Kardiyak Cerrahide Akciğer Koruyucu Ventilasyon

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Anesteziyoloji ve Reanimasyon AD

Başlıklar

- Akciğer koruyucu ventilasyon (PV)
- Önemi
- İntraoperatif PV'un özellikleri
- Kardiyak cerrahideki farklılıklar
- Ventilasyon stratejileri
  - Perioperatif dönem
  - KPB sırasında
- Son söz

İntraoperatif Mekanik Ventilasyon

Konvansiyonel Ventilasyon

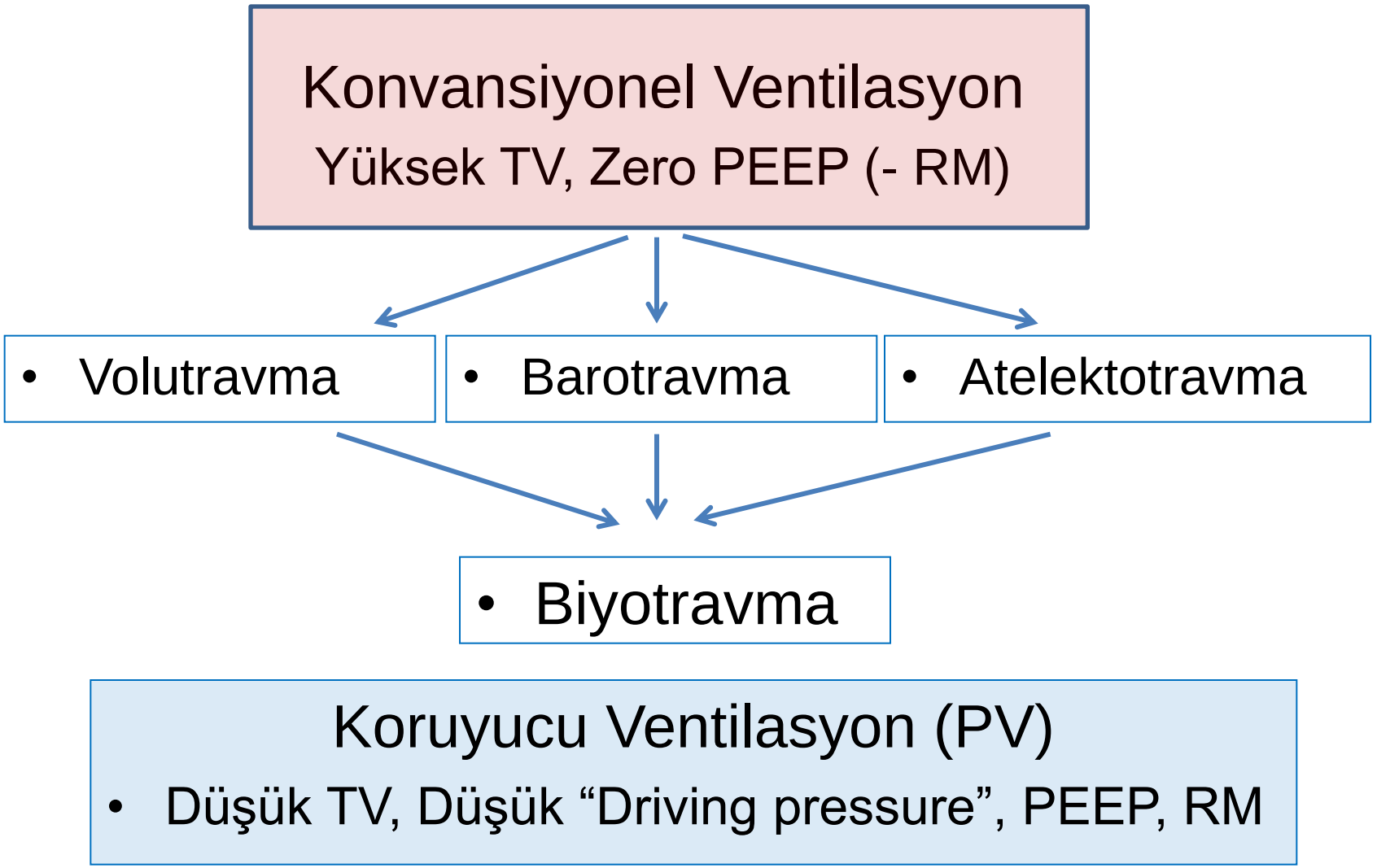
Yüksek TV, Zero PEEP (- RM)

- Akc'de kollabe alanlar ↓
- V/P uyumsuzluğu ↓
- Yüksek FiO_2 gereksinimini↓

- Akciğer "overdistansiyon"
- Dolaşımın baskılanması
  - ↓ CO,
  - Sıvı gereksinimi
  - Vazoaktif ilaç kullanımı

AS Neto, et al. Best Pract Res Clin Anaesthesiol. 2015;29:331

İntraoperatif Mekanik Ventilasyon



İntraoperatif Mekanik Ventilasyon

- Genel anestezi
- Mekanik ventilasyon

Kısa süreli

- Akciğer mekaniğinde değişiklik
- İnflamatuvar yanıt
- Gaz değişiminde farklılık
- Hipoksemi ve atelektazi

ORİGİNAL ARTİCLE ARCHIVE

Impaired Oxygenation in Surgical Patients during General Anesthesia with Controlled Ventilation — A Concept of Atelectasis

