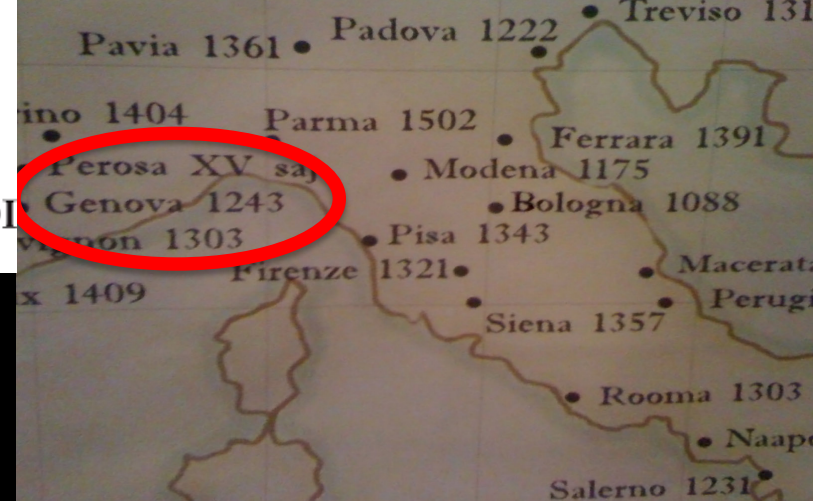




OSPEDALE POLICLINICO SAN MARTINO  
Sistema Sanitario Regione Liguria



UNIVERSITÀ DEGLI STUDI  
DI GENOVA



# Protective ventilation in ALL patients from OR to ICU

**PAOLO PELOSI, MD, FERS**

Department of Surgical Sciences and Integrated  
Diagnostics (DISC), *San Martino Policlinico  
Hospital– IRCCS for Oncology,*  
University of Genoa, Genoa, Italy

[ppelosi@hotmail.com](mailto:ppelosi@hotmail.com)

British – Ukrainian Symposium  
Kiev – Ukraine – April 2018

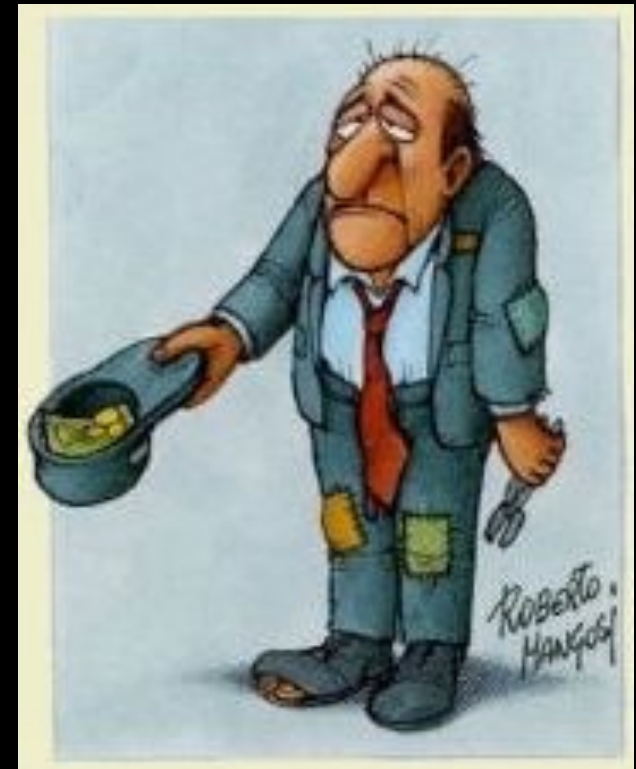
Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



# Conflicts of Interest

---

I declare  
**NO** conflicts of interest

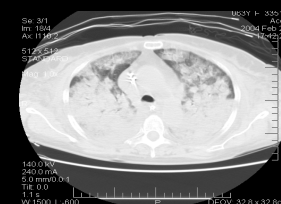
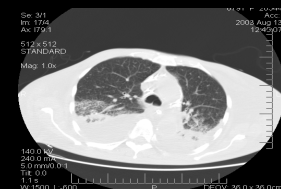
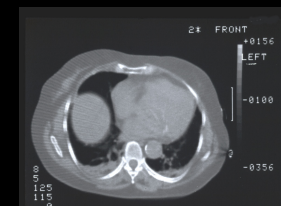




# To prevent or cure acute respiratory distress syndrome: that is the question!

*Paolo Pelosi<sup>a</sup> and Patricia R.M. Rocco<sup>b</sup>*

**Curr Opin Crit Care 2014, 20:1–2**

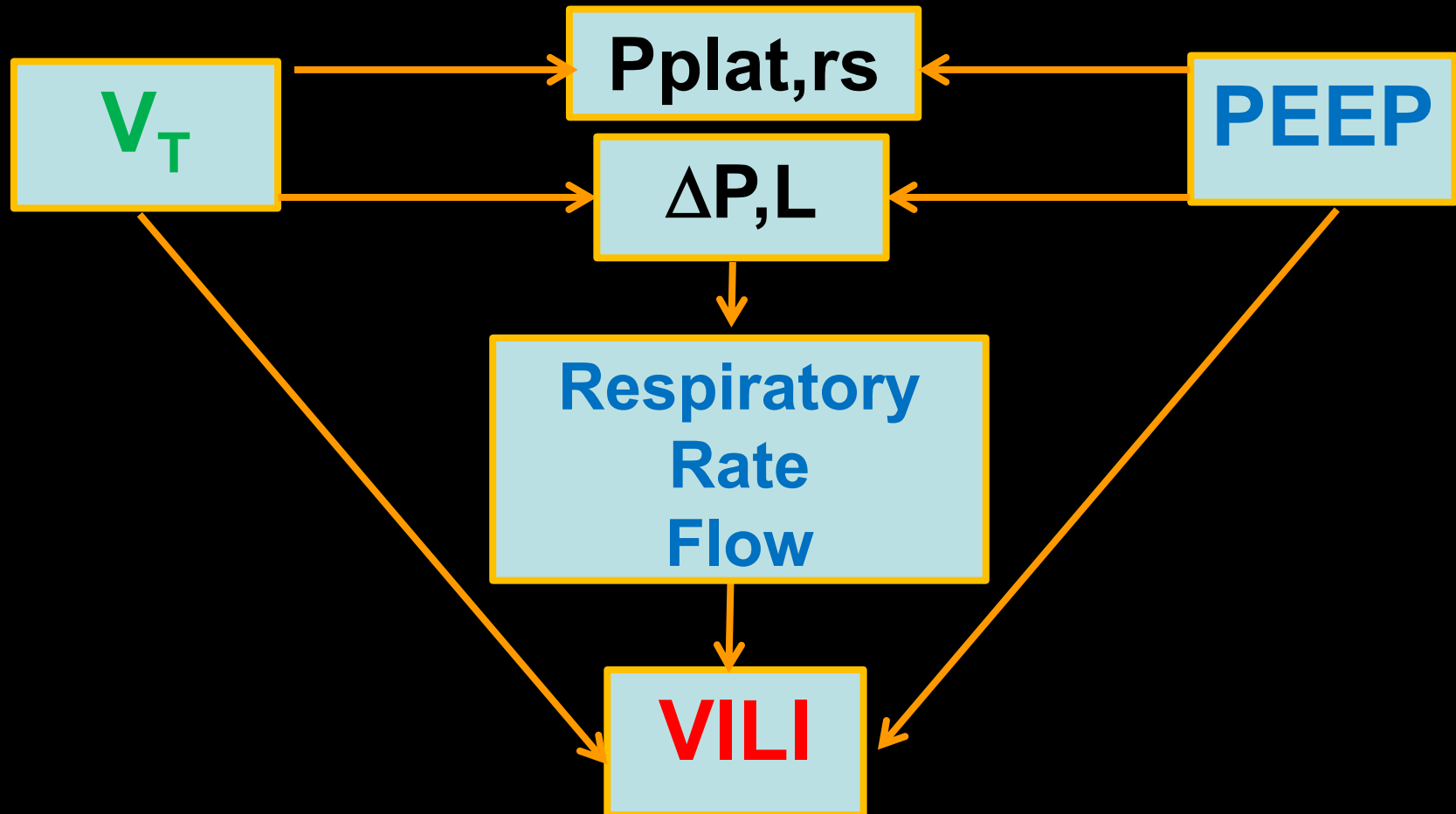


Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))  
Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

# Mechanisms of Ventilator Induced Lung Injury

Rocco PR et al. Curr Opin Anaesthesiol. 2012 Apr;25(2):123-30

Pelosi P, Rocco PR, Abreu MG . et al. Expert Rev Respir Med. 2018 Mar 29:1-12



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



## Ventilation During General Anesthesia for Surgery



**Protective ventilation includes:**

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



**Protective ventilation includes:**

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*



**Protective ventilation includes:**

*severe moderate and severe ARDS*



**Protective ventilation includes:**



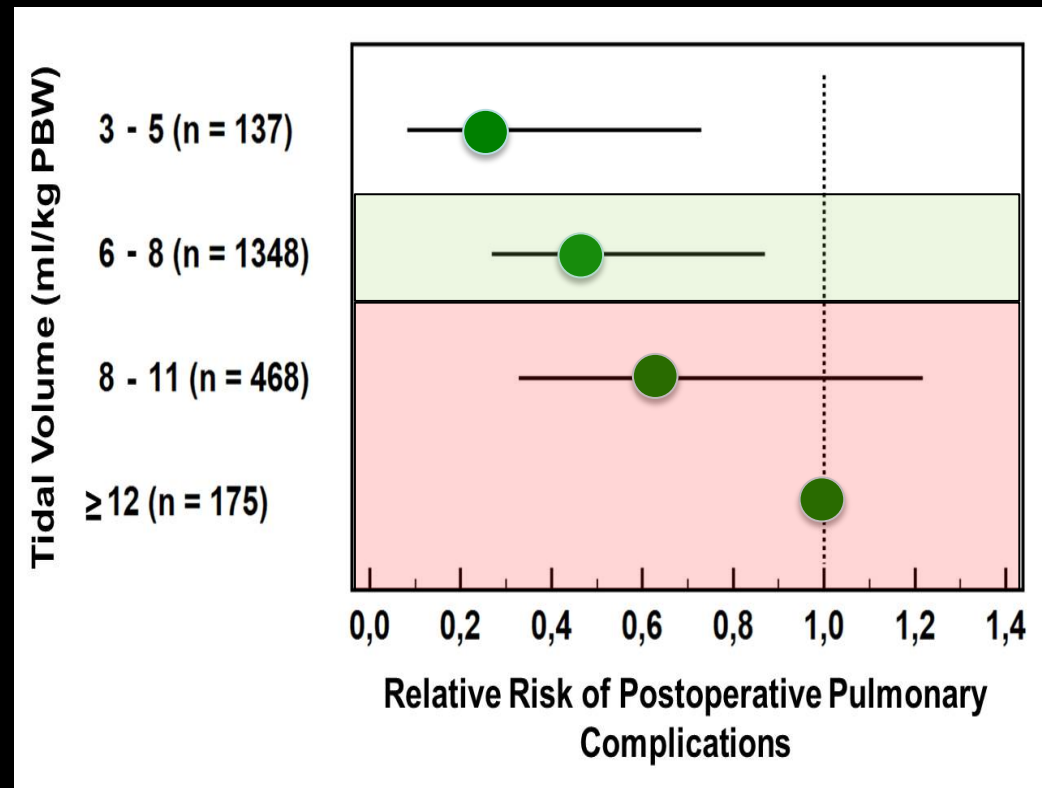
Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

# Intraoperative Use of Low $V_T$ Benefits Surgery Patients without ARDS

Serpa-Neto A. et al. Anesthesiology. 2015 Jul;123(1):66-78

- 2,127 surgery
- patients from 15 studies of intraoperative ventilation
- outcome: PPC

