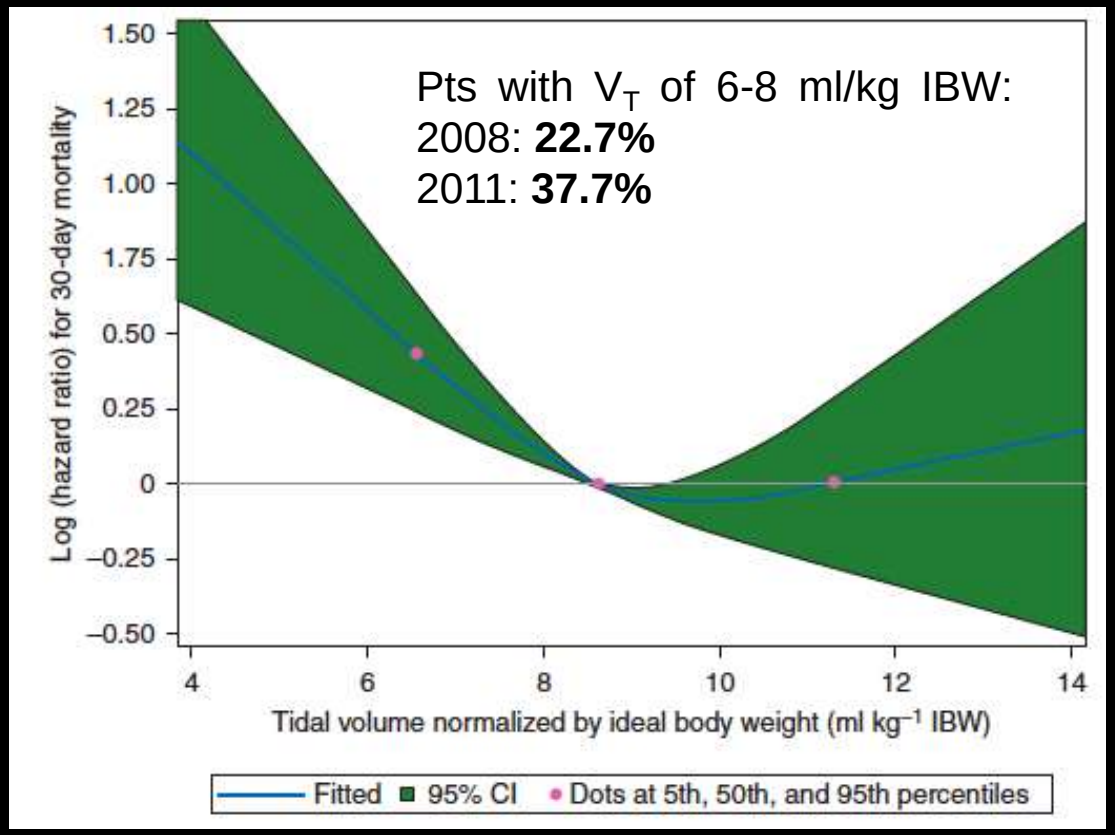
Lung-protective ventilation: V_T <= 8 mL/kg PBW PEEP >= 5 cm H_2O RM
Conventional ventilation: V_T > 8 mL/kg PBW PEEP < 5 cm H_2O No RM

Low Intraoperative Tidal Volume Ventilation with Minimal PEEP is Associated with Increased Mortality

Levin M.A. et al. Br J Anaesth 2014 Jul;113(1):97-108.

Retrospective analysis from 29 343 patients at Mount Sinai (NY, USA)

Median PEEP = 4 [2.2-5] cmH_2O



Low V_T is beneficial only when used with PEEP

Ventilator-Induced Lung Injury

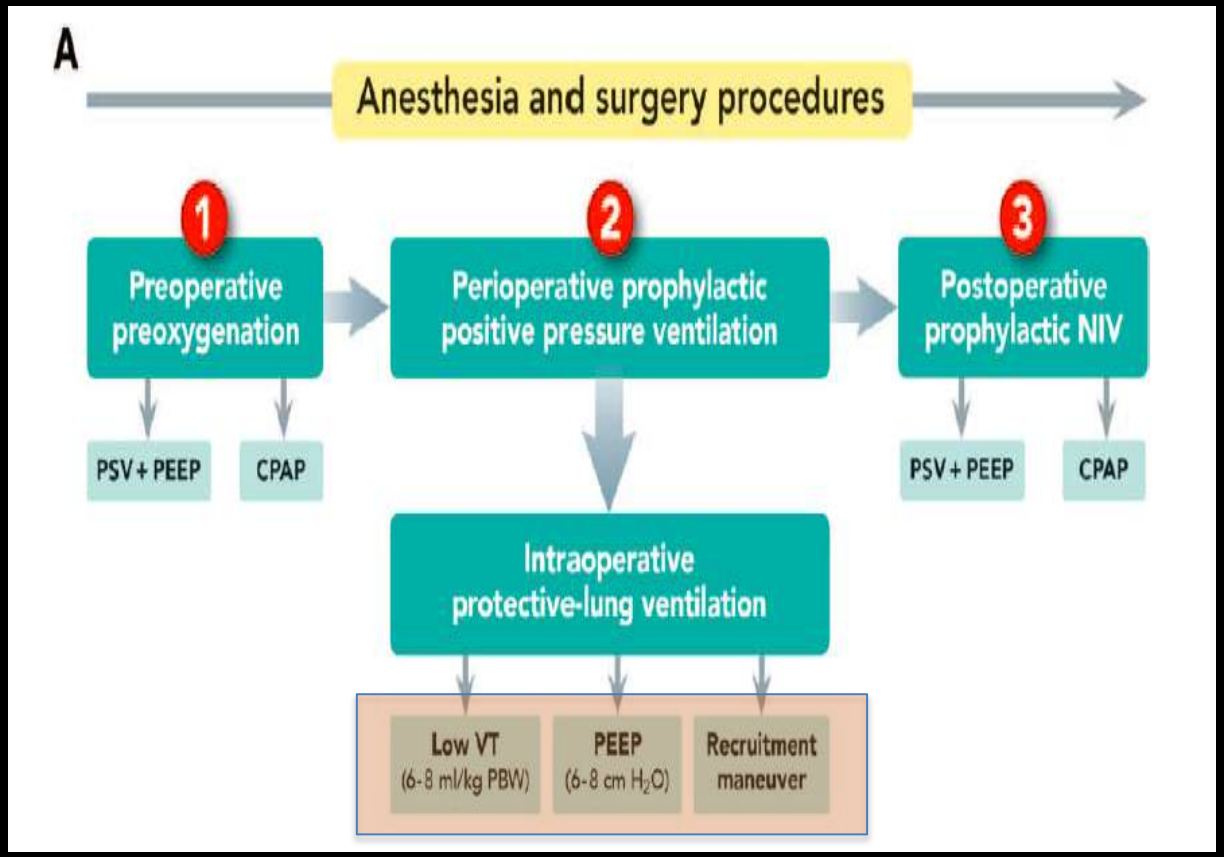
Slutsky AS & Ranieri VM N Engl J Med 2013;369:2126-36

- Patient with normal lungs in ICU
- Anesthetized patient undergoing major abdominal surgery, at high risk for complications

- Tidal volume = 6–8 ml/kg PBW
- Plateau pressure <20 cm of water
- PEEP at 4–8 cm of water
- Recruitment maneuvers every 30 minutes for anesthetized patients

Perioperative Positive Pressure Ventilation
An Integrated Approach to Improve Pulmonary Care

Futier E., Marret E., Jaber S. Anesthesiology 2014; 121:400–8



Initial settings

$6 < VT < 8$ ml/kg PBW

$6 < PEEP < 8$ cmH_2O

Recruitment maneuvers

Repeated every 30-45 min and each derecruitment procedures (suctioning...)