H. H. Bendixen, M.D.[†], Hedley Whyte, M.B., B.Chir.[‡], and M. B. Laver, M.D.[§]

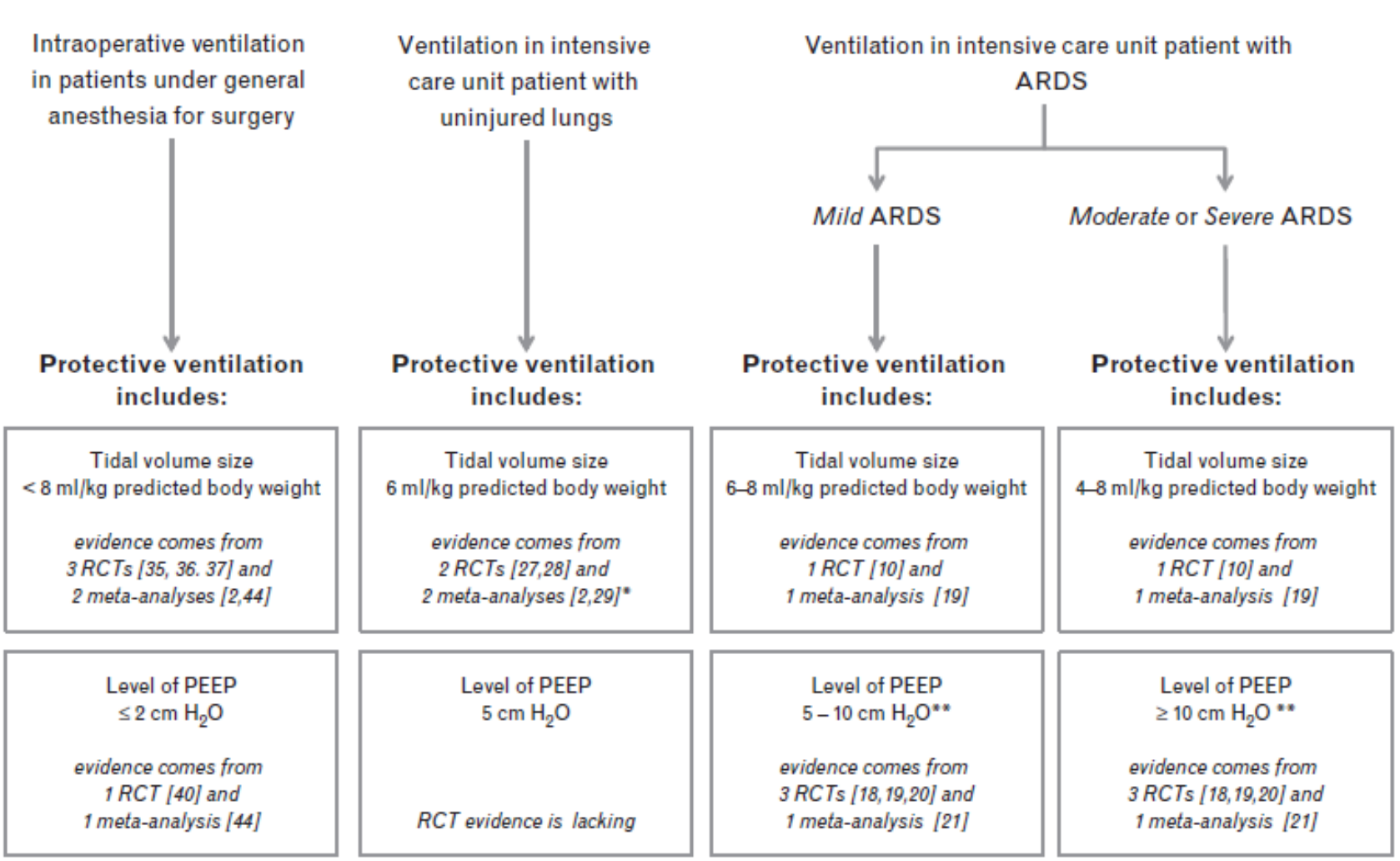
N Engl J Med 1963; 269:991-996 | November 7, 1963 | DOI: 10.1056/NEJM196311072691901

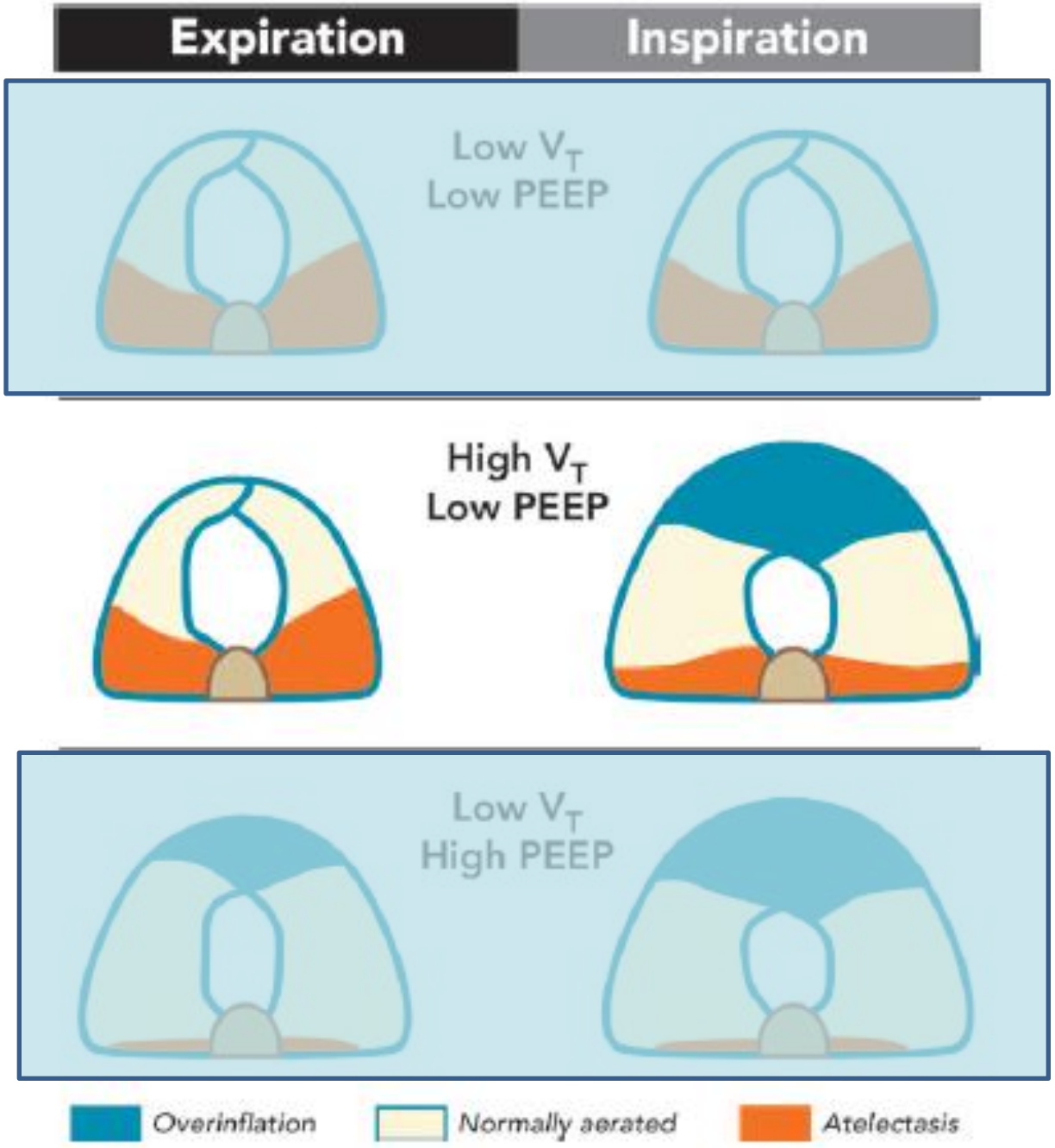
İnsidans: 90%

CURRENT OPINION

Mechanical ventilation strategies for the surgical patient

Marcus J. Schultz[a,b], *Marcelo Gama de Abreu*[c], *and Paolo Pelosi*[d]