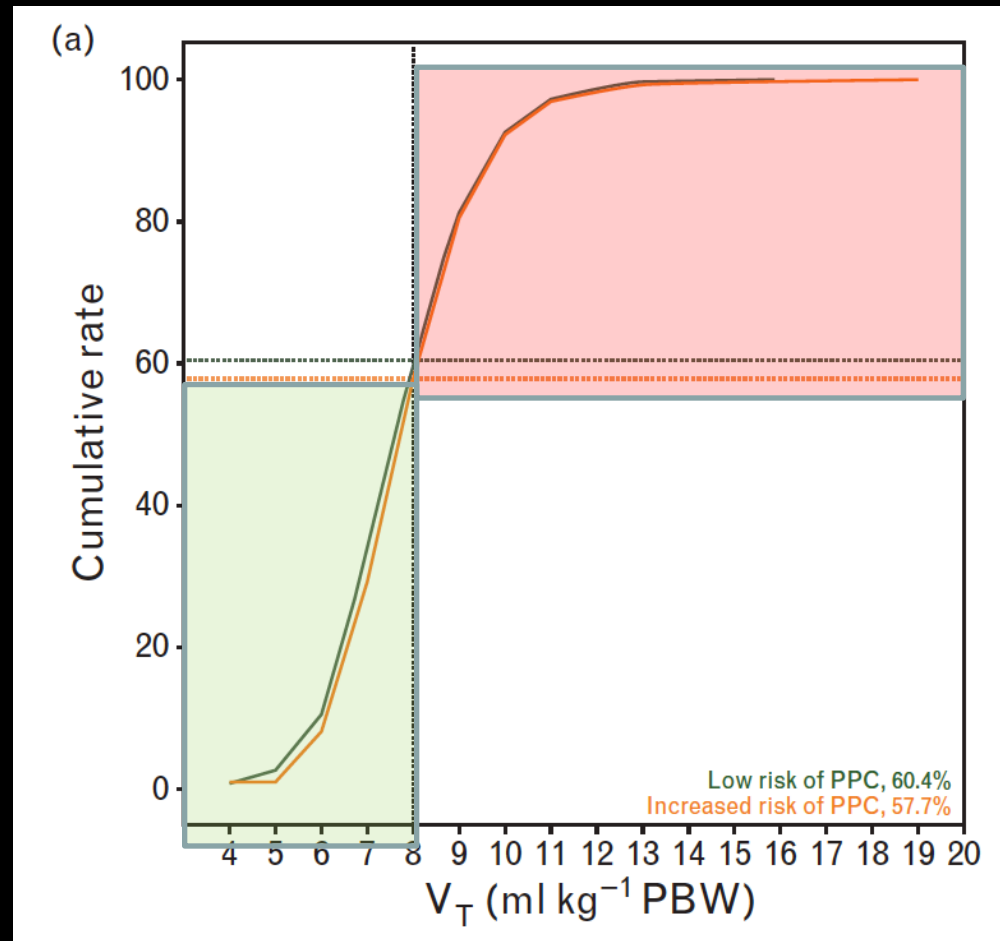


# LAS VEGAS – Practice of Ventilation in ORs Worldwide



The LAS VEGAS Investigators - Eur J Anaesthesiol 2017; 34:492–507

- international observational study
- 8,241 patients
- 8.1 [7.2–9.1] mL/kg PBW
- $V_T > 8$  ml/Kg in 40% of patients



Paolo Pelosi for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

## Ventilation During General Anesthesia for Surgery



**Protective ventilation includes:**

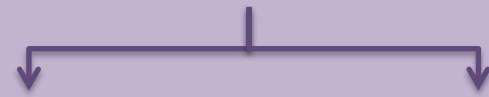
Tidal volume size  
6-8 ml/kg predicted body weight  
evidence comes from  
3 RCTs and  
2 meta-analyses

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



**Protective ventilation includes:**

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*



**Protective ventilation includes:**

*severe moderate and severe ARDS*



**Protective ventilation includes:**

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

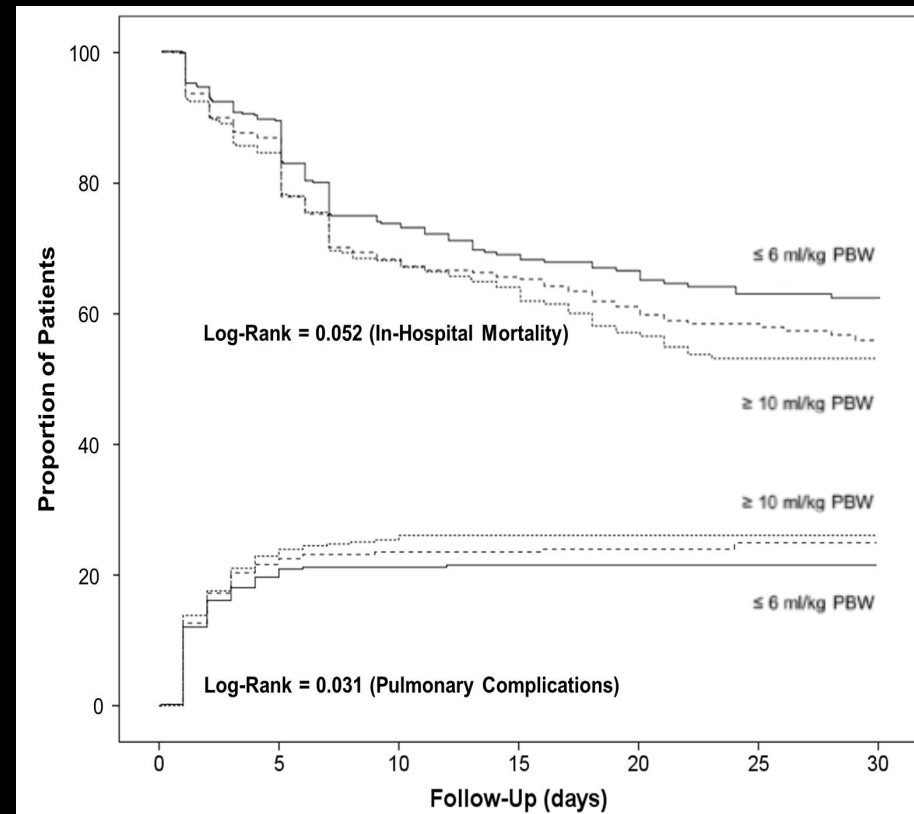
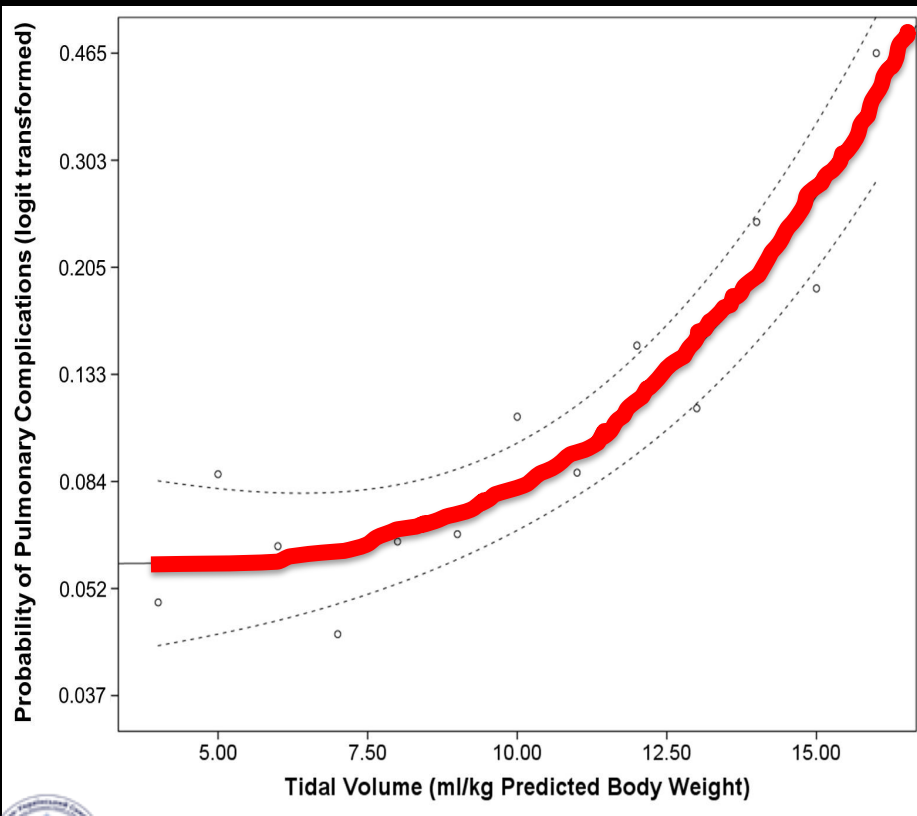


# Use of Lower Tidal Volumes Benefits Patients *without* ARDS

Serpa Neto A. et al. Intensive Care Med. 2014; 40:950

Serpa Neto A. et al. Crit Care Med. 2015; 43:4155

- 2,184 ICU patients without ARDS from 7 studies - outcome: duration of ventilation

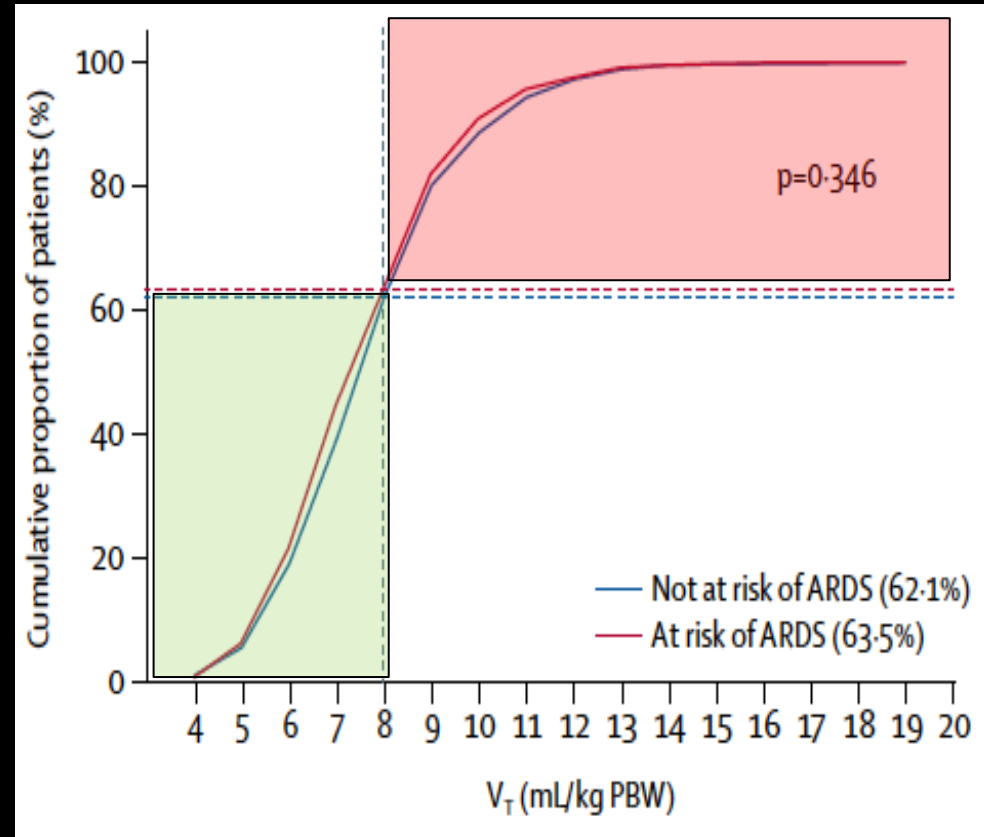


# PRoVENT – Practice of Ventilation in ICUs Worldwide



Serpa-Neto A et al. Lancet Respir Med. 2016 Nov;4(11):882-893.