$12 < RR < 25$ breath/min

$30\% < FiO_2 < 50\%$

Target values and monitoring

Plateau pressure < 25 cmH_2O

$35 < EtCO_2 < 45$ mmHG

ABG if presence of $EtCO_2 > 45$ mmHG

$SpO_2 \geq 95\%$

LAS VEGAS – Intraoperative Ventilation Settings

Schultz M, Hemmes S, Abreu GM , Pelosi P for the PROVEnet and LAS VEGAS investigators

9,682 patients - 38 countries - 146 centers

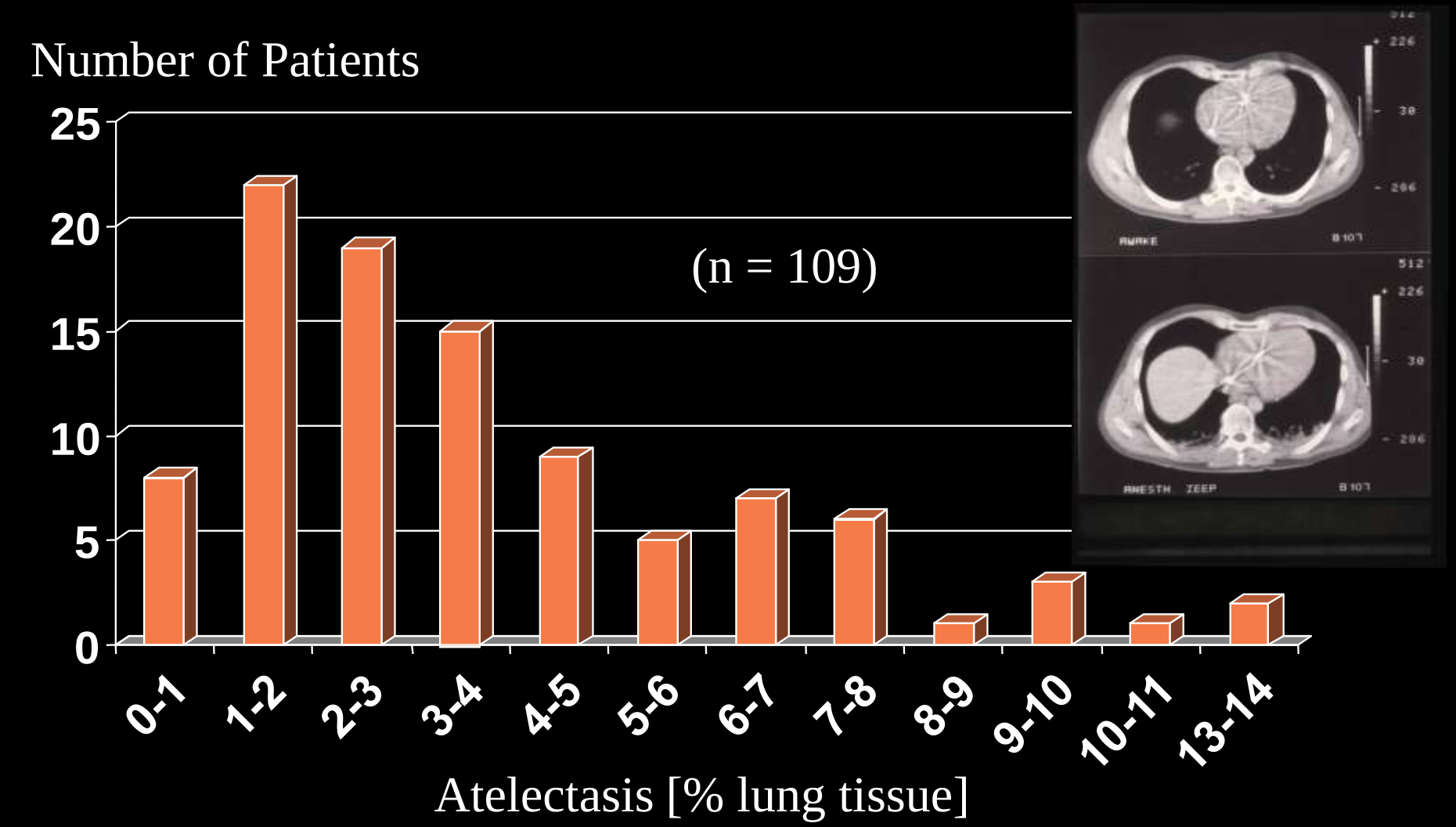
- V_T = 500 [455–557] ml
- V_T = 8.1 [7.3–9.1] ml/kg PBW
- PEEP = 3.5 [0–5] cm H_2O
  - < 2 cm H_2O – 32%
  - 2–5 cm H_2O – 60%
- < 10% RM

LOW V_T – LOW PEEP – NO RMs !