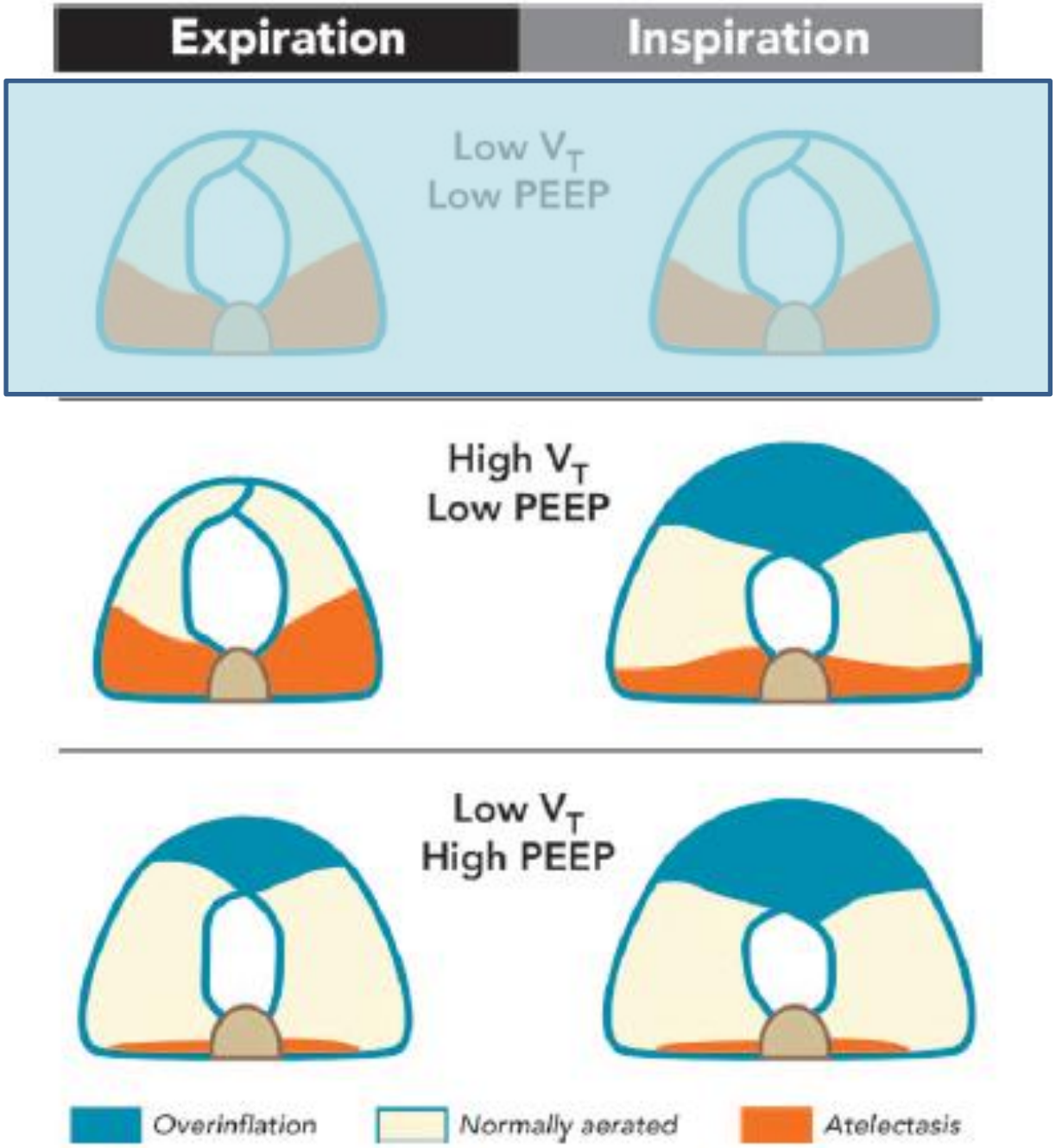
Konvansiyonel MV

Atelektazi ↓

– Aşırı inflasyon oranı

– Kapanma/açılma

A Guldner et al. Anesthesiology 2015;123:692



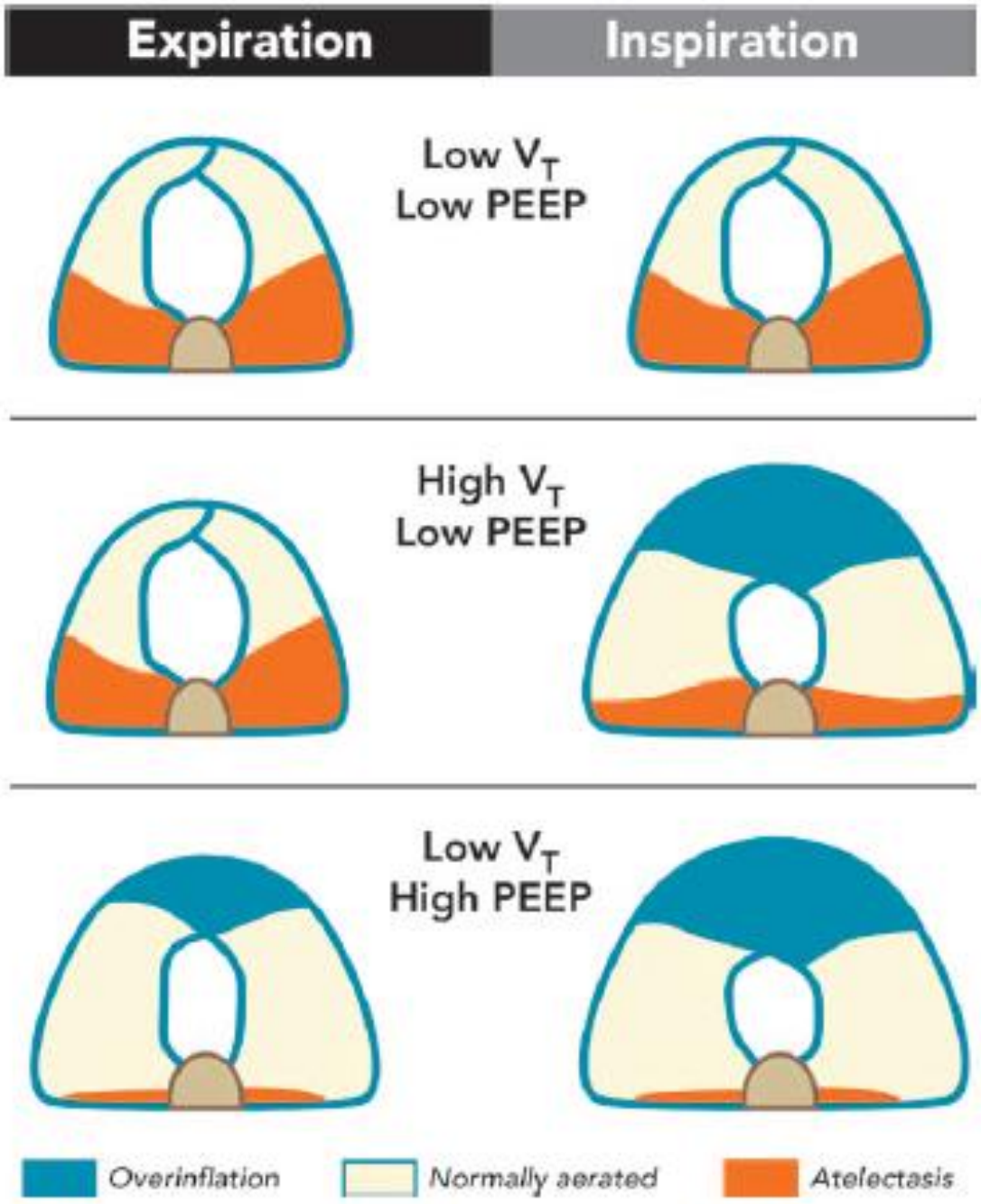
Konvansiyonel MV

Atelektazi ↓

–Aşırı inflasyon oranı

Minimal kapanma/açılma

A Guldner et al. Anesthesiology 2015;123:692



–Atelektazi

↓ Aşırı inflasyon alanı

Konvansiyonel MV

Atelektazi ↓

–Aşırı inflasyon oranı

Minimal kapanma/açılma

A Guldner et al. Anesthesiology 2015;123:692

Intraoperative Lung-Protective Ventilation Trends and Practice Patterns: A Report from the Multicenter Perioperative Outcomes Group.

Multicenter Perioperative Outcomes Group Database

- Genel anestezi + ETT
- 2008 – 2013