- international observational study
- 1,022 patients without ARDS
- 7.9 [6.8–9.1] mL/kg PBW
- $V_T > 8$  ml/Kg in 40% of patients



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



# PreVENT – Low vs. Intermediate $V_T$ in Patients without ARDS

Simonis F for the PreVENT investigators. TRIALS 2015; 16:266

---

- superiority RCT
- $V_T$  4-6 vs 8-10 ml/Kg PBW
- 950 non-ARDS patients
- 5 Dutch ICUs
- VFD-28
- enrolment complete



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

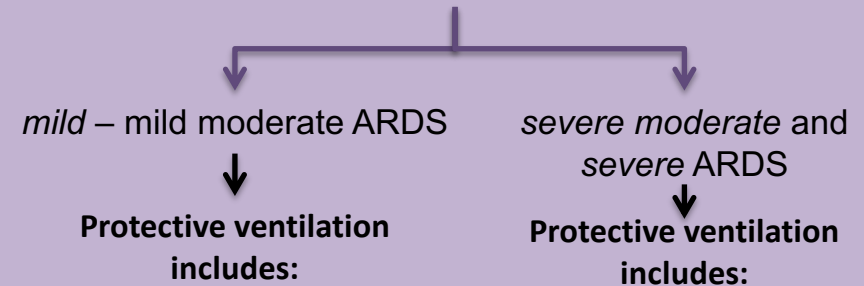
## Ventilation in Intensive Care Unit–patients with Uninjured Lungs



### Protective ventilation includes:

Tidal volume size  
**6-8 ml/kg predicted body weight**  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

## Ventilation in Intensive Care Unit–patients with the Acute Respiratory Distress Syndrome (ARDS)



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



# Use of Lower Tidal Volumes Benefits Patients *with* ARDS

Putensen C et al. Ann Intern Med 2009; 151: 566-576

- 1,297 patients with ARDS from 6 RCTs
- **Pplat 28-30 cmH<sub>2</sub>O**
- Outcome: hospital death

	No	Low V <sub>T</sub> at similar PEEP	High V <sub>T</sub> at similar PEEP	Odds ratio
Brochard	116	–	–	
Brower	52	13/26	12/26	1.17 [0.39 – 3.47]
Brower	861	134/342	171/429	0.68 [0.51 – 0.90]
Stewart	120	30/60	28/60	1.14 [0.56 – 2.34]
				<b>0.75 [0.58 – 0.96]</b>

	No	Low V <sub>T</sub> + high PEEP	High V <sub>T</sub> + low PEEP	Odds ratio
Amato	53	13/29	17/24	0.33 [0.11 – 1.05]
Villar	95	17/50	24/45	0.41 [0.18 – 0.94]
				<b>0.38 [0.20 – 0.75]</b>

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

[METANALYSIS]

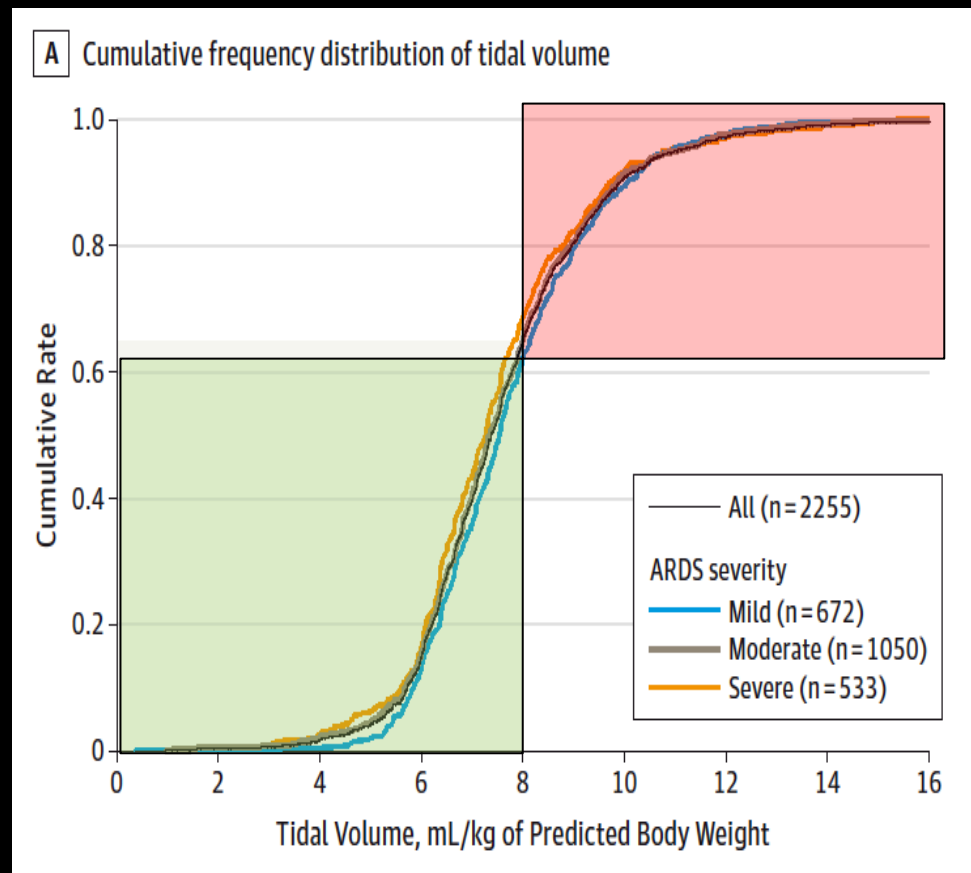


# LungSafe – Practice of Ventilation in ICUs Worldwide



Bellani G JAMA. 2016 Feb 23;315(8):788-800

- international observational study
- 2,396 patients with mild, moderate or severe ARDS
- $V_T > 8$  ml/Kg in 40% of patients



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

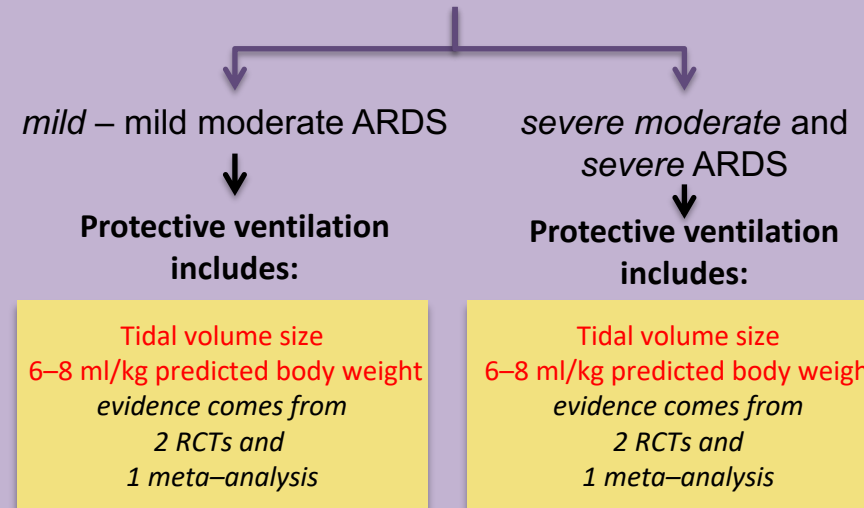
## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

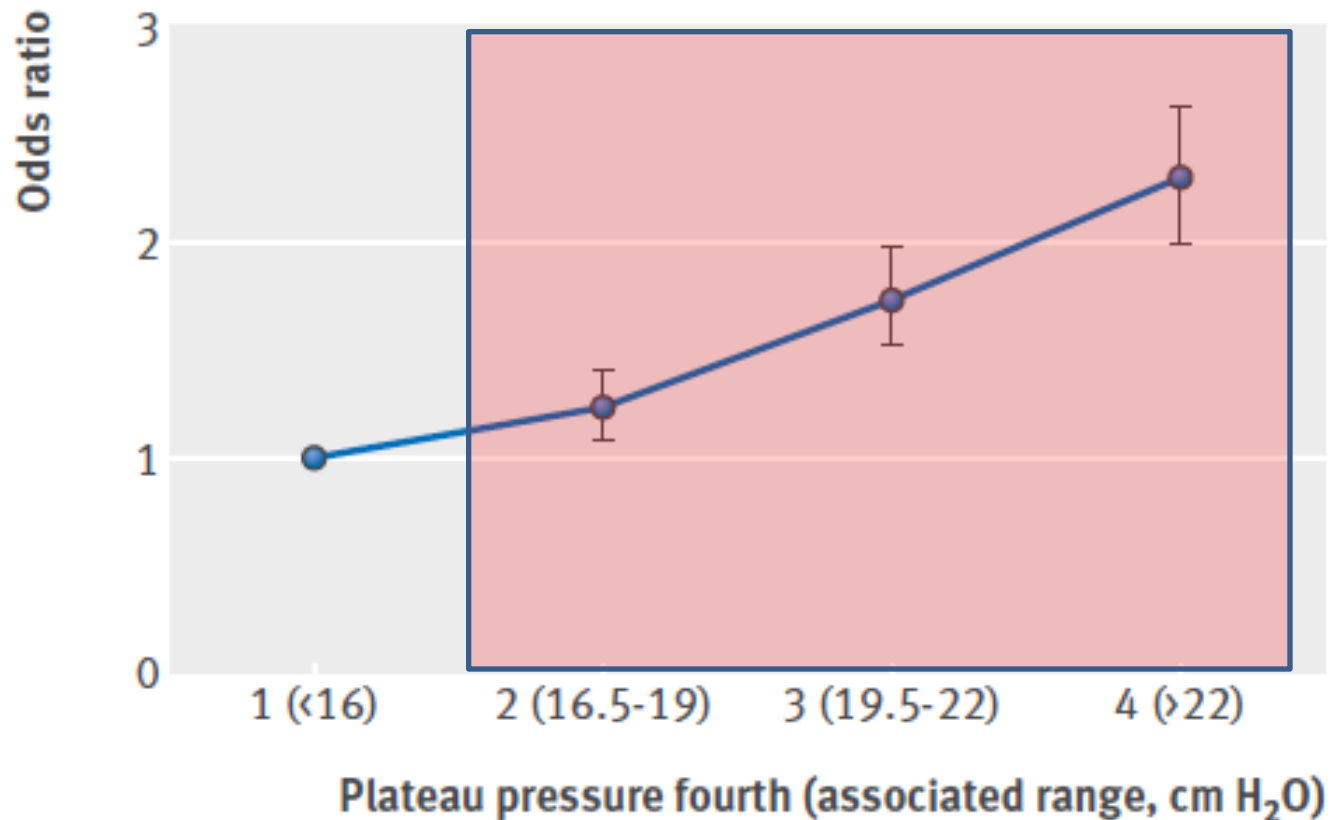
## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



# Intraoperative protective mechanical ventilation and risk of postoperative respiratory complications: hospital based registry study