Atelectasis and General Anesthesia

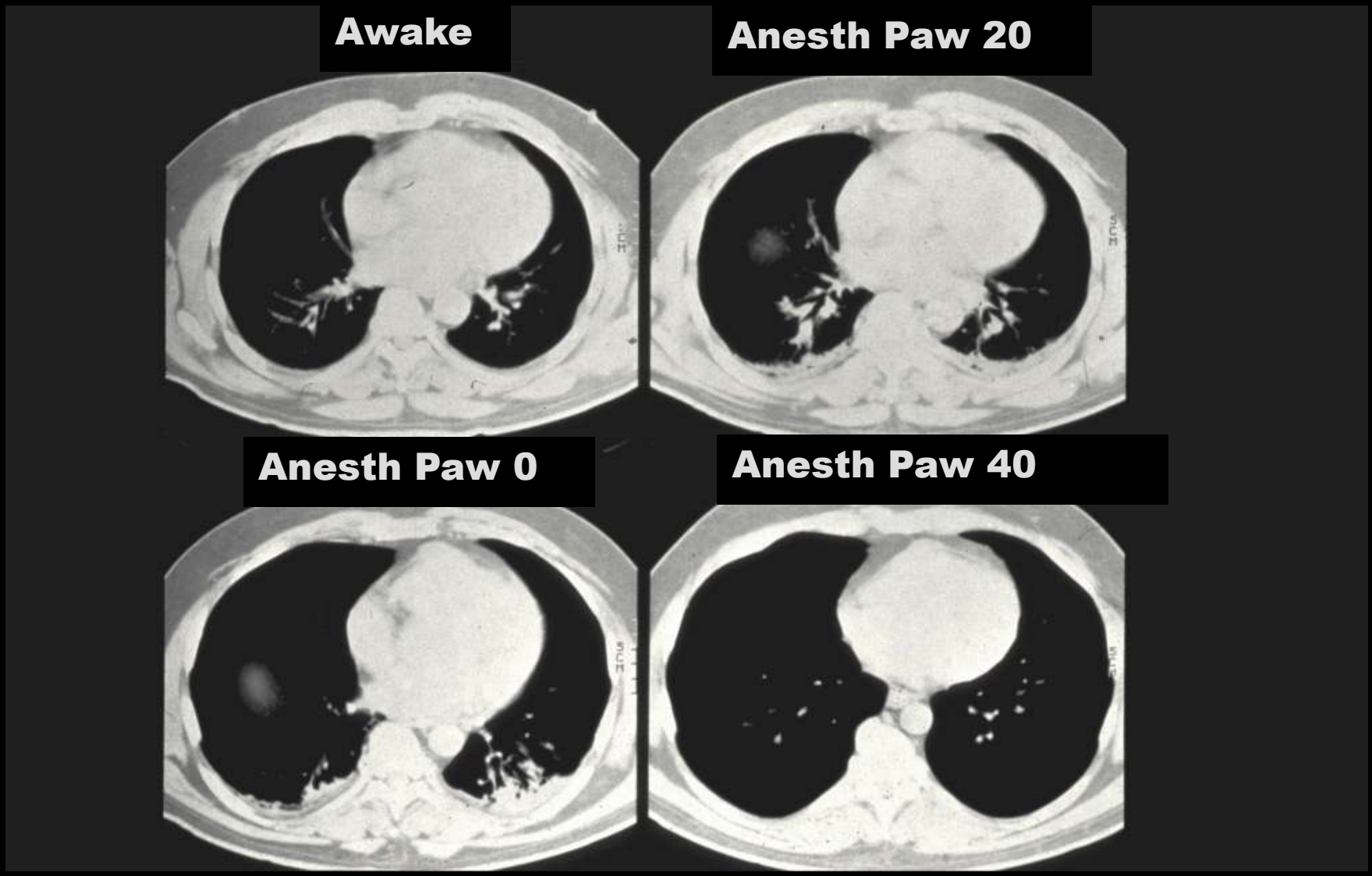
Brismar B et al. Anesthesiology 1985 Apr;62(4):422-8

Lundquist et al. (1995) Acta Radiologica 36; 626-632



Recruitment and Atelectasis

Rothen HU et al. Br J Anaesth 1993 Dec;71(6):788-95.



PROVHILO Trial

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*

The Lancet 2014, Aug 9;384(9942):495-503

The European Society of Anaesthesiology (ESA) and the Academic Medical Center (Amsterdam, Netherlands) financially supported and endorsed the trial

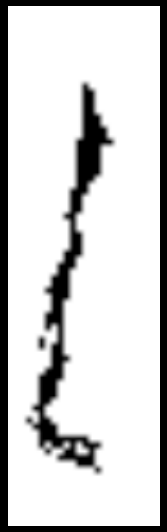
http://www.provenet.eu/

PROVHILO Network

The Lancet 2014 Aug 9;384(9942):495-503

- 8 European countries [28 centers]
- USA [2 centers]
- Chile [1 center]

128 Investigators !



PROVHILO ESA

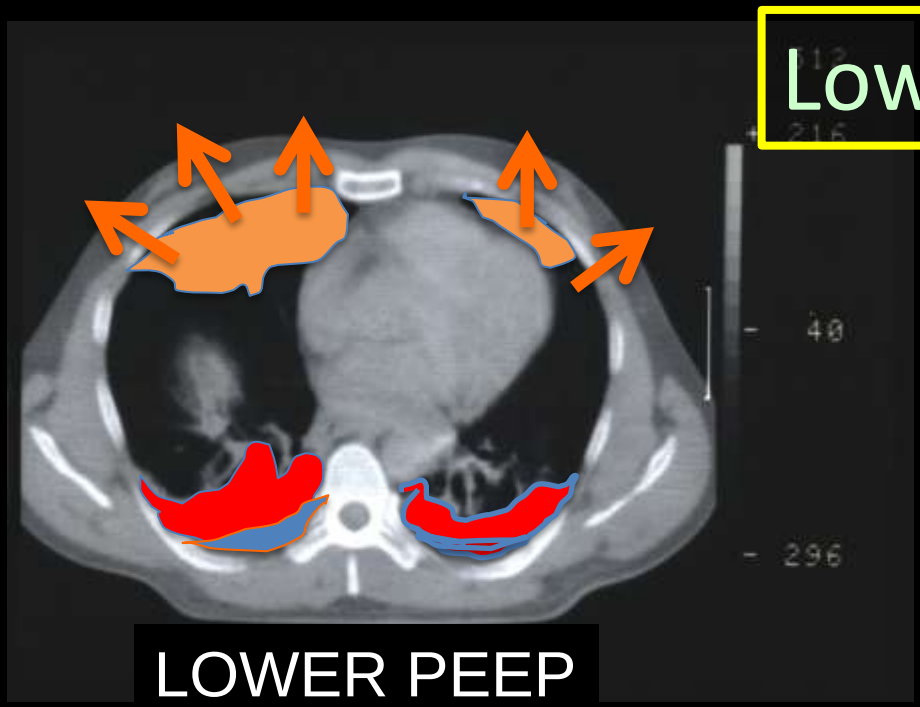
PROTECTIVE VENTILATION NETWORK

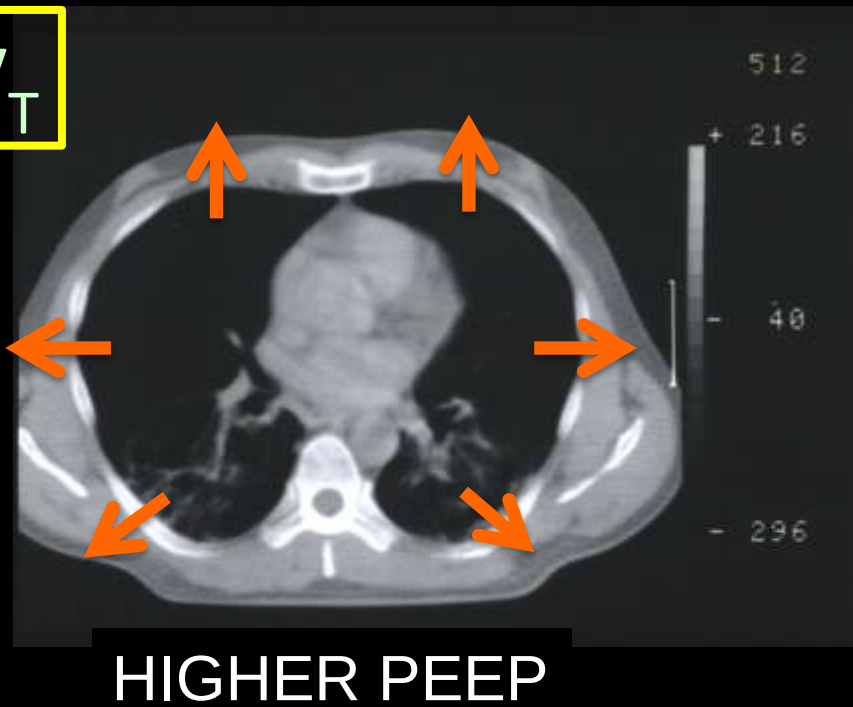
Hypothesis

The Lancet 2014 Aug 9;384(9942):495-503

A ventilation strategy with low V_T and high PEEP plus RMs during general anaesthesia for open abdominal surgery protects against PPCs in patients at risk for complications