- 10 merkez
- Veri değerlendirme: 3 aylık intervaller

Hesaplanan parametreler

1) TV > 10 mL/kg VA uygulama oranı

2) TV (başlangıç ve cerrahi süresince ort.) in mL/kg VA

3) PEEP uygulanma oranı PEEP ≥ 5 cm H2O

Bender SP, et al. Anesth Analg 2015;121:1231

N = 330,823

- TV > 10 mL/kg VA ↓
  - Tüm hastalar (26% - 14%)
  - Obez (41% - 25%)
  - Kısaboy (52% - 36%)
  - Kadın (39% - 24%)

P <0.001

- TV (8.90 - 8.20 mL/kg VA)
- Başlangıç *vs* genel TV (8.65 vs 8.63 mL/kg VA)
- PEEP ≥ 5 cm H_2O (25% - 45%)
- TV uygulamasının merkezlere göre değişkenliği

SONUÇ: İntraoperatif ventilasyonun optimizasyonu için

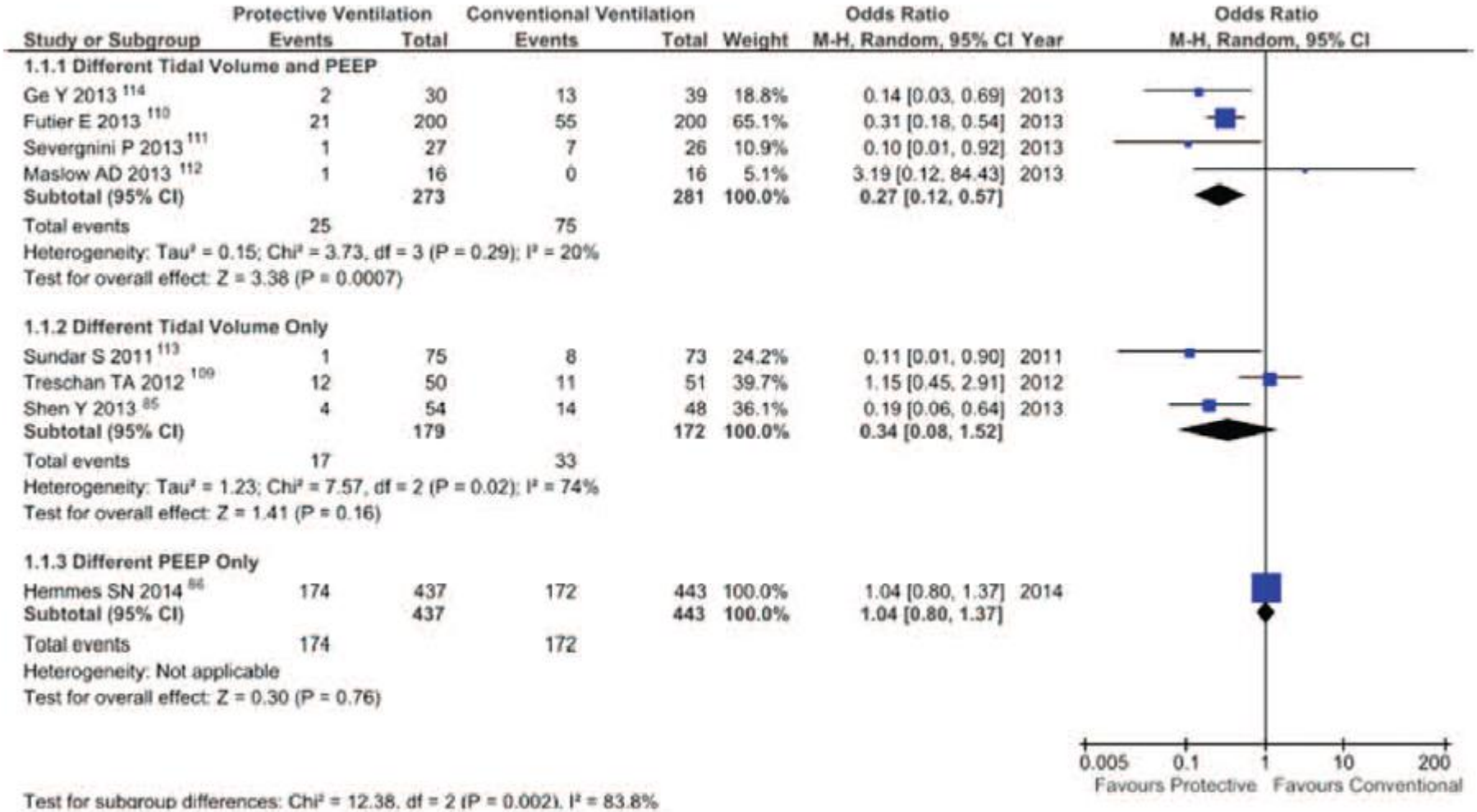
güncel uygulama modelleri konusunda farkındalık yaratmaya