Ladha K et al. BMJ 2015;351:h3646

## Postoperative Pulmonary Complications



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



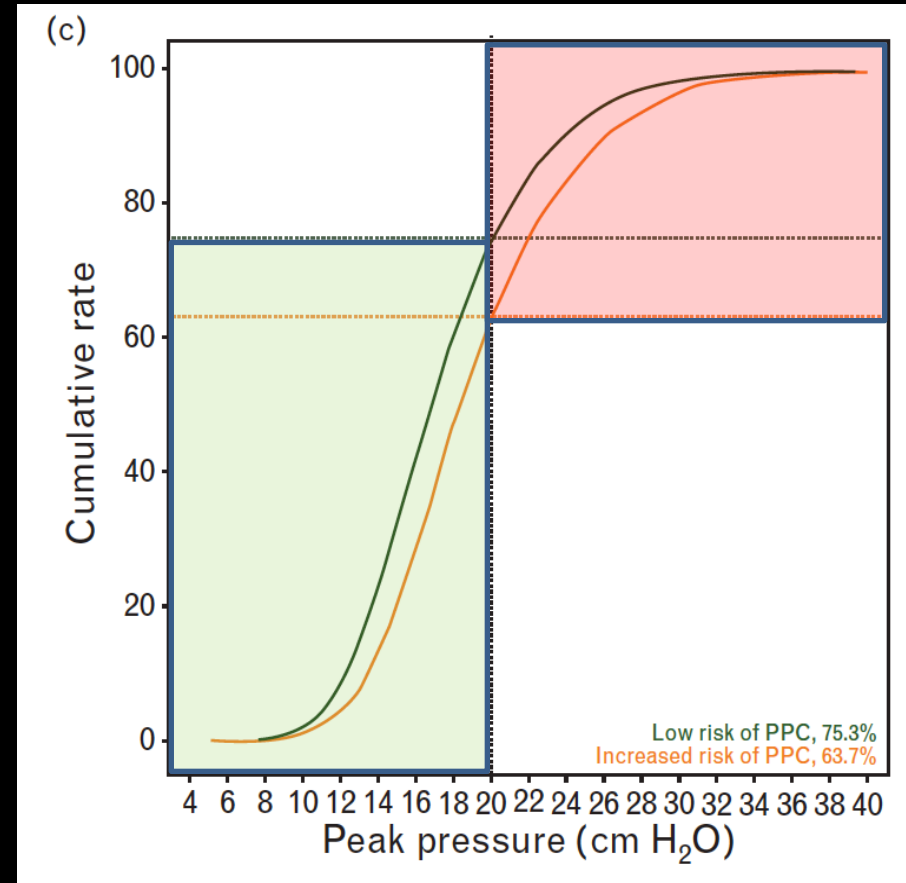


# LAS VEGAS – Practice of Ventilation in ORs Worldwide



The LAS VEGAS Investigators - Eur J Anaesthesiol 2017; 34:492–507

- international study
- 8,241 patients
- Pplat 15.5 [13.0-18.5] cm H<sub>2</sub>O
- Ppeak 17.5 [15.0-21.0] cm H<sub>2</sub>O
- **Ppeak > 20 cm H<sub>2</sub>O (Pplat > 18 cmH<sub>2</sub>O) in 25-30% of patients**



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

**Pplat < 17 cmH<sub>2</sub>O**  
*suggestion comes from  
observational studies*

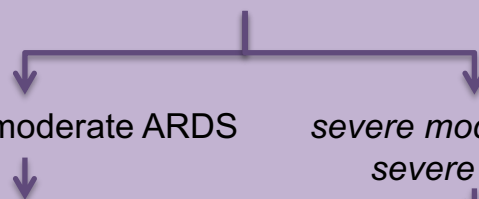
## Ventilation in Intensive Care Unit–patients with Uninjured Lungs



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

## Ventilation in Intensive Care Unit–patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



# Management and Outcome of Mechanically Ventilated in Patients after Cardiac Arrest

Sutherasan Y et al. Crit Care. 2015 May 8;19:215

---

## Factors associated with ARDS

- 1) **Higher ( $> 17 \text{ cmH}_2\text{O}$ ) plateau pressure**  
(odds ratio 1.12, 95% CI interval 1.04 to 1.21)

## Factors associated with ICU acquired pneumonia

- 1) **Higher tidal volume**  
(odds ratio 1.003, 95% CI 1.0003 to 1.01)
- 2) **Higher ( $>5 \text{ cmH}_2\text{O}$ ) applied PEEP levels**  
odds ratio 0.89, 95% CI 0.80 to 0.99)



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

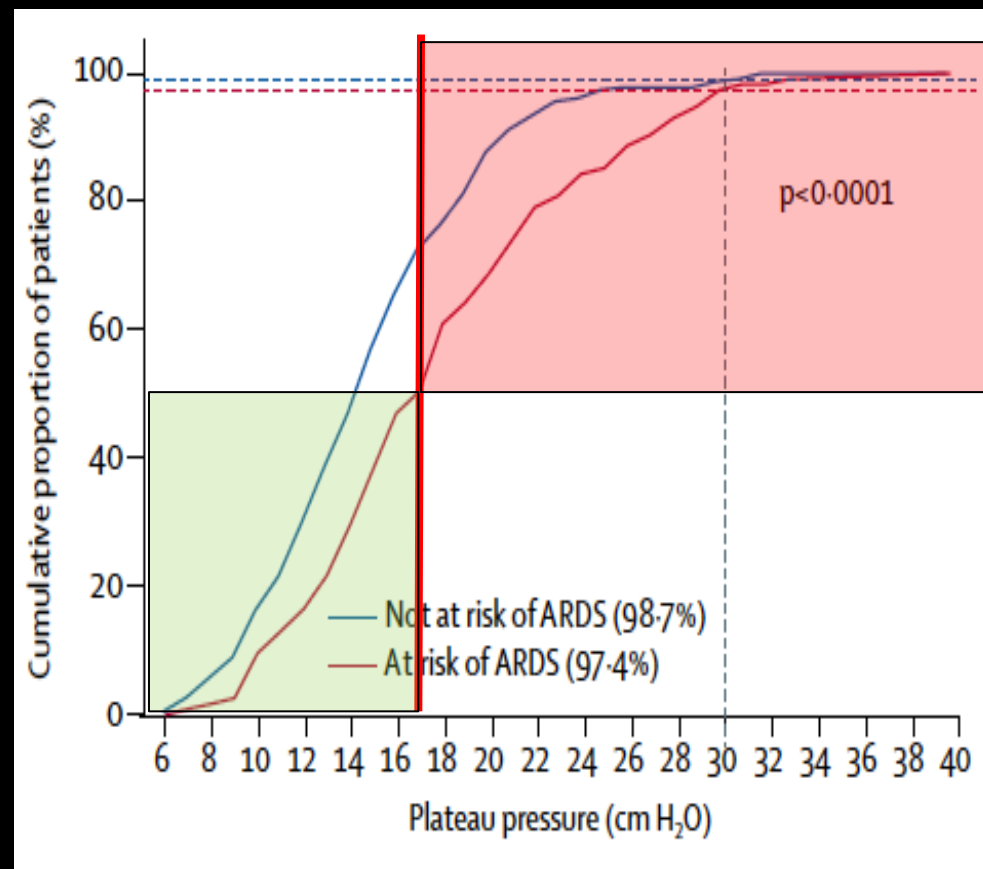
Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

# PRoVENT – Practice of Ventilation in ICUs Worldwide



Serpa-Neto A et al. Lancet Respir Med. 2016 Nov;4(11):882-893.

- international observational study
- 1,022 patients without ARDS
- Pplat 15.0 [13.0-20.0] cm
- **Pplat > 17 cmH<sub>2</sub>O in 30-40% of patients**



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018





## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

**Pplat < 17 cmH<sub>2</sub>O**  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs

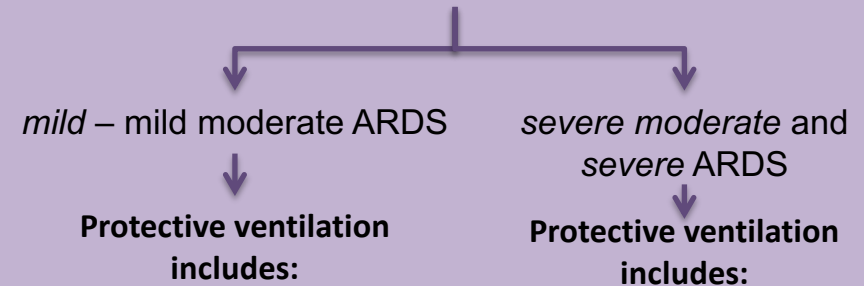


### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

**Pplat < 17 cmH<sub>2</sub>O**  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



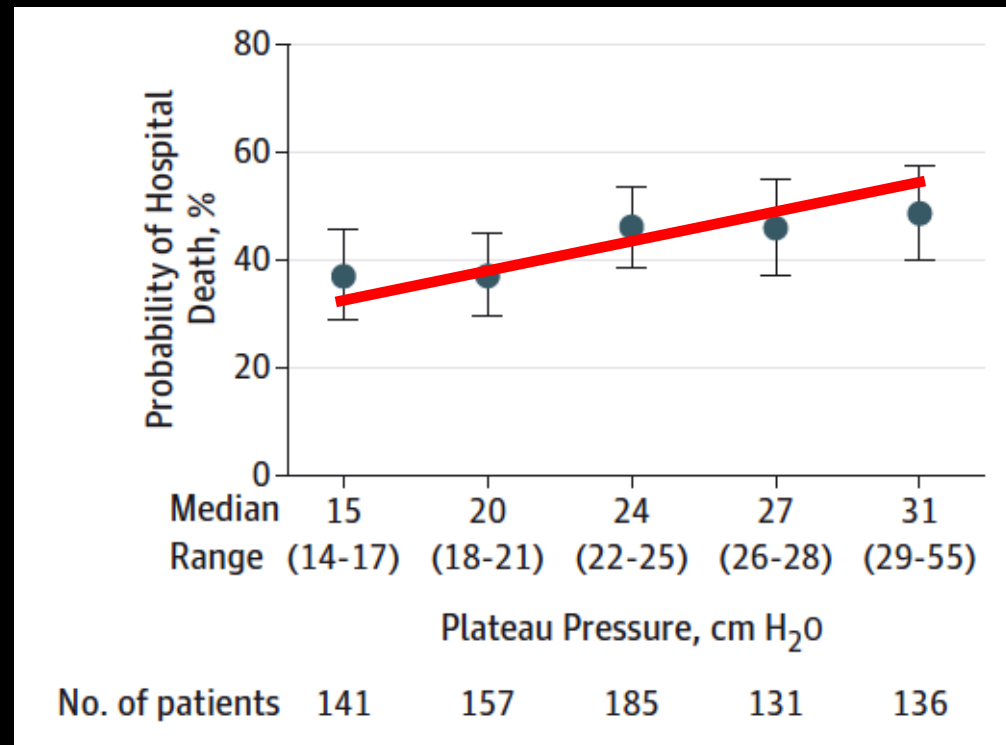
# Lung Safe – Practice of Ventilation in ICUs Worldwide



Bellani G JAMA. 2016 Feb 23;315(8):788-800

## Pplat and Mortality in ARDS

- international observational study
- 2,396 patients with mild, moderate or severe ARDS
- **Higher Plat – Higher Mortality**

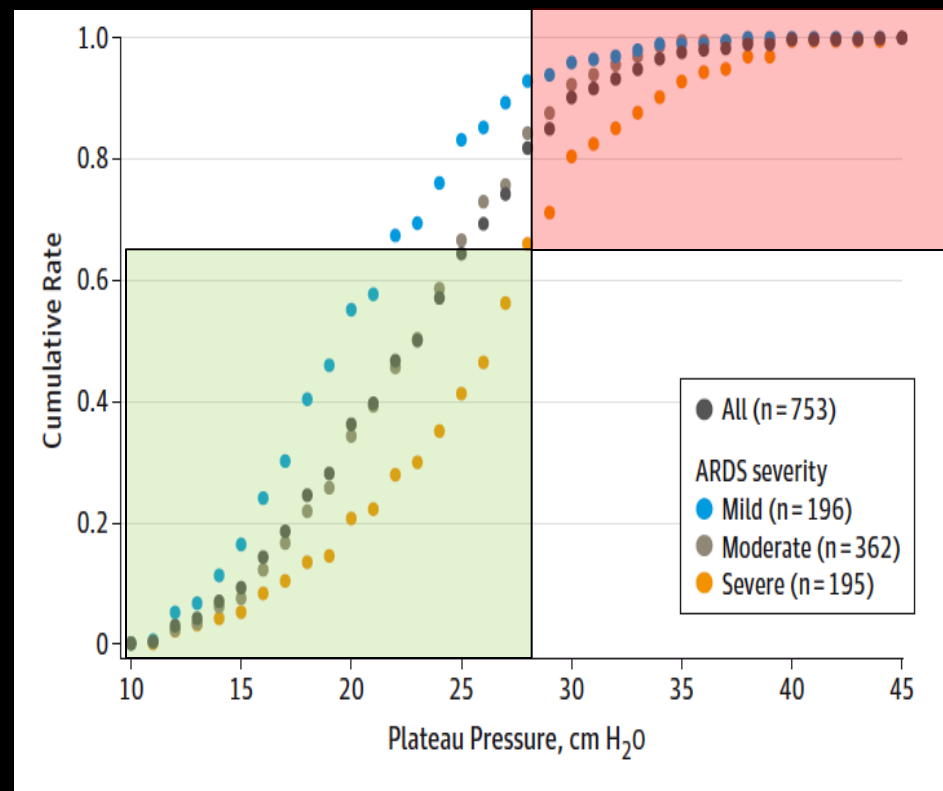


# Lung Safe – Practice of Ventilation in ICUs Worldwide



Bellani G JAMA. 2016 Feb 23;315(8):788-800

- international observational study
- 2,396 patients with mild, moderate or severe ARDS
- 40% of patients with  $\text{Plat} > 27 \text{ cmH}_2\text{O}$