Low V_T





Inclusion criteria

The Lancet 2014 Aug 9;384(9942):495-503

- ✓ Planned open abdominal surgery
- ✓ General anaesthesia
- ✓ High or intermediate risk for PPCs following abdominal surgery (ARISCAT risk score >= 26)
- ✓ Informed consent

Exclusion criteria

The Lancet 2014 Aug 9;384(9942):495-503

- ✓ Planned for laparoscopic surgery
- ✓ Pregnant
- ✓ BMI > 40 kg/m^2
- ✓ Severe cardiac or pulmonary comorbidities

Ventilation Strategies

The Lancet 2014 Aug 9;384(9942):495-503

- Volume Controlled
- V_T 8 ml/kg PBW
- I:E = 1:2
- RR to adjusted to achieve FE' CO_2 35– 45 mmHg
- FiO_2: 0.40 or higher to reach target SpO_2 ≥ 92%
- RM: incremental V_T

Low PEEP Ventilation		**High PEEP Ventilation**
PEEP <=2 cmH_2O	*VS*	PEEP 12 cmH_2O + RM

Rescue strategy:

SpO_2 less than 90% without evidence of:

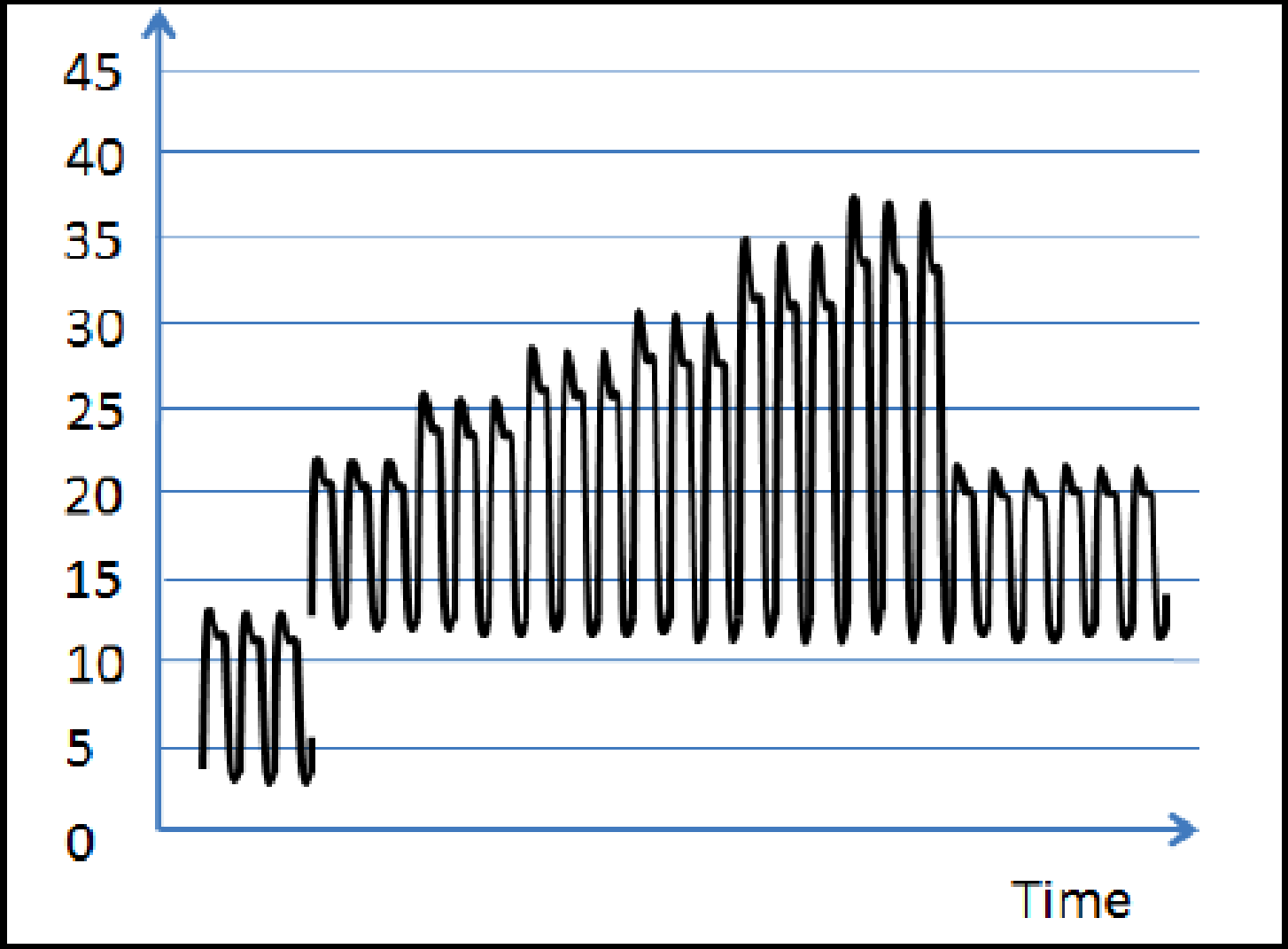
- Airway problems
- Severe haemodynamic impairment
- Ventilator malfunction

Recruitment Manoeuvre:

- After induction of anaesthesia
- After any disconnection from the ventilator
- Just before tracheal extubation

Recruitment: Incremental V_T

The Lancet 2014 Aug 9;384(9942):495-503



Why This Study Design ?