akc koruyucu ventilasyonun etkinliğini göstermeye hala gerek vardır

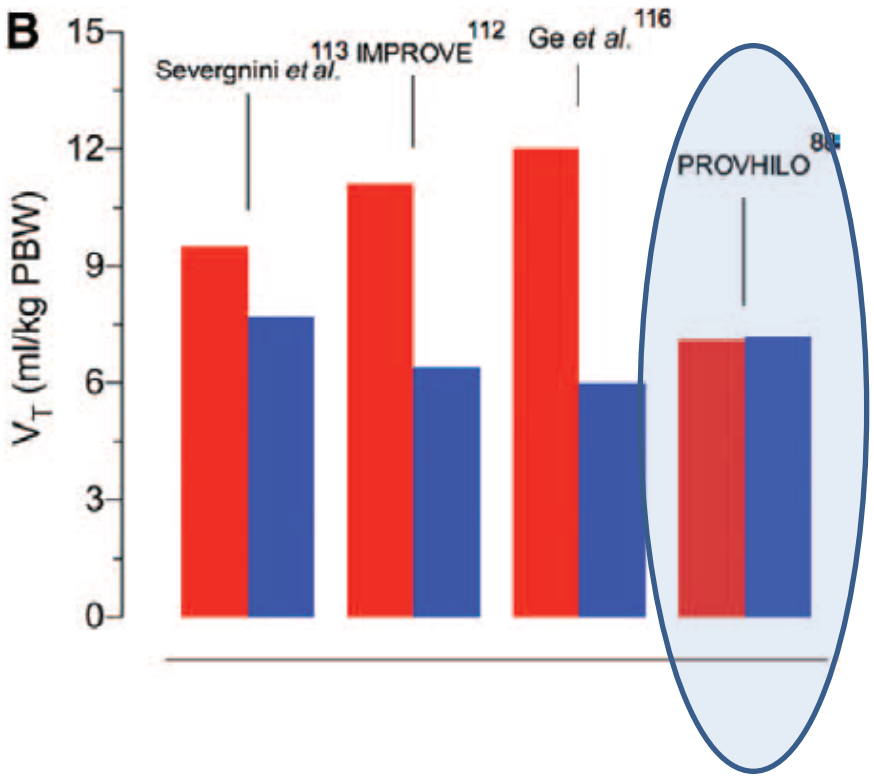
Bender SP, et al. Anesth Analg 2015;121:1231

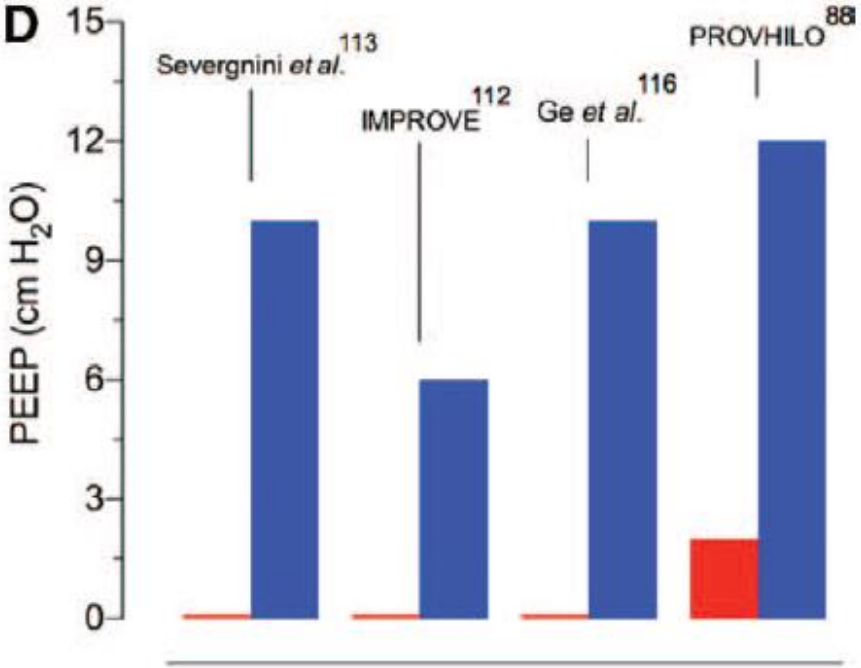
Intraoperative Protective Mechanical Ventilation for Prevention of Postoperative Pulmonary Complications

A Comprehensive Review of the Role of Tidal Volume, Positive End-expiratory Pressure, and Lung Recruitment Maneuvers