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

$P_{plat} < 17 \text{ cmH}_2\text{O}$   
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs

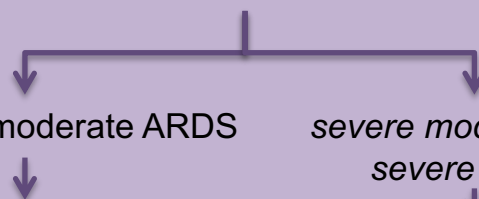


### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

$P_{plat} < 17 \text{ cmH}_2\text{O}$   
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

$P_{plat} < 27 \text{ cmH}_2\text{O}$   
*suggestion comes from  
observational studies*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

$P_{plat} < 27 \text{ cmH}_2\text{O}$   
*suggestion comes from  
observational studies*



# Driving Pressure ( $\Delta P_{rs}$ ) & PPCs

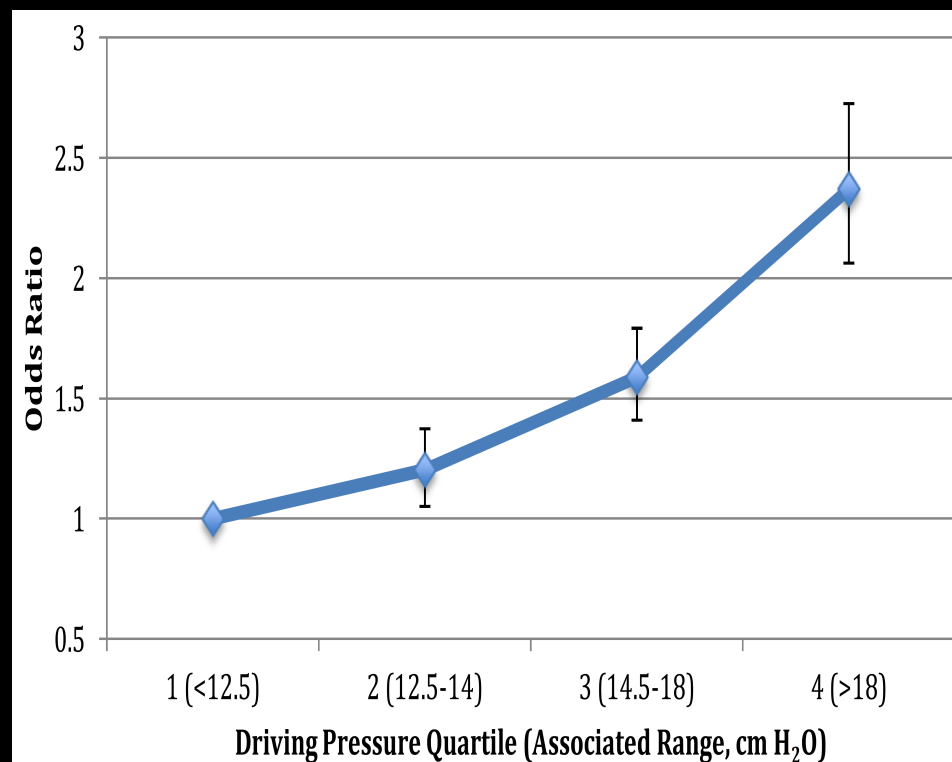
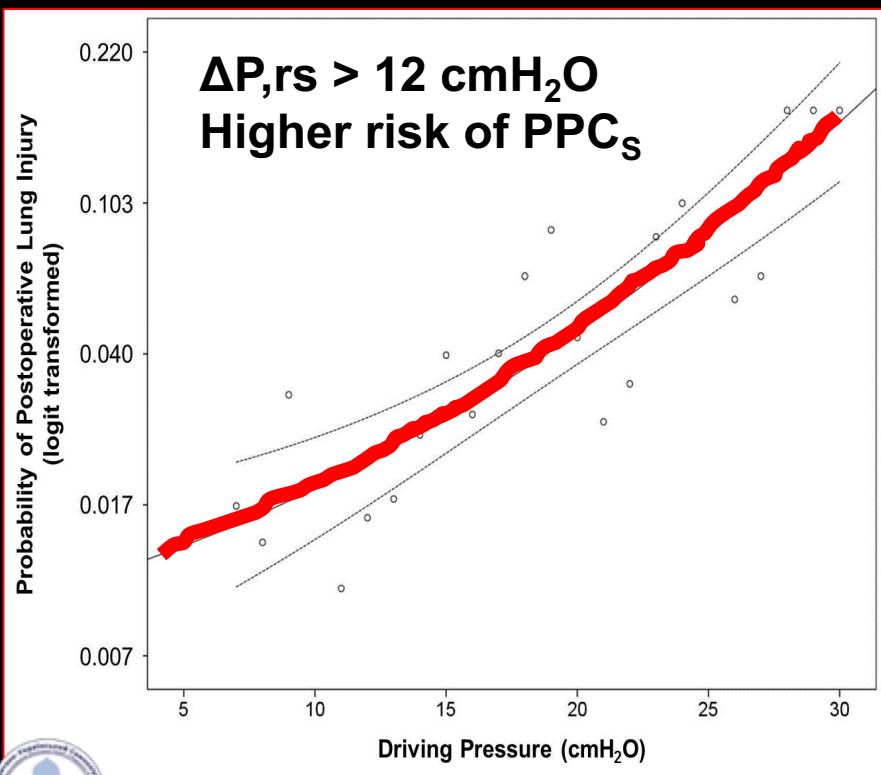
Neto AS et al. Lancet Respir Med. 2016 Apr;4(4):272-80.

Ladha K et al. BMJ 2015;351:h3646

## HIGHER DRIVING PRESSURES INCREASE THE RISK OF PPCs

(2.679 pts. from 15 RCTs)

(69.265 pts. from observational trials)



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

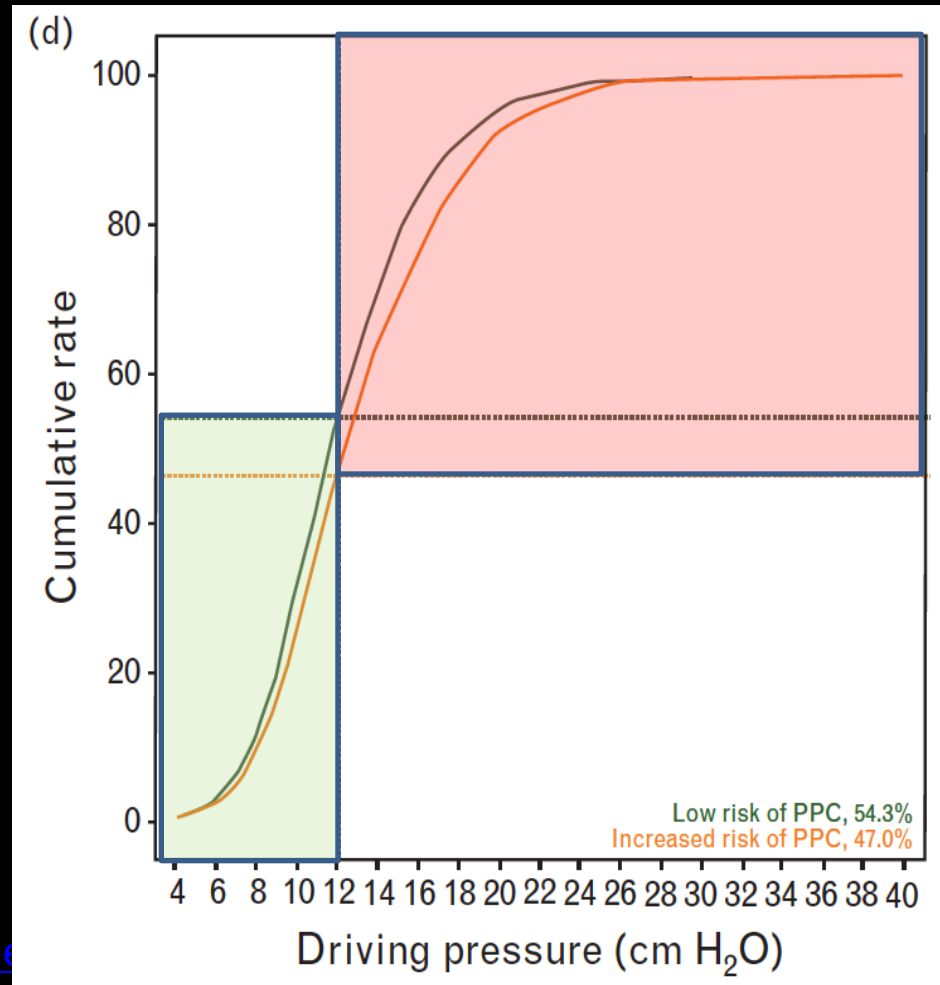


# LAS VEGAS – Practice of Ventilation in ORs Worldwide



The LAS VEGAS Investigators - Eur J Anaesthesiol 2017; 34:492–507

- international study
- 8,241 patients
- $\Delta P$  12.0 [10.0-15.0] cm H<sub>2</sub>O
- $\Delta P > 12$  cm H<sub>2</sub>O in 50% of patients



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs

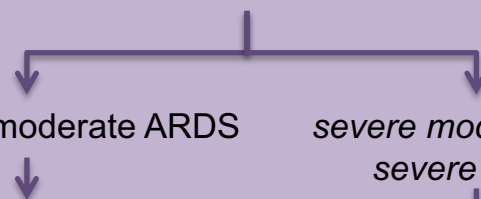


### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*



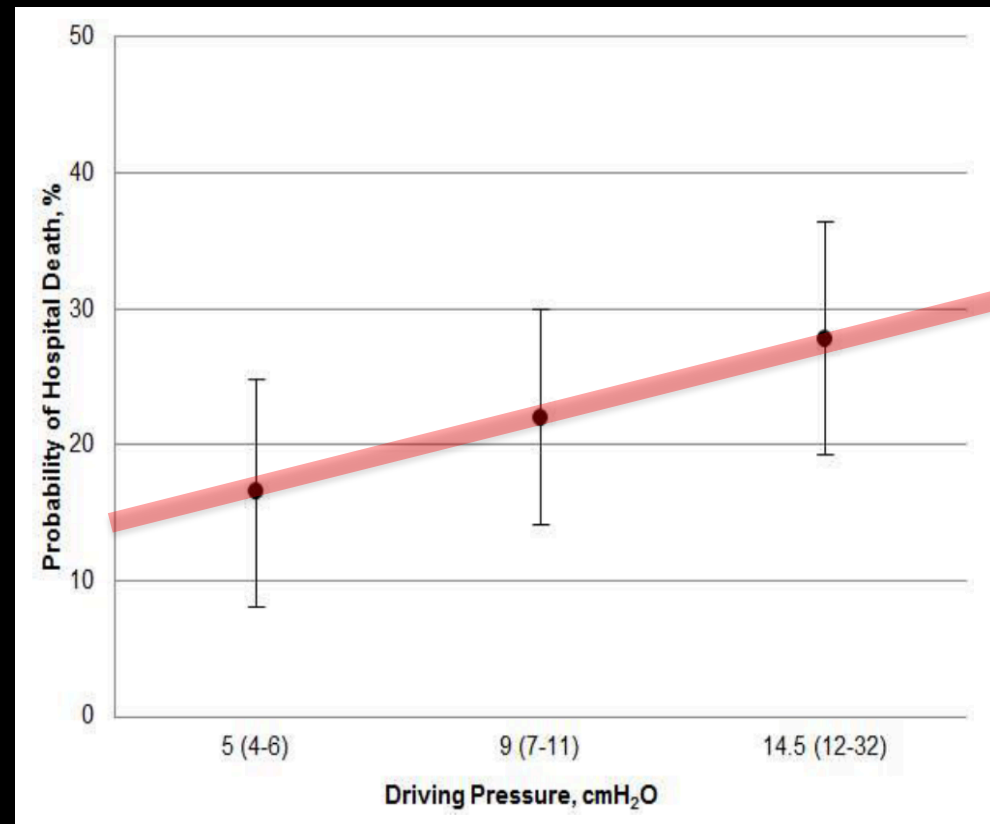


# PRoVENT – Practice of Ventilation in ICUs Worldwide



Serpa-Neto A et al. Lancet Respir Med. 2016 Nov;4(11):882-893.