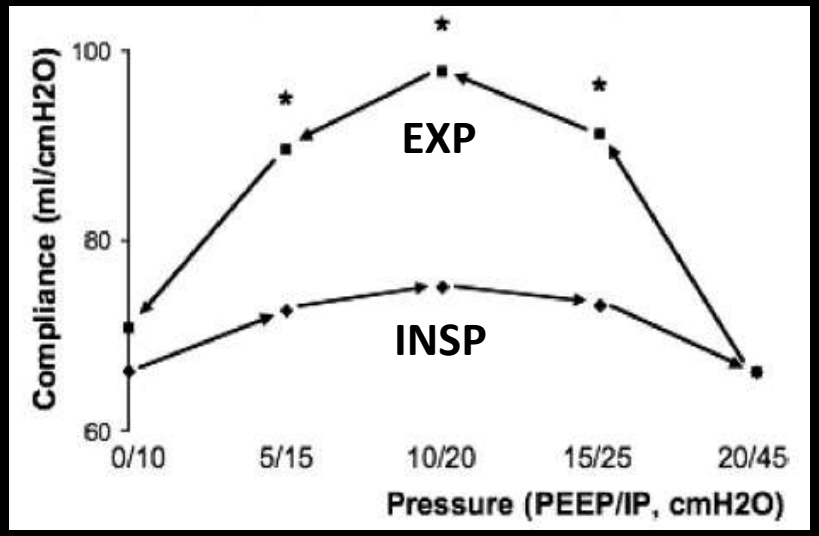
The Lancet 2014 Aug 9;384(9942):495-503

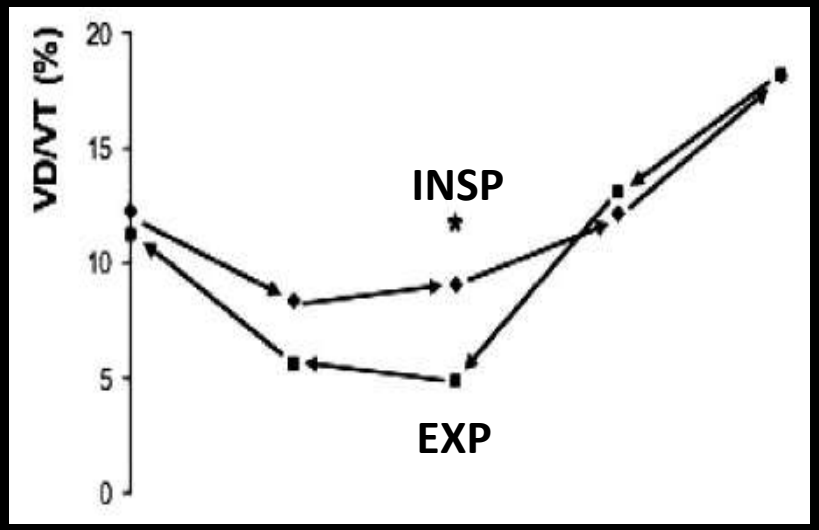
- ✓ Open Abdominal Surgery is at Highest Risk for PPCs (ARISCAT score)
- ✓ Protective V_T = 8 ml/Kg PBW (Fixed)
- ✓ PEEP 10 cmH_2O is the Minimum Level to Keep the Lung Open after RM (CT)
- ✓ Large Sample Size, Multicenter, Multinational, Double Blind

PEEP and Atelectasis

Maisch et al., Anesth Analg 2008;106:175–81

Neumann et al. Acta Anaesthesiol Scand. 1999 Mar;43(3):295-301





ZEEP

PEEP 10 cmH_2O

Primary End-Point

The Lancet 2014 Aug 9;384(9942):495-503

✓ Composite of PPCs Occurring in the First Five Days After Surgery

- Hypoxaemia
- Severe hypoxaemia
- Bronchospasm
- Suspected pulmonary infection
- Pulmonary infiltrate
- Aspiration pneumonitis
- Development of ARDS
- Atelectasis
- Pleural effusion
- Pulmonary oedema caused by cardiac failure
- Pneumothorax

Secondary End-Points

The Lancet 2014 Aug 9;384(9942):495-503

✓ Intraoperative Complications

- SpO_2 less than 90% and needing rescue;
- Hypotension (ie, systolic arterial blood pressure <90 mm Hg for more than 3 min);
- Any need for vasoactive drugs;
- Any new arrhythmias needing intervention;
- Massive transfusion (ie, more than five units of packed-red-blood cells during 1 h);
- Any surgical complication.

✓ Postoperative Extrapulmonary Complications by Day 5

- Development of systemic inflammatory response syndrome;
- Sepsis, severe sepsis, or septic shock;
- Extrapulmonary infection;
- Coma;
- Acute myocardial infarction;
- Acute renal failure; Disseminated intravascular coagulation; Hepatic failure; Gastrointestinal bleeding; Gastrointestinal failure; and impaired wound healing.

Demographic and Clinical Variables

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	**Lower PEEP N=449**
Male sex (%)	58	57
Age - year, median	65	66
BMI – kg/m^2, mean	25.5	25.6
ARISCAT score -median	41	41
Intermediate 26-44 (%)	78	74
High >44 (%)	22	27
ASA I –II (%)	67	64
ASA III-IV (%)	33	37
NYHA I-II (%)	99	99
Hystory of cancer (%)	61	63
Hystory CRF (%)	6	5
COPD (%)	8	7

Types of Surgery

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	Lower PEEP N=449
Colonic (%)	22	22
Pancreatic (%)	13	13
Rectal (%)	11	11
Bladder (%)	9	10
Gastric (%)	9	9
Liver (%)	7	7
Vascular (%)	4	4
Biliary (%)	3	2
Kidney (%)	2	3
Other (%)	18	18

Intraoperative Ventilatory Setting

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	**Lower PEEP N=449**	**P**
Tidal volume ml/Kg PBW, mean	7.2 (1.5)	7.1 (1.2)	
PEEP –cmH_2O, median	12 [12 – 12]	2 [0 – 2]	< 0·0001
Cdyn cmH_2O, (begin) median	45 [36 – 57]	33 [27 – 43]	< 0·0001
Cdyn cmH_2O, (end) median	44 [36 – 54]	35 [27 – 42]	< 0·0001
RR - b/min, mean	11	11	0.13
FiO_2 - %, median	40 [40 – 49]	41 [40 – 50]	0.06
SpO_2 -%, median	99 [98.5 – 100]	99 [98 – 99.8]	< 0·0001
$FE'CO_2$-mmHg, mean	35.2 (3.7)	34.5 (3.4)	< 0·0007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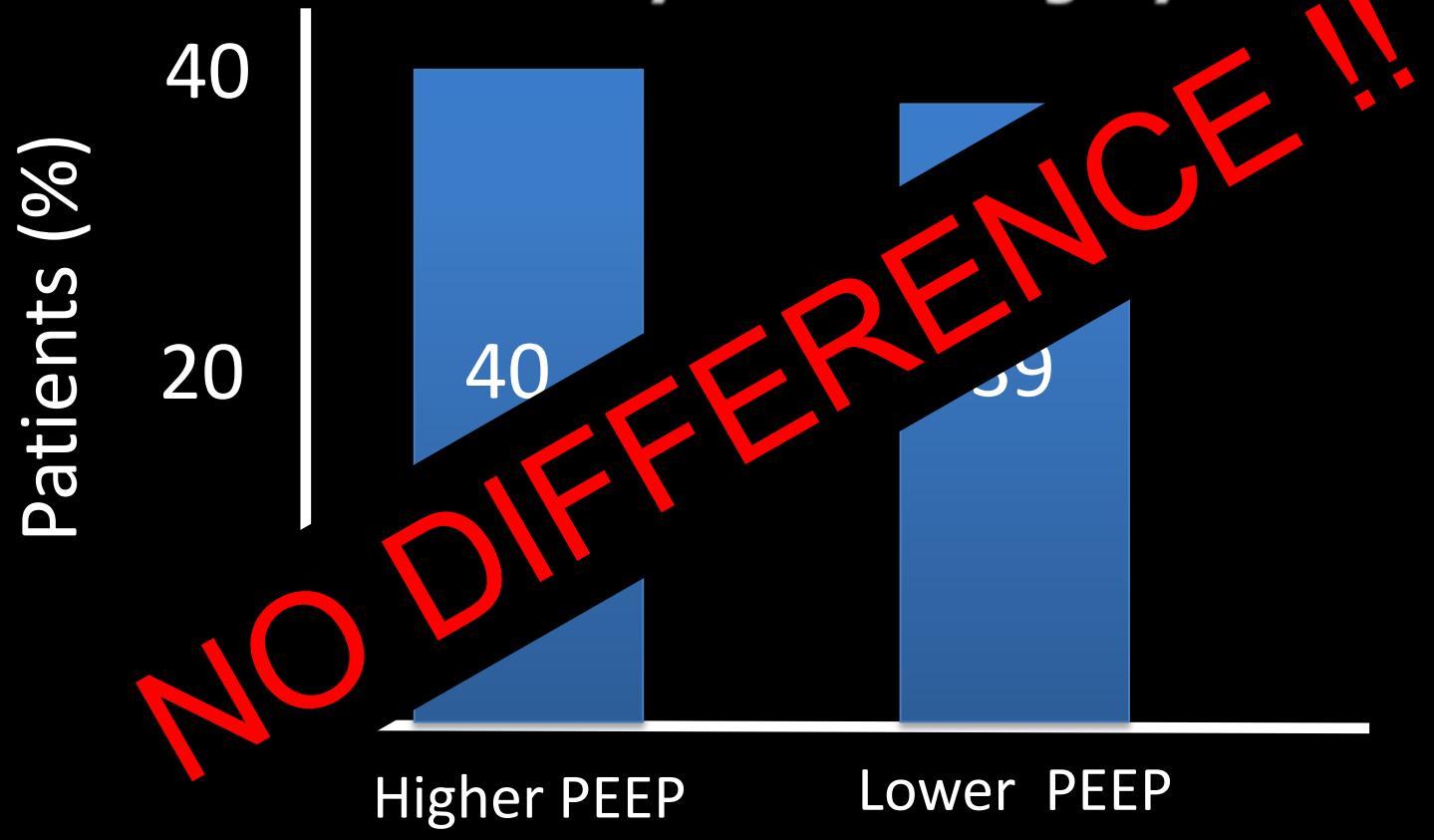
Postoperative Pulmonary Complications