A Guldner et al. Anesthesiology 2015;123:692



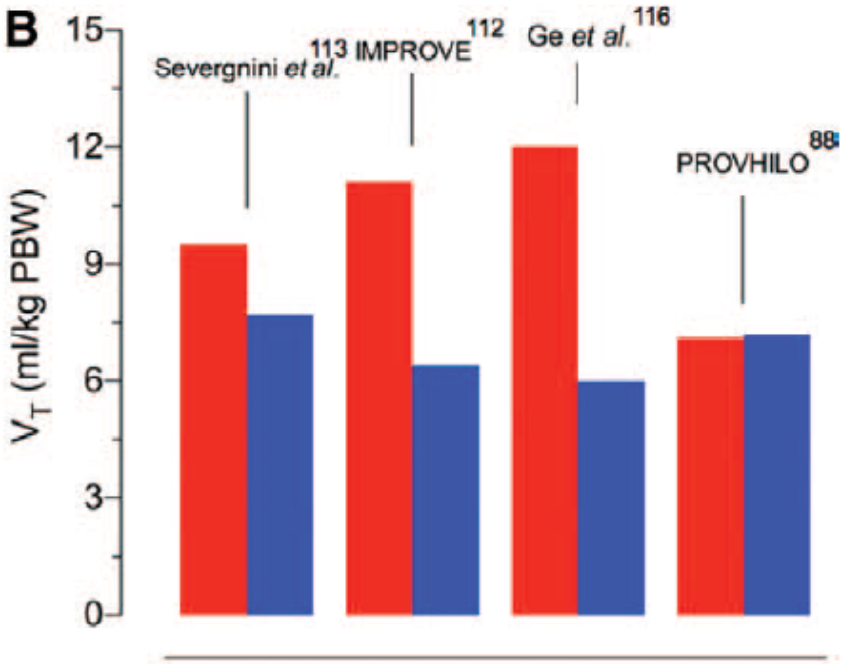


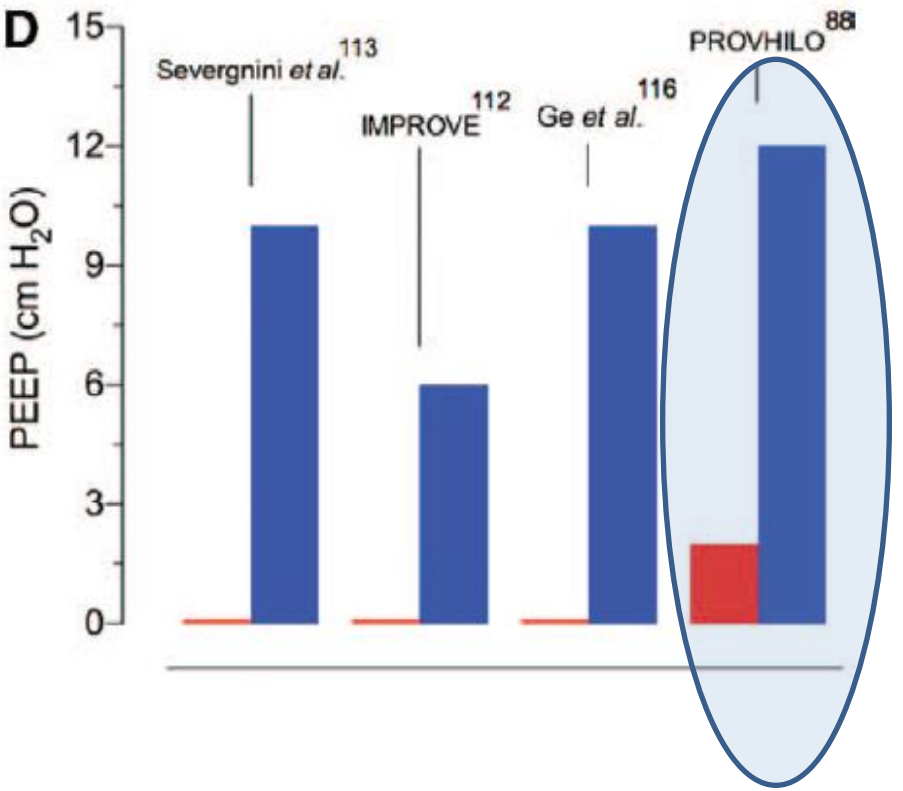
Büyük, 4 RKÇ ⇒ IPD meta-analysis

İntraoperatif PV ⇒ Düşük TV + zeroPEEP

Tüm çalışmalarda kontrol gruplarındaki MV standart uygulamadan farklı, PROVHİLO çalışması dışında