- international observational study
- 1,022 patients without ARDS
- Driving pressure associated with mortality



Paolo Pelosi for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



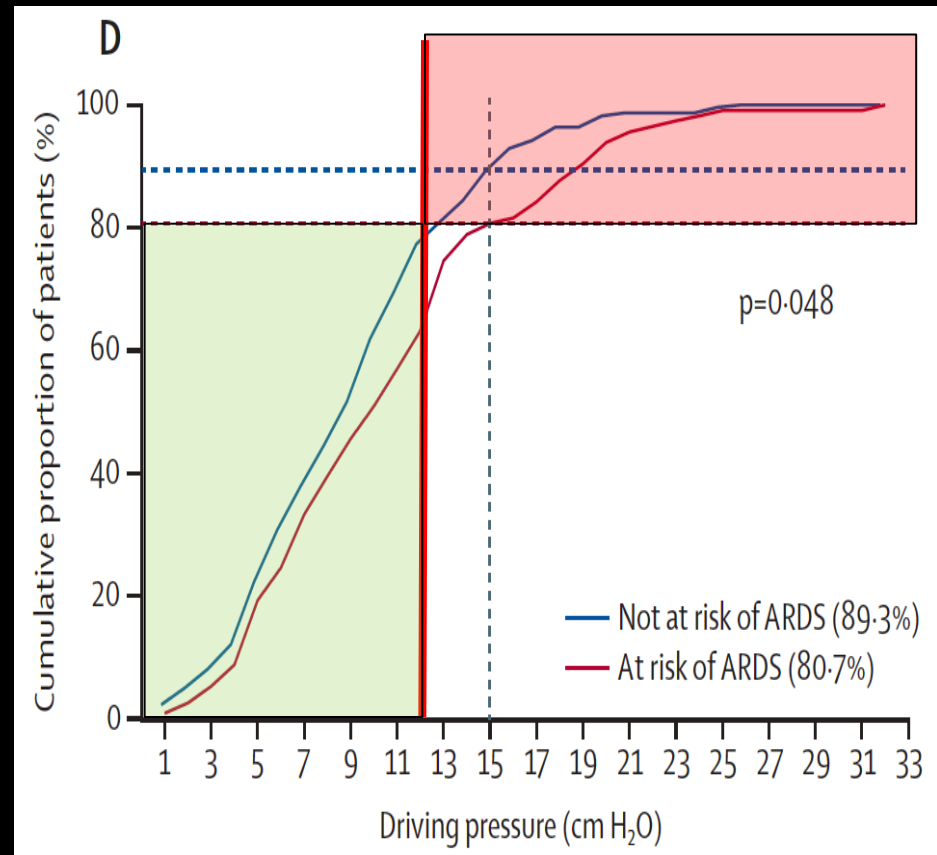
Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

# PRoVENT – Practice of Ventilation in ICUs Worldwide



Serpa-Neto A et al. Lancet Respir Med. 2016 Nov;4(11):882-893.

- international observational study
- 1,022 patients without ARDS
- $\Delta P$  10.0 [6.0-13] cm H<sub>2</sub>O
- $\Delta P > 12$  cmH<sub>2</sub>O in 30-40% of patients



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



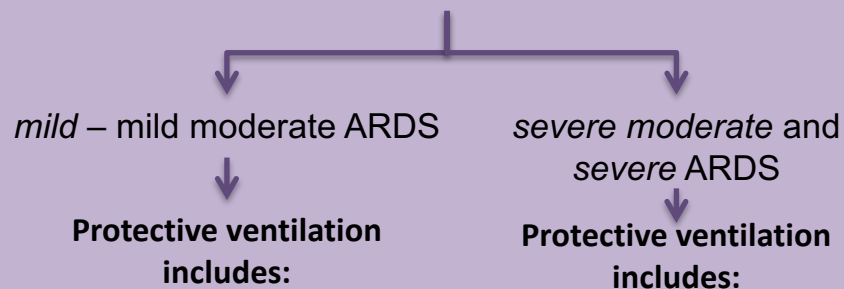
### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1  
meta-analysis and 2  
IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

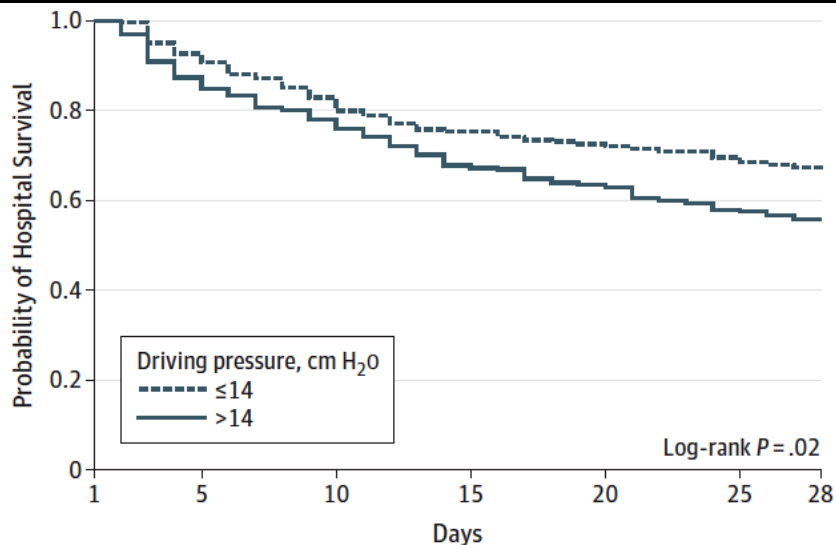


# LungSafe – Practice of Ventilation in ICUs Worldwide



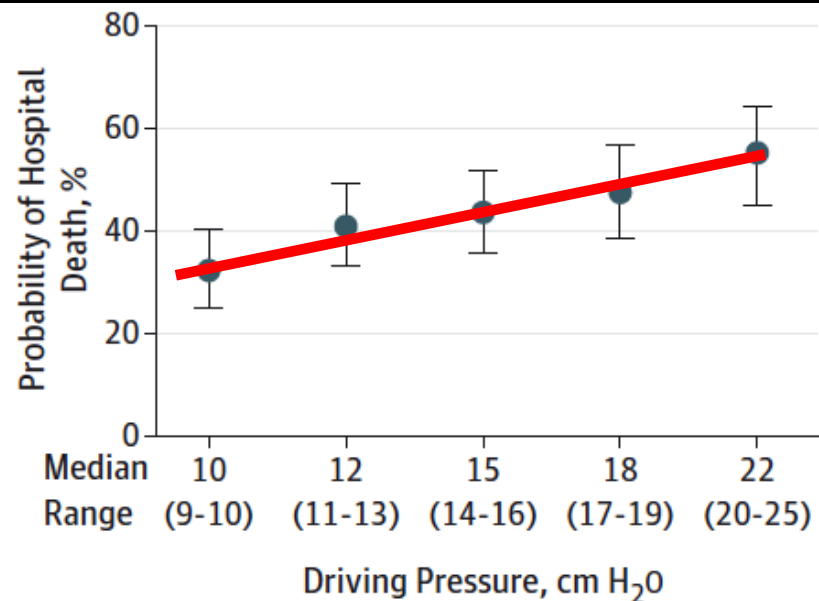
Bellani G JAMA. 2016 Feb 23;315(8):788-800

- 2,396 pts with mild, moderate or severe ARDS



No. at risk

Driving pressure, cm H <sub>2</sub> O	1	5	10	15	20	25	28
≤14	370	342	306	277	266	254	245
>14	342	298	262	225	211	192	185



No. of patients	155	149	154	120	125
Driving pressure, cm H <sub>2</sub> O	10	12	15	18	22

# IPD Metaanalysis of studies in ARDS–patients receiving ELS

Serpa-Neto A et al Intensive Care Med. 2016 Nov;42(11):1672-168

- 653 patients from 12 studies
- RR for hospital death
- median settings in the first 3 days
- **$\Delta P$  is associated with mortality**

	ALL N = 653	ECMO N = 545	ECCO <sub>2</sub> R N = 108
RR [95%–CI] ( <i>p</i> –value) for hospital death			
V <sub>T</sub> , ml/kg PBW	0.97 [0.87–1.08] ( <i>p</i> = 0.602)	0.94 [0.83–1.06] ( <i>p</i> = 0.294)	1.03 [0.80–1.32] ( <i>p</i> = 0.817)
PEEP, cm H <sub>2</sub> O	0.97 [0.92–1.02] ( <i>p</i> = 0.249)	0.97 [0.91–1.03] ( <i>p</i> = 0.323)	0.92 [0.83–1.02] ( <i>p</i> = 0.125)
Pplat, cm H <sub>2</sub> O	1.03 [0.97–1.09] ( <i>p</i> = 0.298)	1.03 [0.97–1.10] ( <i>p</i> = 0.308)	0.94 [0.81–1.10] ( <i>p</i> = 0.454)
<b><math>\Delta P</math>, cm H<sub>2</sub>O</b>	<b>1.07</b> <b>[1.02–1.12]</b> <b>(<i>p</i> = 0.004)</b>	<b>1.06</b> <b>[1.01–1.12]</b> <b>(<i>p</i> = 0.029)</b>	<b>1.19</b> <b>[1.04–1.35]</b> <b>(<i>p</i> = 0.009)</b>
adjusted for risk of death, age and severity of ARDS			

Paolo Pelosi for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

[METANALYSIS]

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



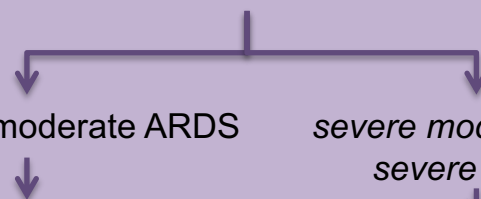
### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1 meta-analysis  
and 2 IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and 1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

**Driving Pressure < 13 cmH<sub>2</sub>O**  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

**Driving Pressure < 13 cmH<sub>2</sub>O**  
*suggestion comes from  
Observational several studies and  
1 IPD meta-analysis*