The Lancet 2014 Aug 9;384(9942):495-503



	Relative risk (95% CI)	P value
Primary outcome	1.01 (0.85-1.20)	0.84

Pulmonary Post-Operative Complications

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	Lower PEEP N=449	P
Hypoxemia	24 (105/437)	21 (95/443)	0·36
Severe hypoxemia	7 (29/437)	8 (34/443)	0·55
Bronchospasm	4 (18/437)	4 (18/443)	0·97
Suspected pulm. infection	16 (68/437)	17 (75/443)	0·58
Pulmonary infiltrate	8 (35/437)	7 (32/443)	0·66
Aspiration pneumonitis	0.2 (1/437)	1 (4/443)	0·18
ARDS	1 (5/437)	2 (8/443)	0·41
Atelectasis	12 (53/437)	12 (55/443)	0·90
Pleural effusion	21 (90/437)	21 (92/443)	0·95
PE by cardiac failure	4.3 (19/437)	4.5 (20/443)	0·90
Pneumothorax	3.4 (15/437)	2.7 (12/443)	0·53

Intraoperative Complications (%, n/N)

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	**Lower PEEP N=449**	**P**
Rescue for de–saturation	2 (11/442)	8 (34/445)	< 0·0008
Hypotension	46 (205/441)	36 (162/449)	0·0016
Vasoactive drugs	62 (274/444)	51 (228/445)	0·0016
New arrhythmias	3 (12/442)	1 (5/445)	0·09
Organ perforation	1 (4/444)	1(4/444)	1

Rescue Strategies in Higher and Lower PEEP

The Lancet 2014 Aug 9;384(9942):495-503

Rescue strategy with higher PEEP group

Step	1	2	3	4	5	6	7	8	
FIO2	0·5	0·5	0·5	0·5	0·6	0·7	0·8	0·8	
PEEP	12	10	8	6	6	6	6	4 or lower	
Patients (nTOT – n)	9	4	2	1	1	1	0	0	0

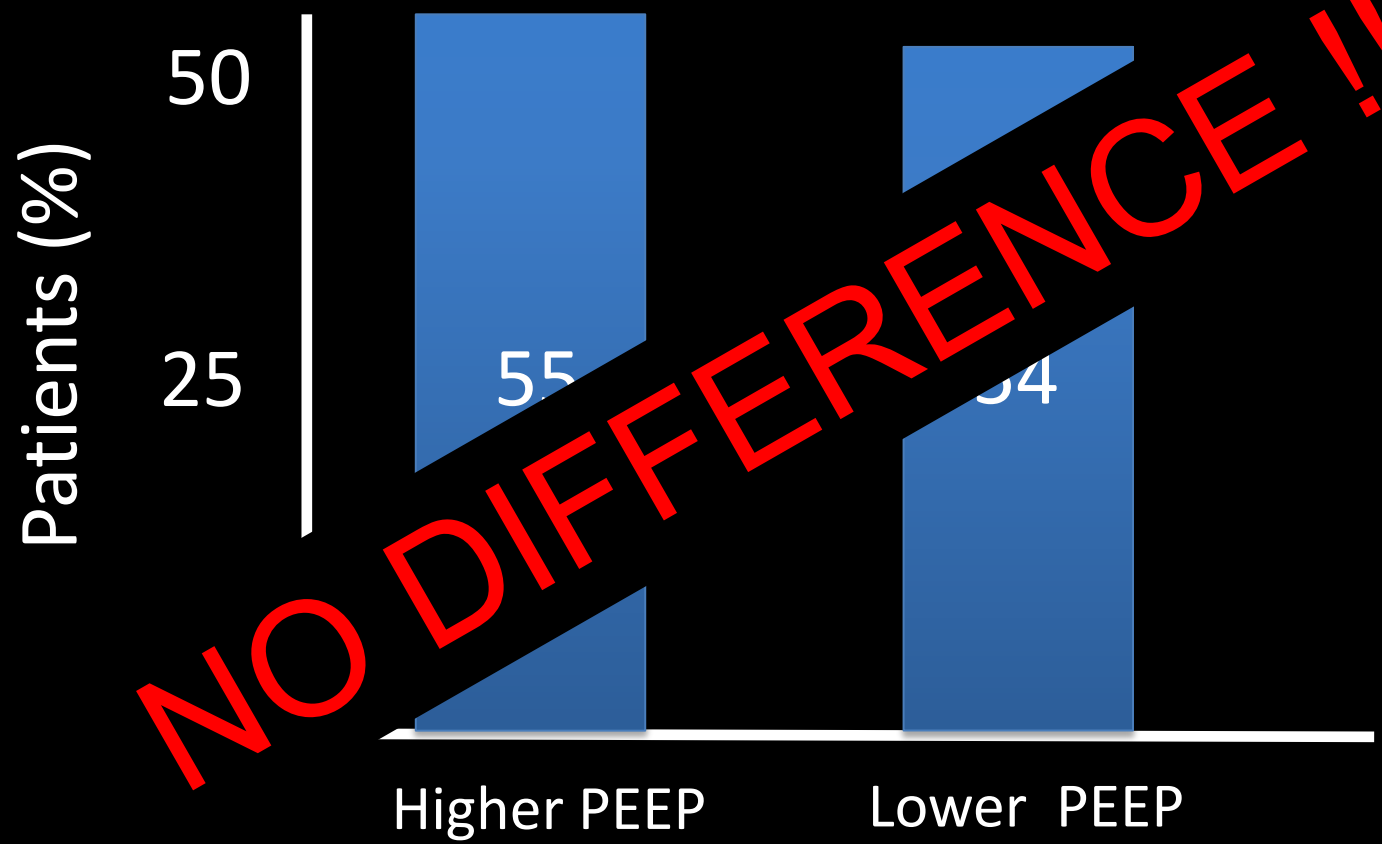
Rescue strategy with lower PEEP group

Step	1	2	3	4	5	6	7	8	9
FIO2	0·5	0·6	0·6	0·6	0·6	0·7	0·8	0·8	RM
PEEP	2	2	3	4	5	5	5	6	6
Patients (nTOT – n)	28	5	8	1	0	9	4	0	1	0