A Guldner et al. Anesthesiology 2015;123:692



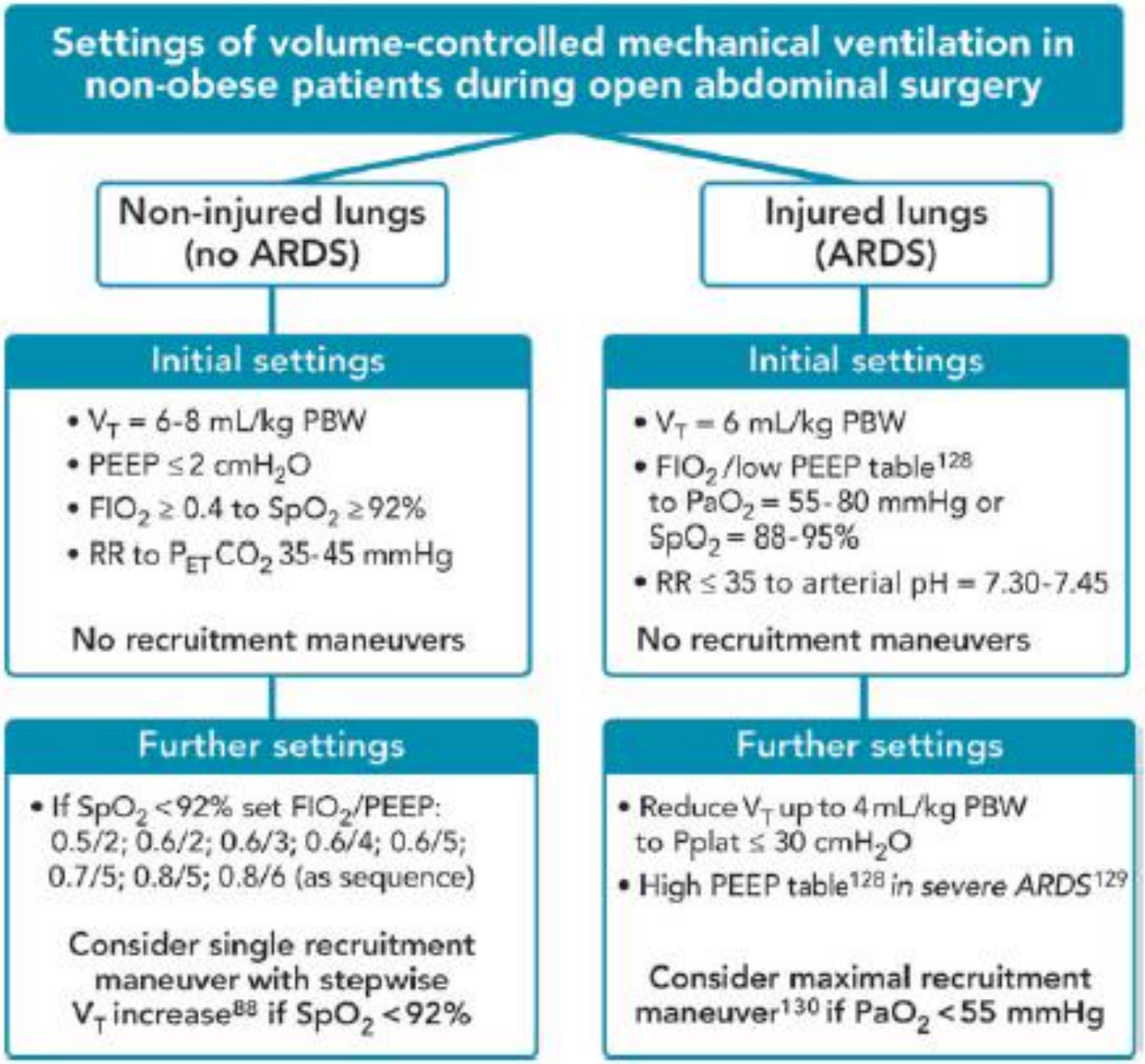


PROVHILO

Düşük TV (8 ml/kg) *vs*
Düşük PEEP (2 cmH_2O) *vs* Yüksek PEEP (12 cmH_2O) + RM

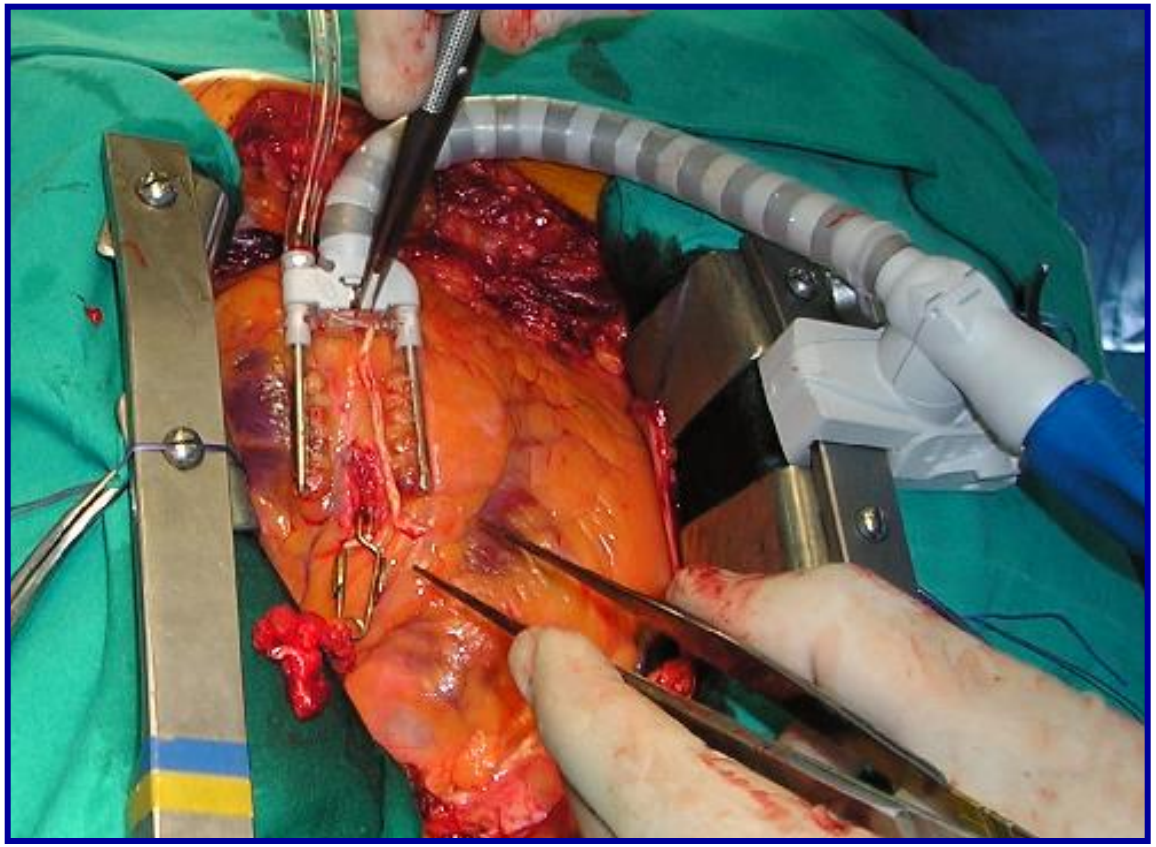
Sonuç: PPK insidansı benzer, fakat yüksek PEEP grubunda hipotansiyon, sıvı resüsitasyon ve vazopresör gereksinimi daha fazla

A Guldner et al. Anesthesiology 2015;123:692



A Guldner et al. Anesthesiology 2015;123:692

- Kardiyak cerrahide farklı olan nedir?



PPK - Risk Faktörleri

PPK - Skorlama - Bağımsız risk faktörlerinden biri

KARDİYAK CERRAHİ

V Mazo et al. Anesthesiology 2014;121:219
DJ Kor, et al. Anesthesiology 2014;120:1168
C Fernando, et al. Curr Opin Anesthesiol 2015;28:73

Patient Characteristics	Preoperative Testing	Surgery	Anesthetic Management
Age	Low albumin	Open thoracic surgery	General anesthesia
Male sex	Low SpO_2 (≤95%)	Cardiac surgery	High respiratory driving pressure (≥13 cm H_2O)
ASA class ≥3	Anemia (Hb <10 g/dl)	Open upper abdominal surgery	High inspiratory oxygen fraction
Previous respiratory infection		Major vascular surgery	High volume of crystalloid administration
Functional dependency		Neurosurgery	Erythrocyte transfusion
Congestive heart failure		Urology	Residual neuromuscular blockade
COPD		Duration of surgery >2 h	Nasogastric tube use
Smoking		Emergent surgery	
Renal failure			
Gastroesophageal reflux disease			
Weight loss			

Respiratory driving pressure is defined as inspiratory plateau airway pressure *minus* positive end-expiratory pressure.