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

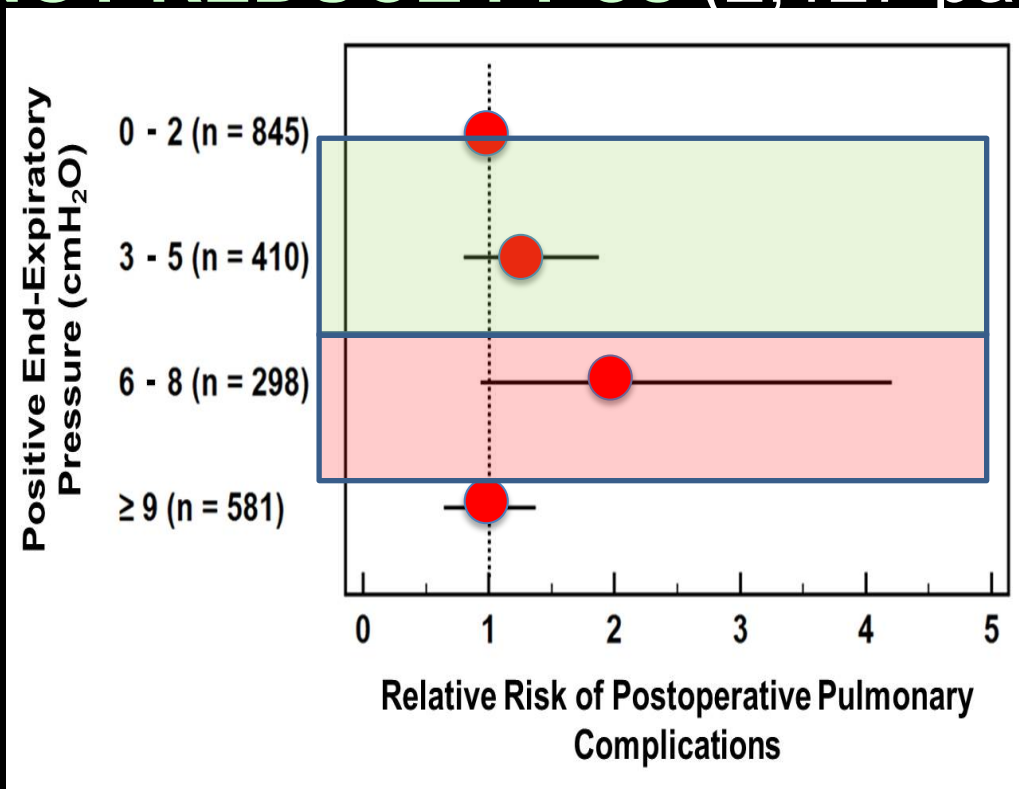


# Dose–Response Relationship Between PPCs and PEEP during Surgery

Serpa-Neto A. et al. Anesthesiology. 2015 Jul;123(1):66-78

**PEEP**

**DOES NOT REDUCE PPCs (2,127 patients)**



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018

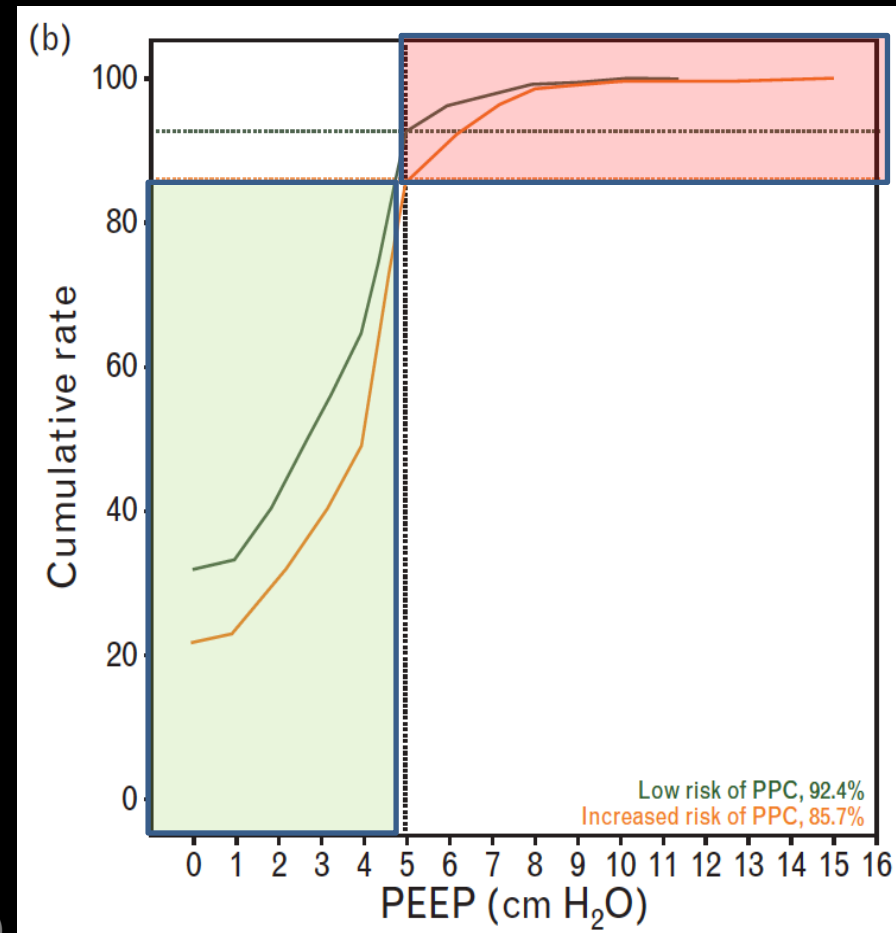


# LAS VEGAS – Practice of Ventilation in ORs Worldwide



The LAS VEGAS Investigators - Eur J Anaesthesiol 2017; 34:492–507

- international study
- 8,241 patients
- PEEP 4.0 [0–5] cm H<sub>2</sub>O
- **PEEP 0 and 5 cm H<sub>2</sub>O** most frequently used
- **FiO<sub>2</sub> 50 [45–70]%**
- **SatO<sub>2</sub> 99 [98–100]%**



Paolo Pelosi for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))





## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



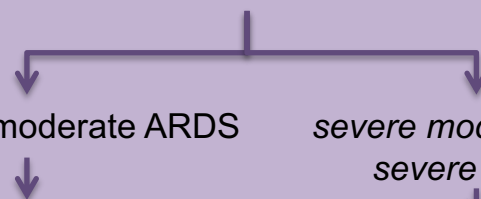
### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1 meta-analysis  
and 2 IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and 1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

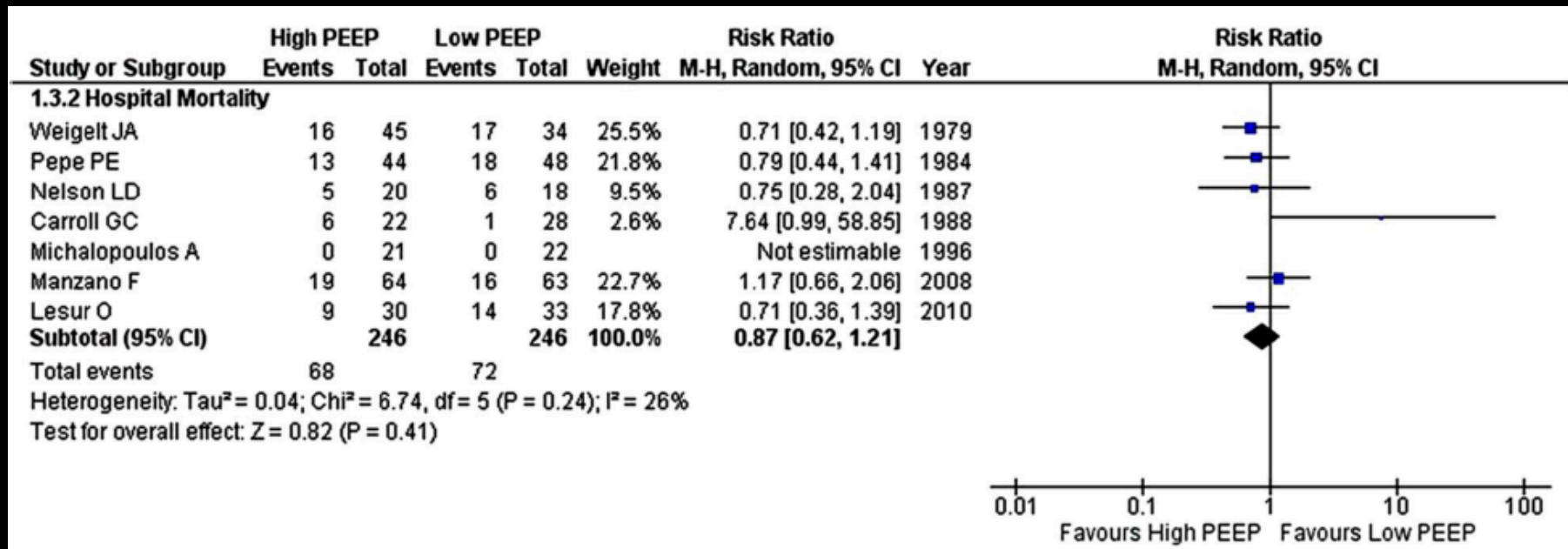
Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



# Associations between PEEP and outcome of patients without ARDS at onset of ventilation: a systematic review and meta-analysis of randomized controlled trials

Serpa Neto et al. Ann. Intensive Care (2016) 6:109

**Low PEEP** =  $2.0 \pm 2.8$  cmH<sub>2</sub>O      **High PEEP** =  $9.7 \pm 4.0$  cmH<sub>2</sub>O



**High PEEP: No effect on duration of MV – Lower rate of ARDS (high I<sup>2</sup>)**

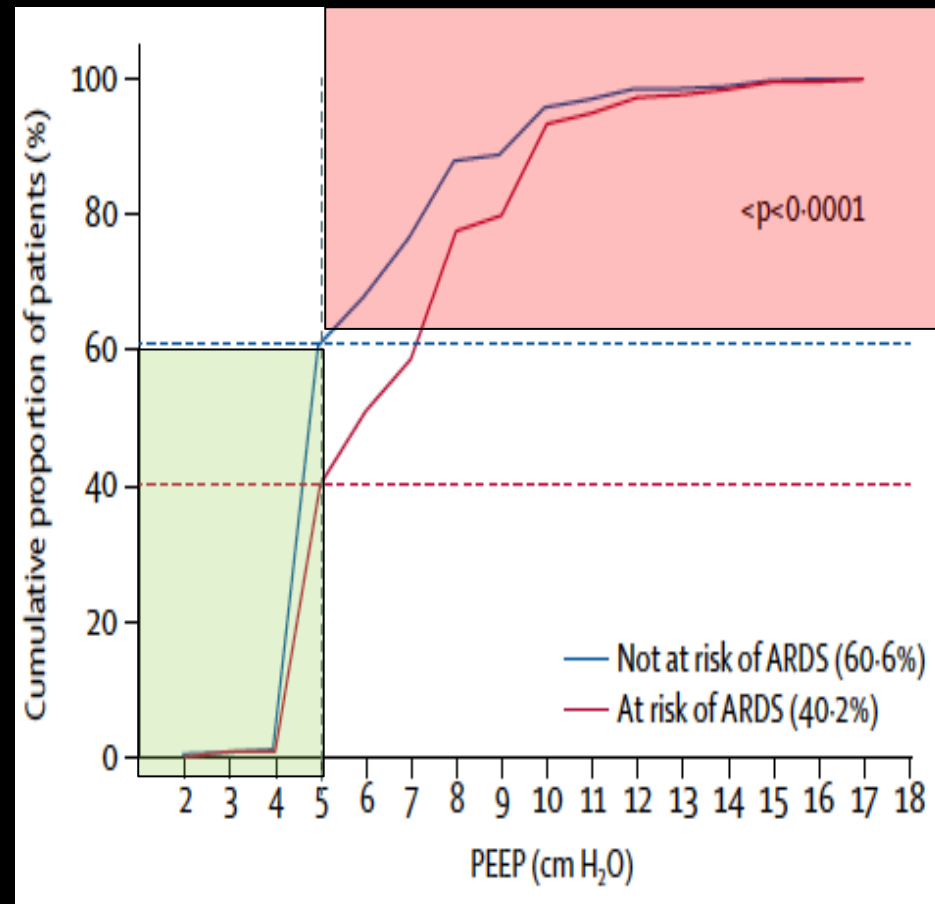
Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018  
Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

# PRoVENT – Practice of Ventilation in ICUs Worldwide



Serpa-Neto A et al. Lancet Respir Med. 2016 Nov;4(11):882-893.

- international observational study
- 1,022 patients without ARDS
- **PEEP > 5 cmH<sub>2</sub>O** in 60-40% of patients
- FiO<sub>2</sub> 50 [40–70]%
- PaO<sub>2</sub> /FiO<sub>2</sub> 261 [165–100]



Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))

Paolo Pelosi. 10-й Британсько-Український Симпозіум. Київ, 2018



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
3 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



### Protective ventilation includes:

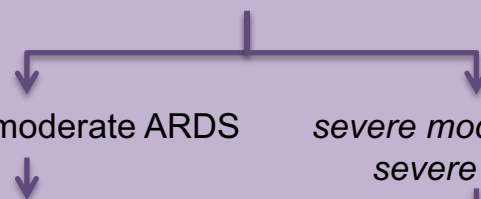
Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1 meta-analysis  
and 2 IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

**PEEP < 5 cmH<sub>2</sub>O**  
*suggestion comes from  
6 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



*mild – mild moderate ARDS*

*severe moderate and  
severe ARDS*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and 1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

### Protective ventilation includes:

Tidal volume size  
6–8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

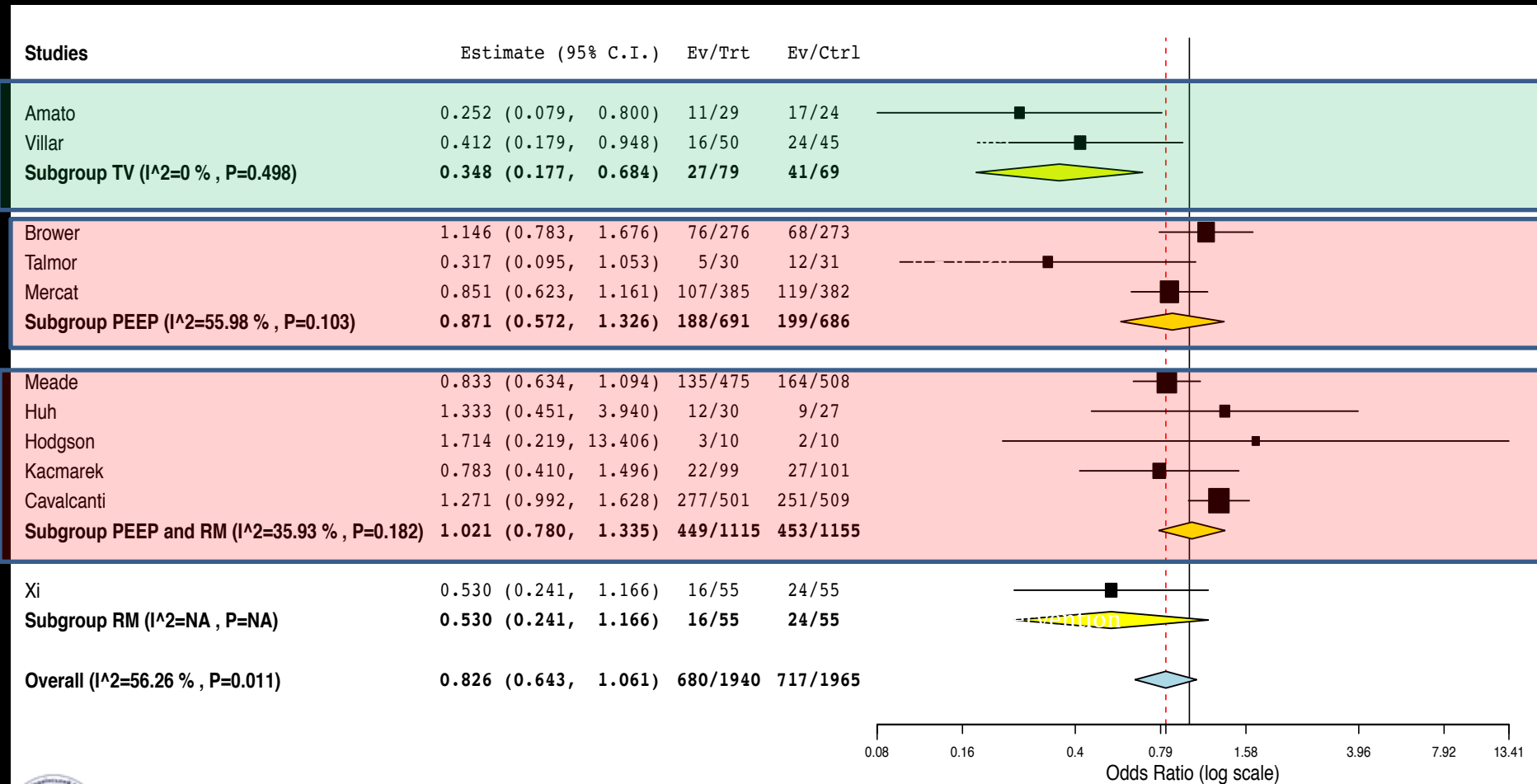
Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

Pelosi P for the PROVE Network ([www.provenet.eu](http://www.provenet.eu))



# Effect of Lung Recruitment and PEEP on mortality in Patients With ARDS: updated metaanalysis



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
3 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



### Protective ventilation includes:

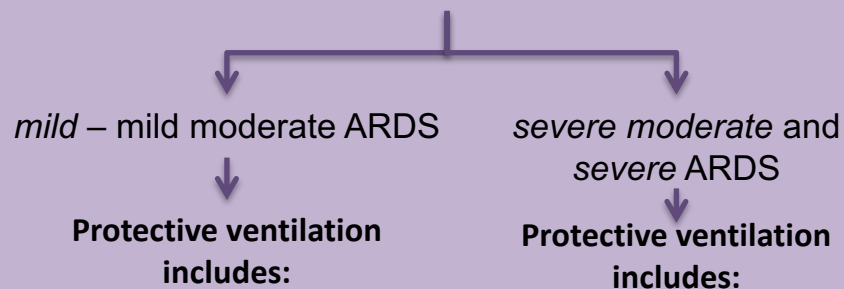
Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1 meta-analysis  
and 2 IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
6 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and 1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

**PEEP < 10 cmH<sub>2</sub>O**  
*suggestion comes from  
4 RCTs and IDP meta-analysis*

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

**PEEP 10-15 cmH<sub>2</sub>O**  
*suggestion comes from  
4 RCTs and IDP meta-analysis*



## Ventilation During General Anesthesia for Surgery



### Protective ventilation includes:

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
3 RCTs and  
2 meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
3 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with Uninjured Lungs



### Protective ventilation includes:

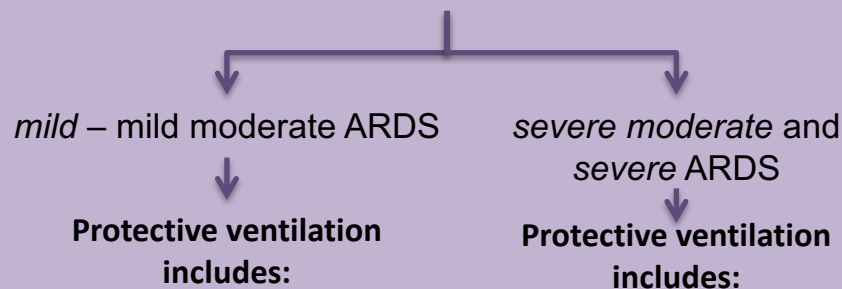
Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs, 1 meta-analysis  
and 2 IPD meta-analyses*

Pplat < 17 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

PEEP < 5 cmH<sub>2</sub>O  
*suggestion comes from  
6 RCTs and IDP meta-analysis*

## Ventilation in Intensive Care Unit—patients with the Acute Respiratory Distress Syndrome (ARDS)



Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and 1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

PEEP < 10 cmH<sub>2</sub>O  
*suggestion comes from  
4 RCTs and IDP meta-analysis*

Tidal volume size  
6-8 ml/kg predicted body weight  
*evidence comes from  
2 RCTs and  
1 meta-analysis*

Pplat < 27 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies*

Driving Pressure < 13 cmH<sub>2</sub>O  
*suggestion comes from  
observational studies and  
1 IPD meta-analysis*

PEEP 10-15 cmH<sub>2</sub>O  
*suggestion comes from  
4 RCTs and IDP meta-analysis*





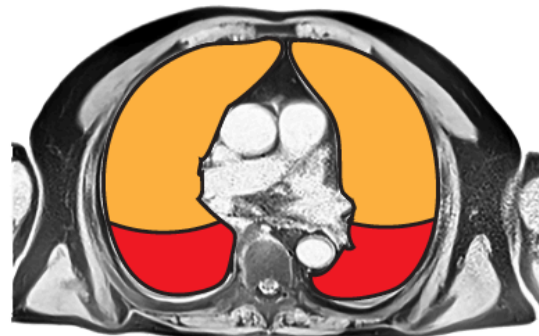
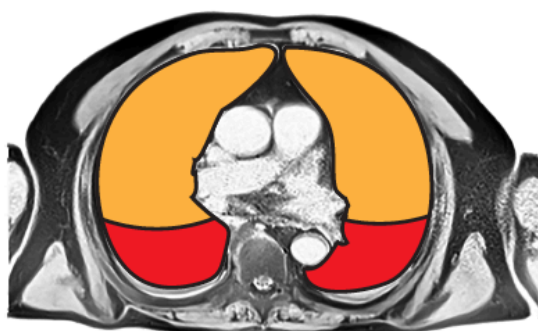
# Close the lungs and keep them rested !

Pelosi P, Rocco PRM, de Abreu MG Crit Care. 2018 Mar 20;22(1):72

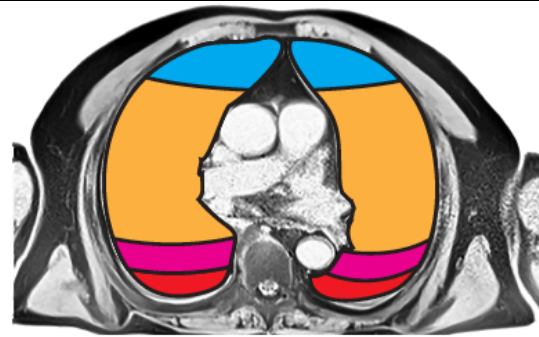
Expiration

Inspiration

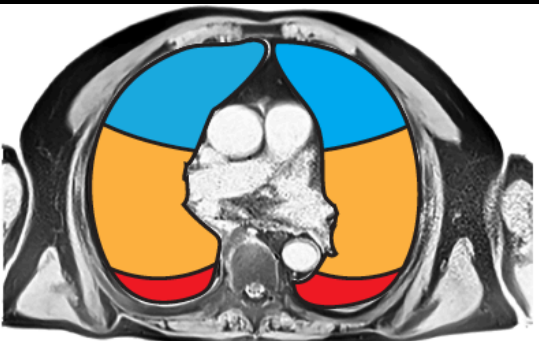
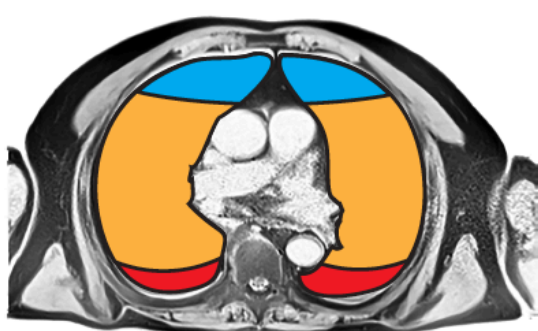
LOW  $V_T$   
LOW  $P_{Plat}$   
LOW PEEP  
LOW DP



LOW  $V_T$   
HIGH  $P_{Plat}$   
MODERATE PEEP  
LOW-MODERATE DP



LOW  $V_T$   
HIGH  $P_{Plat}$   
HIGH PEEP  
LOW-MODERATE DP





# *Protective Mechanical Ventilation In ALL patients !*

**“Less is More”**

**JUST DO IT !**