Postoperative Extrapulmonary Complications

The Lancet 2014 Aug 9;384(9942):495-503

Postoperative Extrapulmonary Complications at day 5 after Surgery



	Relative risk (95% CI)	P value
Primary outcome	1.02 (0.90-1.15)	0.78

Postoperative Ventilation and Outcome

The Lancet 2014 Aug 9;384(9942):495-503

	Higher PEEP N= 445	Lower PEEP N=449	P
Need for new or continued MV – % (n/N)	4 (18/437)	5 (24/443)	0.74
ICU admission – % (n/N)	24 (106/442)	23 (104/452)	0.79
Length of hospital stay – days, median [IQR]	10 [7 – 14]	10 [7 – 14]	0.24
Mortality by day 5 – % (n/N)	0.4 (2/443)	0.2 (1/448)	0.56
In hospital mortality – % (n/N)	2 (7/ 438)	2 (7/442)	0.99

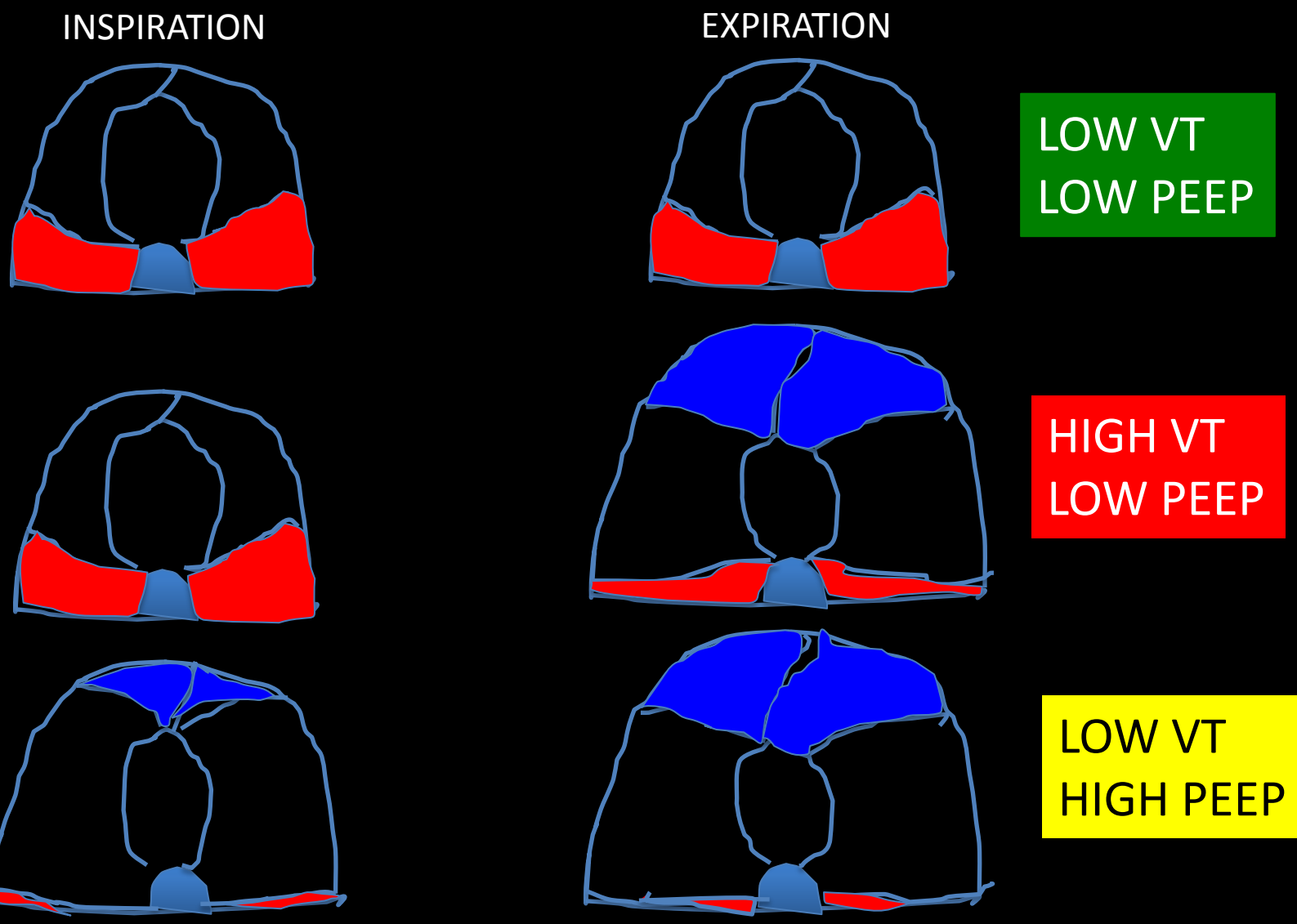
Conclusions

The Lancet 2014 Aug 9;384(9942):495-503

- ✓ Anesthesiologists should ventilate with Low V_T (7 ml/Kg PBW) & PEEP less than 5 cmH_2O, without RMs
- ✓ We suggest to increase PEEP with RMs only in case of hypoxemia not responding to increasing FiO_2 (up to 60%)