A Güldner, et al. Anesthesiology 2015; 123:692
J Canet, et al. . Anesthesiology 2010; 113:1338

Kardiyak Cerrahi - PPK

Postoperatif Pulmoner Disfonksiyon (PPD) Mekanizmaları

- Genel anestezi + MV
- Kardiyak cerrahiye spesifik faktörler
  - Mediyan sternotomi
  - Miyokard koruması için topikal soğutma
  - LİMA diseksiyonu sırasında plevranın açılması
  - KPB

E Apostolakis et al. J Surg Card 2010;25:47

KPB

- Hipotermi
- Kan ürünleri kullanımı
- Kan komponentlerinin KPB devresi ile teması
- Akciğerlerdeki iskemi–reperfüzyon
- Ventilasyonun durdurulması, atelektazi gelişimi……

R Badenes, et al. Crit.Care Research and Pract 2015;420513:8
E Apostolakis et al. J Surg Card 2010;25:47

Kardiyak Cerrahi - PPK

PPD

- Plevral effüyon % 27 – 95
- Atelektazi % 17 – 88
- Postoperatif hipoksemi % 3 – 10
- ARDS % 0.5 – 1.7

(Mortality 50 –90%)

Atelektazi $\Rightarrow$ Cerrahi sonrası

Kardiyak cerrahi = 6 x Abdominal cerrahi

R Badenes, et al. Crit.Care Research and Pract 2015;420513:8

Cardiac Surgery - MV

- İntraoperatif MV
  - Yüksek TV (10-12 ml/kg)
    - Atelektazi ↓
  - Minimal PEEP
    - Hemodinamik değişimi ↓
- KPB sırasında
  - Ventilasyon ∅
    - Düşük değerlerde CPAP
    - Ventilatörden ayırma

PV ile ARDS hastalarında elde edilen olumlu sonuçlar sonrası

kardiyak cerrahi hastalarında inflamatuvar yanıt ve buna bağlı PPK oranı ↓ ⇒ **Klinik yarar ?**

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

F Lellouche et al. Anesthesiology 2012;116:1072

- 3,434 erişkin, kardiyak cerrahi
- YB ‘da 3 farklı TV uygulaması

Düşük TV <10 ml/kg PBW

Alışılmış TV 10-12 ml/kg PBW

Yüksek TV >12 ml/kg PBW

	Tidal Volumes (ml/kg of PBW)			
	Less Than 10 (n = 724)	10–12 (n = 1,567)	More Than 12 (n = 1,143)	*P* Value
Any organ failure, n (%)	82 (11)	230 (15)	206 (18)	<0.001 (†)
Multiple organ failure, n (%)	21 (2.9)	74 (4.7)	70 (6.1)	0.006 (†)
ICU length of stay (days)	1.0 (1.0–2.2)	1.2 (0.9–2.6)	1.8 (1.0–3.0)	<0.001 (†, ‡)
ICU length of stay more than 24 h, n (%)	478 (20)	1,036 (45)	814 (35)	0.003 (†, ‡)
ICU length of stay more than 48 h, n (%)	225 (31)	518 (33)	447 (39)	<0.001 (†, ‡)
ICU length of stay more than 7 d, n (%)	19 (16)	46 (38)	57 (47)	0.005 (†, ‡)
Hospital length of stay (days)	6 (5–8)	6 (5–8)	7 (5–9)	0.06
ICU mortality, n (%)	13 (1.8)	30 (1.9)	29 (2.5)	0.44
Hospital mortality, n (%)	22 (3.0)	49 (3.1)	43 (3.8)	0.59
Hospital and late mortality, n (%)	91 (13)	208 (13)	154 (13)	0.85

Outcome data	**Düşük TV** <10 ml/kg PBW	**Traditional TV** 10-12 ml/kg PBW	**Yüksek TV** >12 ml/kg PBW	
Duration of mechanical ventilation (hours)	6.0 (5–12)	6.5 (4.5–13)	7.4 (4.8–14.9)	<0.001 (†)
Reintubation, n (%)	25 (3.5)	72 (4.6)	64 (5.6)	0.10
Intubation more than 24 h, n (%)	31 (4.3)	84 (5.4)	87 (7.6)	0.006 (†)
Intubation more than 48 h, n (%)	11 (1.5)	46 (2.9)	44 (3.9)	0.01 (†)
Intubation more than 7 d, n (%)	3 (0.4)	9 (0.6)	11 (1.0)	0.30
Hemodynamic instability, n (%)	39 (5.4)	124 (7.9)	115 (10.1)	0.001 (†)
Renal failure, n (%)	57 (7.9)	163 (10.4)	145 (12.7)	0.004 (†)
Hemodialysis, n (%)	9 (1.2)	47 (3.0)	36 (3.2)	0.02 (*, †)

Table 4. Multivariate Analysis of Risk Factors for High Tidal Volumes after Cardiac Surgery

	Odds Ratio	95% CI	*P* Value
BMI more than 30 kg/m^2	6.25	5.26–7.42	<0.001
Female sex	4.33	3.64–5.15	<0.001

F Lellouche et al. Anesthesiology 2012;116:1072

Protective Ventilation Attenuates Postoperative Pulmonary Dysfunction in Patients Undergoing Cardiopulmonary Bypass

Mark A. Chaney, MD, Mihail P. Nikolov, MD, Bradford P. Blakeman, MD, and Mamdouh Bakhos, MD

- N= 25, TV: 6 mL/kg *vs* 12 mL/kg
- Düşük riskli hasta, CABG
- Akciğer fonksiyonları
  - Entübasyon sonrası
  - YB'da 60. dakikada
- FiO_2 :1.0, PEEP: 5 cm H_2O, SS : 16 *vs* 8 /dk

- **Yüksek TV**
  - ↑ Pik havayolu ve plato basıncı
  - ↑ Akciğer kompliyansı
  - ↓ Statik akciğer kompliyansı
  - ↑ Şant oranı

Düşük TV

Fark ∅

PV , MV bağlı akciğer hasarını azaltır ve kardiyak cerrahi sonrası PPK görülme oranını olumlu yönden etkileyebilir

Hermann Wrigge
Ulrike Uhlig
Georg Baumgarten
Jan Menzenbach
Jörg Zinserling
Martin Ernst
Daniel Drömann
Armin Welz
Stefan Uhlig
Christian Putensen

Mechanical ventilation strategies and inflammatory responses to cardiac surgery: a prospective randomized clinical trial

Intensive Care Med 2005;31:1379

Influence of Low Tidal Volume Ventilation on Time to Extubation in Cardiac Surgical Patients

Sugantha Sundar, M.D.,* Victor Novack, M.D., Ph.D.,† Karinne Jervis, M.D.,‡
S. