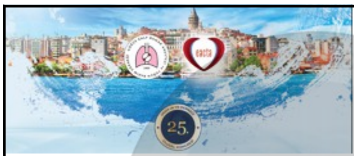


"Sürücü basınç" (*"driving pressure"*)

Mert Şentürk

ARDS tedavisi → paO2 ↑

YAPAY SOLUNUM

Barotravma
Volutravma
Atelektotravma
Biotravma

VALI → paO2 ↓

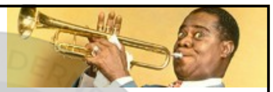
ARDS tedavisi → paO2 ↑ / VALI önlenmesi

KORUYUCU YAPAY SOLUNUM

«Open the lung and Keep the lung open»

TV ↓
FiO2 ↓
PEEP
Permissif Hiperkapni
Recruitment Man.
......

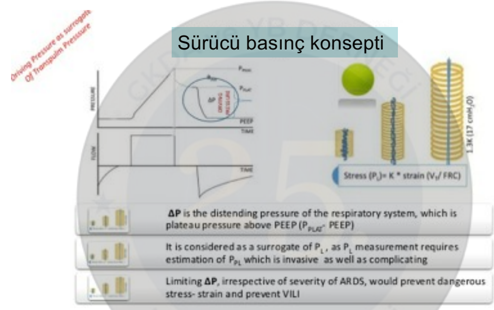
Hangi basınç?

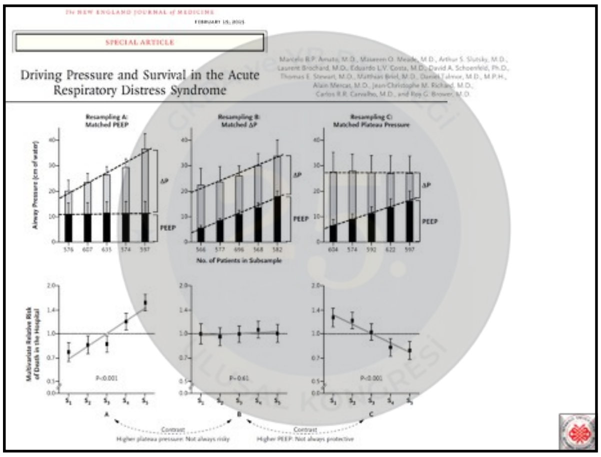


- ARDS-Net(2000): Plato basıncı (< 30 cm H2O)
- Protti ve ark (2013): endinspiratuar akciğer volümü (="strain")nün 2 komponenti var:
  - PEEP ile oluşan (static strain = PEEP V/FRC)
  - **TV ile oluşan (dynamic strain = TV/FRC)**
- Grasso ve ark (2012): plato basıncında göğüs duvarı elastansının payı → transpulmoner basınç

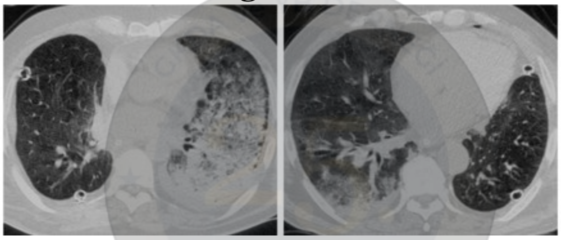
$$P_{tp} = P_{alv} - P_{ip}$$

Sürücü basınç konsepti





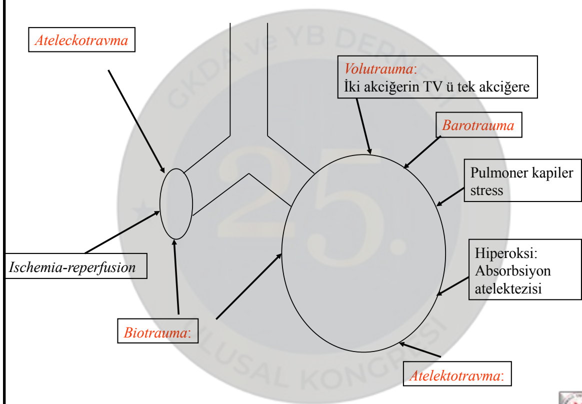
Akciğer hasarı?