Permissive Atelectasis during GA

Güldner A. et al., Anesthesiology 2014; in press



IMPROVE vs PROVHILO

	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	

Courtesy of Prof Samir Jaber

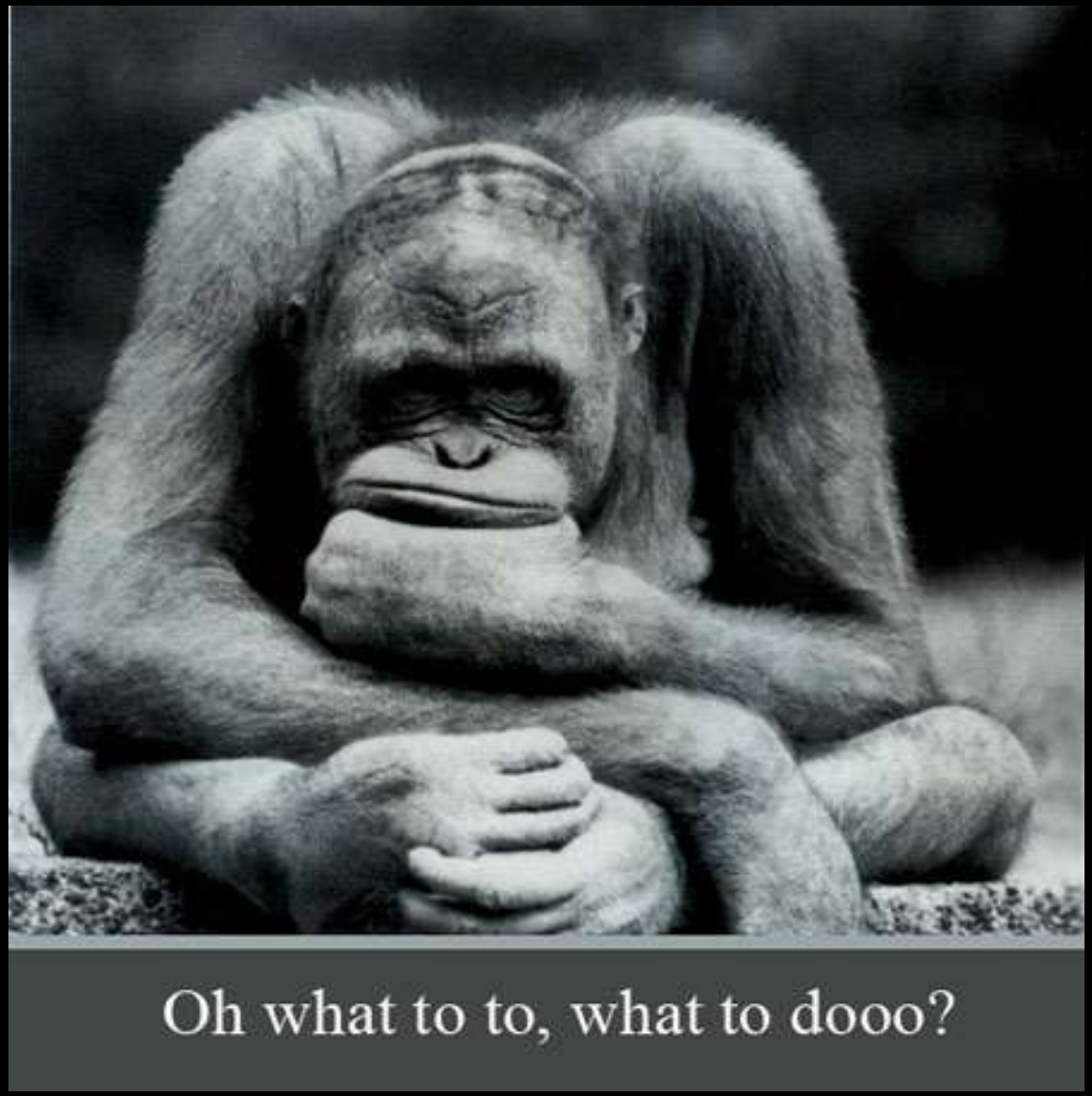
Future RCTs of Intraoperative Ventilation

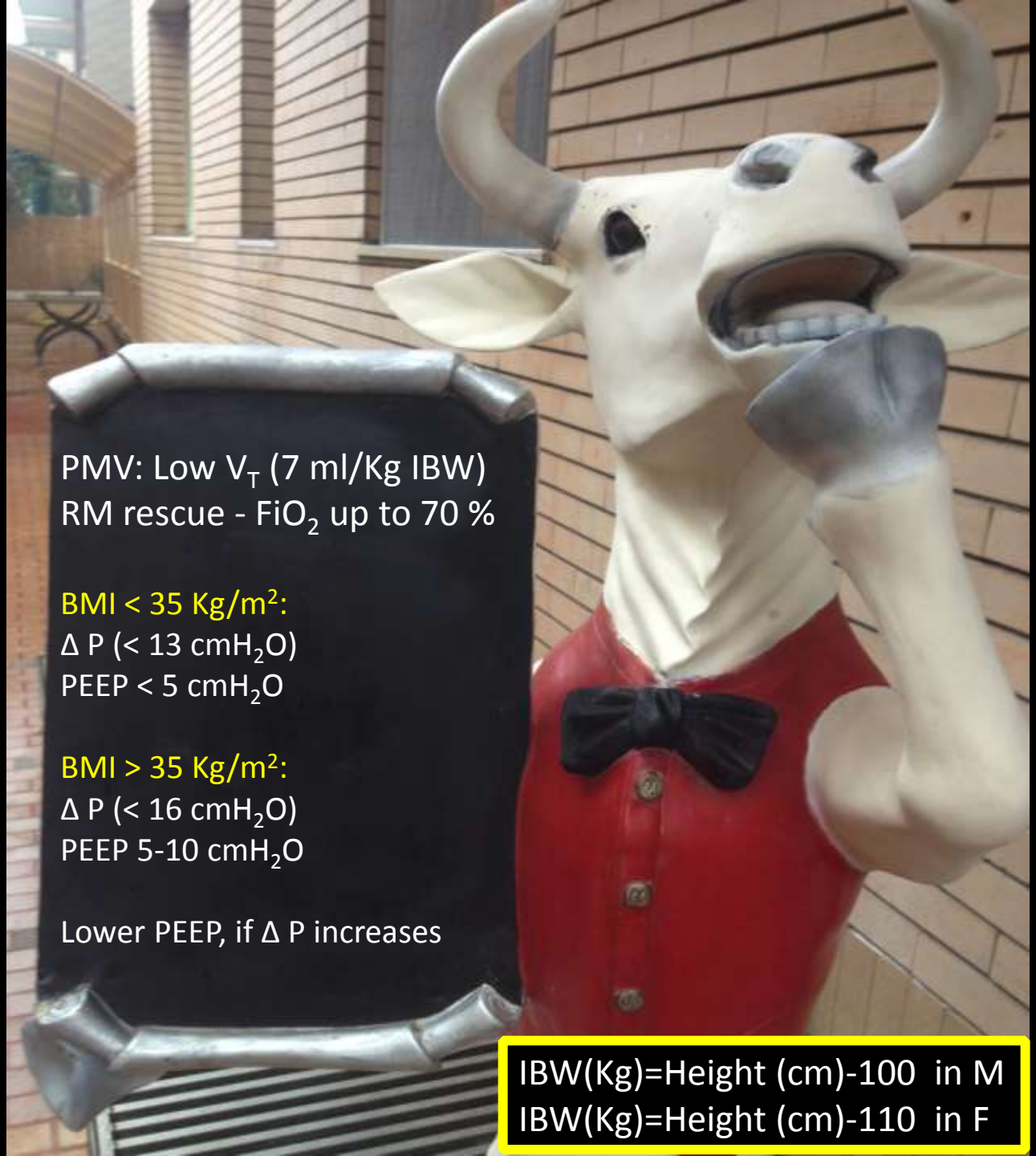
- PROBESE trial (obese patients): high vs. low PEEP, during lower V_T ventilation

- PROTHOR trial (OLV): high vs. low PEEP, during lower V_T ventilation

http://www.provenet.eu/

Decide What you Want to do




PMV: Low V_T (7 ml/Kg IBW)
RM rescue - FiO_2 up to 70 %
BMI < 35 Kg/m²:
Δ P (< 13 cmH_2O)
PEEP < 5 cmH_2O
BMI > 35 Kg/m²:
Δ P (< 16 cmH_2O)
PEEP 5-10 cmH_2O
Lower PEEP, if Δ P increases
IBW(Kg)=Height (cm)-100 in M
IBW(Kg)=Height (cm)-110 in F

Protective Mechanical Ventilation During General Anesthesia ?

Low Tidal Volume and Driving Pressures

Protective Mechanical Ventilation During General Anesthesia ?

Thanks!

To Everyone who collaborated for the success of this project:

- Anesthesiologists
- Surgeons
- Nurses
- Residents
- Patients and Families
- Office Administrations
- Supporting Entities (AMC – ESA – PROVEnet)
- Ethical Committees

PROTECTIVE VENTILATION NETWORK

ESA

Low Tidal Volume and Driving Pressures