Simon P. G. Padley, FRCP, FRCR
Simon J. Jordan, FRCS
Peter Goldstraw, FRCS
Athol U. Wells, MD, FRACP
David M. Hansell, MD, FRCP, FRCR

Asymmetric ARDS Following Pulmonary Resection: CT Findings—Initial Observations[1]

Radiology 2002; 223:468–473



Şentürk; Yearbook of resp. care clin., 2008

Prospective External Validation of a Predictive Score for Postoperative Pulmonary Complications

PPC

Valentin Mazo, M.D., Sergi Sabaté, M.D., Ph.D., Jaume Canet, M.D., Ph.D., Lluis Gallart, M.D., Ph.D., Marcelo Gama de Abreu, M.D., Ph.D., Javier Belda, M.D., Ph.D., Olivier Langeron, M.D., Ph.D., Andreas Hoeft, M.D., Ph.D., Paolo Pelosi, M.D.

(Anesthesiology 2014; 121:219-31)

Table 2. Postoperative Pulmonary Complication: Any One or More of the Following In-hospital Fatal or Nonfatal Postoperative Respiratory Events

Respiratory failure
- Postoperative Pa_{O_2} <60 mmHg on room air, a ratio of Pa_{O_2} to inspired oxygen fraction <300, or arterial oxyhemoglobin saturation measured with pulse oximetry <90% and requiring oxygen therapy

Suspected pulmonary infection
- Treatment with antibiotics for a respiratory infection, plus at least one of the following criteria:
  - New or changed sputum
  - New or changed lung opacities on a clinically indicated chest radiograph
  - Temperature >38.3°C
  - Leukocyte count >12,000/mm³

Pleural effusion
- Chest radiograph demonstrating blunting of the costophrenic angle, loss of the sharp silhouette of the ipsilateral hemidiaphragm (in upright position), evidence of displacement of adjacent anatomical structures, or (in supine position) a hazy opacity in one hemithorax with preserved vascular shadows

Atelectasis
- Suggested by lung opacification with shift of the mediastinum, hilum, or hemidiaphragm toward the affected area, and compensatory overinflation in the adjacent nonatelectatic lung

Pneumothorax
- Air in the pleural space with no vascular bed surrounding the visceral pleura

Bronchospasm
- Newly detected expiratory wheezing treated with bronchodilators

Aspiration pneumonitis
- Respiratory failure after the inhalation of regurgitated gastric contents

---

Table 1. The Seven ARISCAT Risk Predictors, β Regression Coefficients, and Points Assigned*

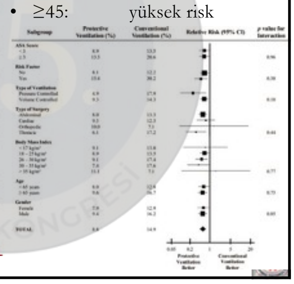
	β Regression Coefficients	Score
Age (yr)		
≤50	0	0
51–80	0.331	3
>80	1.619	16
Preoperative Sp_{O_2}		
≥96%	0	0
91–95%	0.802	8
≤90%	2.375	24
Respiratory infection in the last month		
No	0	0
Yes	1.698	17
Preoperative anemia (Hb ≤10g/dl)		
No	0	0
Yes	1.105	11
Surgical incision		
Peripheral	0	0
Upper abdominal	1.480	15
Intrathoracic	2.431	24
Duration of surgery (h)		
<2	0	0
2–3	1.593	16
>3	2.268	23
Emergency procedure		
No	0	0
Yes	0.768	8

Prospective External Validation of a Predictive Score for Postoperative Pulmonary Complications

Valentin Mazo, M.D., Sergi Sabaté, M.D., Ph.D., Jaume Canet, M.D., Ph.D., Lluis Gallart, M.D., Ph.D., Marcelo Gama de Abreu, M.D., Ph.D., Javier Belda, M.D., Ph.D., Olivier Langeron, M.D., Ph.D., Andreas Hoeft, M.D., Ph.D., Paolo Pelosi, M.D.

(Anesthesiology 2014; 121:219-31)

- <6: düşük risk
- 26-44: orta risk
- ≥45: yüksek risk



British Journal of Anaesthesia 100 (4): 549–59 (2008)
doi:10.1093/bja/aen021 Advance Access publication February 27, 2008

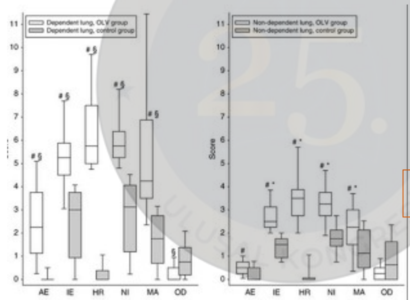
BJA

One-lung ventilation induces hyperperfusion and alveolar damage in the ventilated lung: an experimental study

A. Kozian[1 2], T. Schilling[1 2*], F. Fredén[3], E. Maripuu[4], C. Röcken[5], C. Strang[2 3], T. Hachenberg[1] and G. Hedenstierna[2]

7 pigs OLV:
- TV: 10 mL /kg
- 5 cm PEEP

4 pigs TLV:
- TV: 10 mL /kg
- 5 cm PEEP



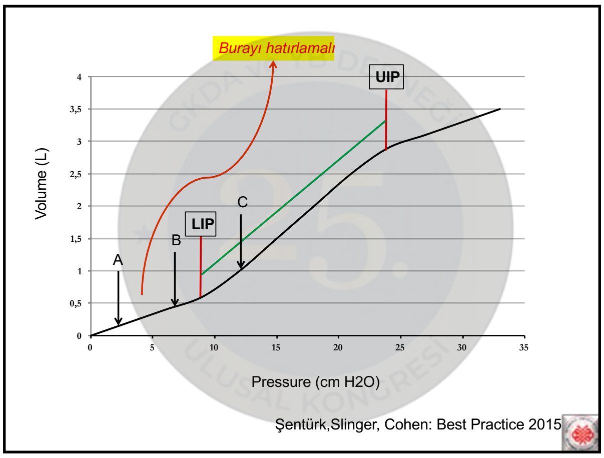
TAV'da VILI daha sık

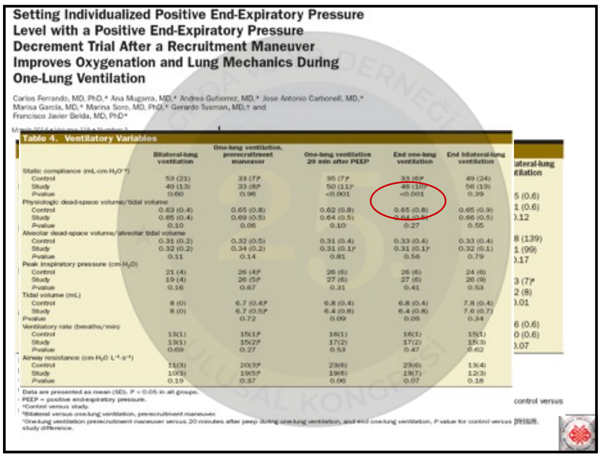
TAV'da (ve bütün yapay solunumlarda)

HEDEF

- Solunumun amaçlarına ulaşmak
  - Oksijenlenme
  - CO2 eliminasyonu
- Akciğere zarar vermemek
  - Düşük TV
  - PEEP
  - RM

- Eş etkili mi?
- Gerçekten etkili mi?
- Her vakada etkili mi?
- Hangi dozda etkili?





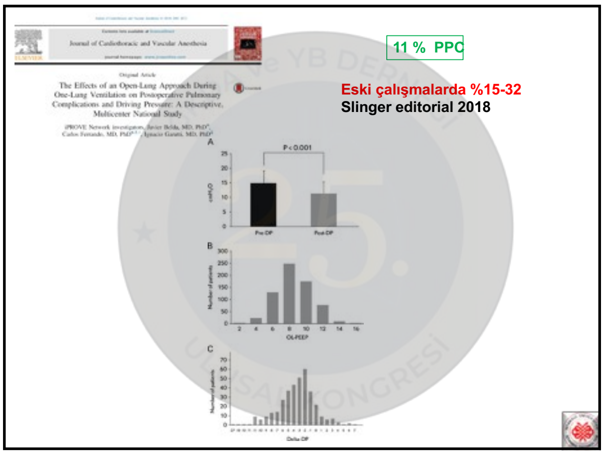
Setting Individualized Positive End-Expiratory Pressure Level with a Positive End-Expiratory Pressure Decrement Trial After a Recruitment Maneuver Improves Oxygenation and Lung Mechanics During One-Lung Ventilation

Carlos Ferrando, MD, PhD,* Ana Mugarra, MD,* Andrea Gutierrez, MD,* Jose Antonio Carbonell, MD,* Marisa Garcia, MD,* Marina Soro, MD, PhD,* Gerardo Tusman, MD,† and Francisco Javier Belda, MD, PhD*

Table 4. Ventilatory Variables

	Bilateral-lung ventilation	One-lung ventilation, prerecruitment maneuver	One-lung ventilation 20 min after PEEP	End one-lung ventilation	End bilateral-lung ventilation
Static compliance (mL·cm H₂O⁻¹)					
Control	53 (21)	33 (7)ᵇ	35 (7)ᵇ	33 (6)ᵇ	49 (24)
Study	49 (13)	33 (8)ᵇ	50 (11)ᶜ	48 (10)ᶜ	56 (19)
P value	0.60	0.96	<0.001	<0.001	0.39
Physiologic dead-space volume/tidal volume					
Control	0.63 (0.4)	0.65 (0.8)	0.62 (0.8)	0.65 (0.8)	0.65 (0.9)
Study	0.65 (0.4)	0.69 (0.5)	0.64 (0.5)	0.64 (0.5)	0.66 (0.5)
P value	0.10	0.06	0.10	0.27	0.55
Alveolar dead-space volume/alveolar tidal volume					
Control	0.31 (0.2)	0.32 (0.5)	0.31 (0.4)	0.33 (0.4)	0.33 (0.4)
Study	0.32 (0.2)	0.34 (0.2)	0.31 (0.1)ᶜ	0.31 (0.1)ᶜ	0.32 (0.1)
P value	0.11	0.14	0.81	0.56	0.79
Peak inspiratory pressure (cm H₂O)					
Control	21 (4)	26 (4)ᵇ	26 (6)	26 (6)	24 (6)
Study	19 (4)	26 (5)ᵇ	27 (6)	27 (6)	26 (9)
P value	0.16	0.67	0.31	0.41	0.53
Tidal volume (mL)					
Control	8 (0)	6.7 (0.4)ᵇ	6.8 (0.4)	6.8 (0.4)	7.8 (0.4)
Study	8 (0)	6.7 (0.5)ᵇ	6.4 (0.8)	6.4 (0.8)	7.6 (0.7)
P value		0.72	0.09	0.05	0.34
Ventilatory rate (breaths/min)					
Control	13(1)	15(1)ᵇ	16(1)	16(1)	15(1)
Study	13(1)	15(2)ᵇ	17(2)	17(2)	15(3)
P value	0.69	0.27	0.53	0.47	0.62
Airway resistance (cm H₂O L⁻¹·s⁻¹)					
Control	11(3)	20(3)ᵇ	23(6)	23(6)	13(4)
Study	10(3)	19(5)ᵇ	19(6)	19(7)	12(3)
P value	0.19	0.37	0.06	0.07	0.18

Data are presented as mean (SD). P < 0.05 in all groups.
PEEP = positive end-expiratory pressure.
ᵃControl versus study.
ᵇBilateral versus one-lung ventilation, prerecruitment maneuver.
ᶜOne-lung ventilation prerecruitment maneuver versus 20 minutes after peep during one-lung ventilation, and end one-lung ventilation, P value for control versus study difference.



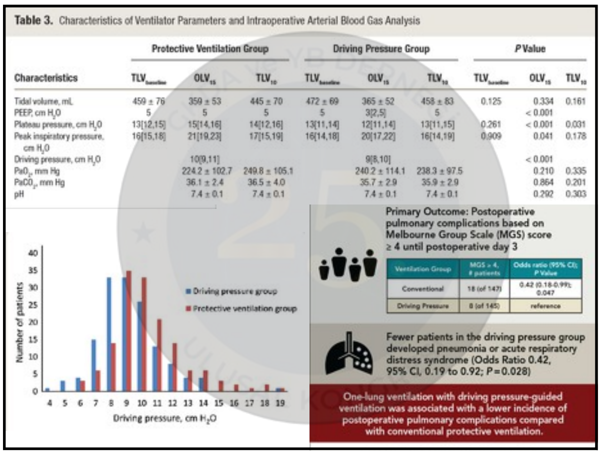
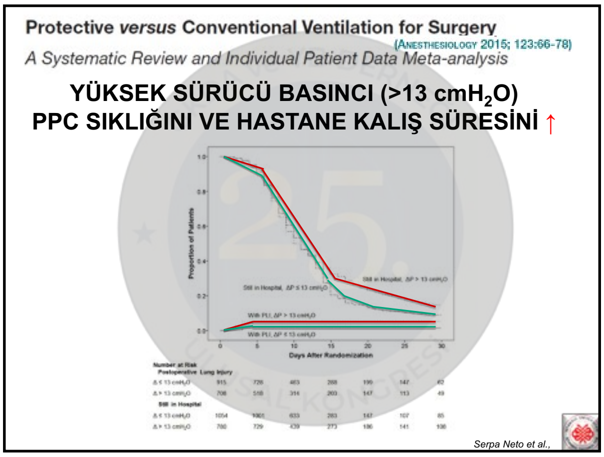
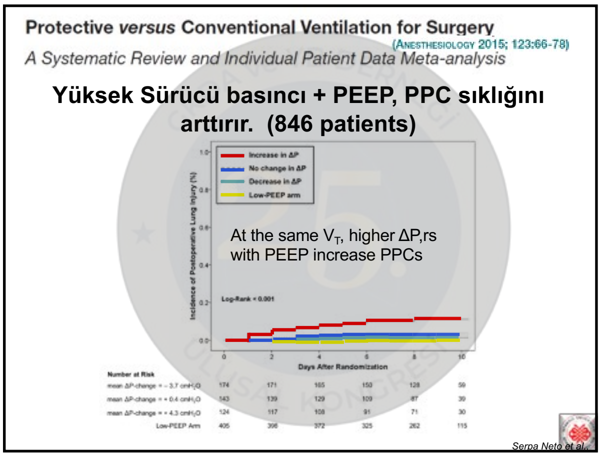


Table 3. Characteristics of Ventilator Parameters and Intraoperative Arterial Blood Gas Analysis

	Protective Ventilation Group			Driving Pressure Group			P Value		
Characteristics	$TLV_{baseline}$	OLV_{15}	TLV_{10}	$TLV_{baseline}$	OLV_{15}	TLV_{10}	$TLV_{baseline}$	OLV_{15}	TLV_{10}
Tidal volume, mL	459 ± 76	359 ± 53	445 ± 70	472 ± 69	365 ± 52	458 ± 83	0.125	0.334	0.161
PEEP, cm H_2O	5	5	5	5	3[2,5]	5		< 0.001	
Plateau pressure, cm H_2O	13[12,15]	15[14,16]	14[12,16]	13[11,14]	12[11,14]	13[11,15]	0.261	< 0.001	0.031
Peak inspiratory pressure, cm H_2O	16[15,18]	21[19,23]	17[15,19]	16[14,18]	20[17,22]	16[14,19]	0.909	0.041	0.178
Driving pressure, cm H_2O		10[9,11]			9[8,10]			< 0.001	
PaO_2, mm Hg		224.2 ± 102.7	249.8 ± 105.1		240.2 ± 114.1	238.3 ± 97.5		0.210	0.335
$PaCO_2$, mm Hg		36.1 ± 2.4	36.5 ± 4.0		35.7 ± 2.9	35.9 ± 2.9		0.864	0.201
pH		7.4 ± 0.1	7.4 ± 0.1		7.4 ± 0.1	7.4 ± 0.1		0.292	0.303



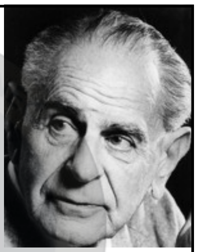


In so far as a scientific statement speaks about reality, it must be falsifiable; and in so far as it is not falsifiable, it does not speak about reality.

Whenever a theory appears to you as the only possible one, take this as a sign that you have neither understood the theory nor the problem which it was intended to solve.

Bilimsel bir ifade gerçeklik hakkında birşeyler söylüyorsa, **yanlışlanabilir** olmalıdır.
Yanlışlanabilir olmadığı sürece, gerçeklik hakkında konuşmuyor demektir

Eğer bir teori sana sanki tek olası açıklama gibi geliyorsa,
bil ki ne o teoriyi anlamışsın,
ne de çözülmesi beklenen sorunu…



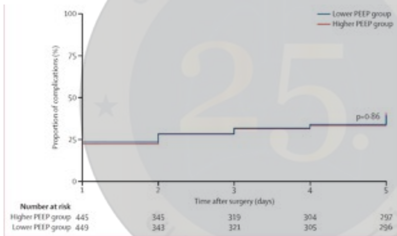
Karl POPPER

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

www.thelancet.com Published online June 1, 2014

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

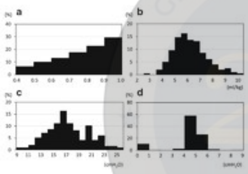
447 vs 453 Pt
High PEEP: **12 cmH2O + RM**
Low PEEP: **≤ 2 cmH20, no RM**



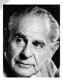
BMC Anesthesiology

RESEARCH ARTICLE Open Access

Associations between intraoperative ventilator settings during one-lung ventilation and postoperative pulmonary complications: a prospective observational study



	Patients with PPCs (N = 51)	Patients without PPCs (N = 146)	P value
Preoperative baseline			
Age - years	67.4 ± 12.9	63.7 ± 13.2	0.094
Sex (male) - no. (%)	33 (64.7)	88 (60.3)	0.57
ARISCAT score	50 (43-50)	50 (27-50)	0.44
Preoperative SpO2 - %	97 (96-98)	98 (96.25-99)	0.055
%VC - %	101 ± 18	104 ± 18	0.31
FEV1.0% - %	75 ± 13	75 ± 10	0.72
Anesthesia & Operation			
Lung resection (+) - no. (%)	45 (88.2)	123 (84.2)	0.64
TIVA - no. (%)	31 (60.8)	78 (53.8)	0.39
Epidural anesthesia - no. (%)	37 (72.6)	109 (74.7)	0.77
Oxygen therapy to the non-ventilated lung - no. (%)	3 (5.9)	2 (1.4)	0.08
Duration of anesthesia - min	285 (185-362)	263 (162-333)	0.17
Duration of operation - min	205 (118-276)	194 (102-258)	0.15
Duration of OLV - min	173 (96-240)	167 (77-224)	0.33
Total volume of infusion - ml	1660 (1250-2190)	1550 (958-2100)	0.14
Total blood loss - ml	40 (10-100)	15 (10-93)	0.37
Minimum SpO2 - %	94 (91-96)	95.5 (93-97)	0.0053
Ventilator setting during OLV			
Mode (PCV) - no. (%)	46 (90.2)	135 (92.5)	0.62
TWA F_IO_2	0.85 (0.73-1.0)	0.77 (0.63-0.89)	0.0032
TWA V_T - ml/kg	6.2 (5.2-7.4)	6.1 (5.4-7.0)	0.8495
TWA ΔP - cmH2O	18 (15-21)	16 (15-18)	0.0717
TWA PEEP - cmH2O	4 (4-5)	4 (4-5)	0.1504



Ya recruitment?

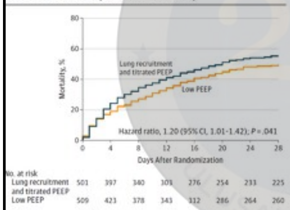
EpVENT 2

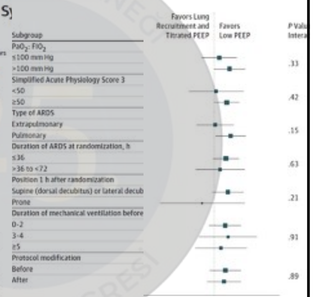
JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome
A Randomized Clinical Trial

Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators

Figure 2. 28-Day Mortality in the Lung Recruitment Maneuver With Titrated PEEP Group vs the Low-PEEP Group

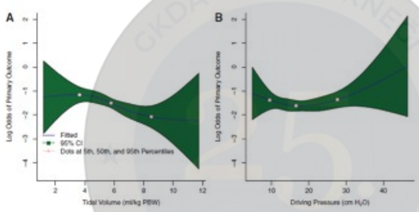




Management of One-lung Ventilation

Impact of Tidal Volume on Complications after Thoracic Surgery

(ANESTHESIOLOGY 2016; 124:1286-95)



What We Already Know about This Topic

- Low tidal volume is an important component of protective ventilation and may minimize lung injury during surgery, but the optimal combination of tidal volume and positive end-expiratory pressure (especially during one-lung ventilation) is unknown.

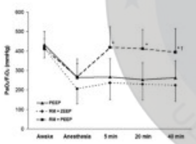
What This Article Tells Us That Is New

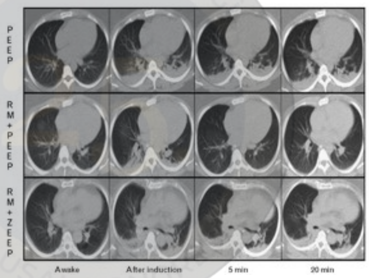
- Analysis from 1,019 patients undergoing one-lung ventilation indicated that low tidal volume in the presence of low positive end-expiratory pressure is associated with increased pulmonary complications. This suggests that low tidal volume during one-lung ventilation is protective only when accompanied by adequate positive end-expiratory pressure.

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

A Computerized Tomography Study

BMI: 45 ± 4
İndüksiyondan sonra atelektazi
RM (55 cm$H_2$0; 10 s)
PEEP: 10 cm H_2O





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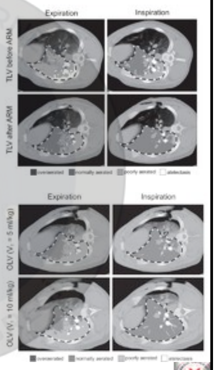
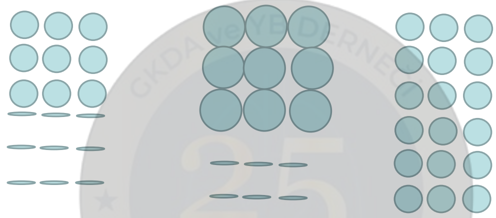
Ventilatory Protective Strategies during Thoracic Surgery

Effects of Alveolar Recruitment Maneuver and Low-tidal Volume Ventilation on Lung Density Distribution

Alf Kozian, M.D., Ph.D.,* Thomas Schilling, M.D., Ph.D., D.E.A.A.,* Hartmut Schütze, Ph.D.,† Mert Senturk, M.D.,‡ Thomas Hachenberg, M.D., Ph.D.,§ Göran Hedenstierna, M.D., Ph.D.||

- 8 piglets
- RM before OLV
- TV during OLV: 5 mL/kg vs 10 ml/kg
- Distribution of aeration

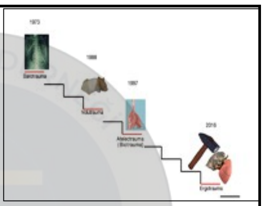




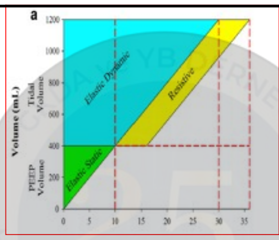
Driving pressure and mechanical power: new targets for VILI prevention

Ann Transl Med 2017;5(14):286

Tommaso Tonetti, Francesco Vasques, Francesca Rapetti, Giorgia Maiolo, Francesca Collino, Federica Romitti, Luigi Camporota, Massimo Cressoni, Paolo Cadringher, Michael Quintel, Luciano Gattinoni

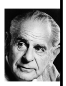


- VILI, when RR = 15
  Protti, AJRCCM 2011
- No VILI, when RR =3-6
  Cressoni, Anesthesiology 2016
- Strain > Stress
  Prott, CCM, 2013



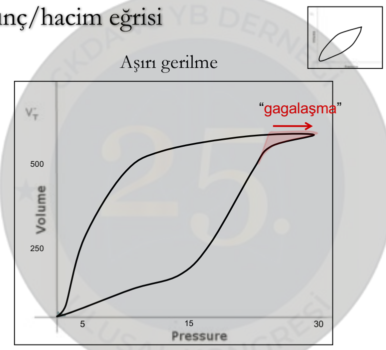
TAV'da da Geçerli mi?

$$P = E_{rs} \cdot \Delta V + R_{aw} \cdot F + PEEP$$



Basınç/hacim eğrisi

Aşırı gerilme



Havayolu basıncı hacimde pek fazla değişiklik olmaksızın artar, kuş gagasına benzer bir durum gözlenir; bu durumda TV azaltmak gerekir.

Son söz

- Sürücü basınç (Pplat - PEEP), akciğeri koruma konusunda önemli bir parametre.
- Koruyucu ventilasyonun bileşenleri ile etkileşimi araştırılması gerekiyor
- PROTHOR
- Bundan sonraki durak «power» olsa gerek...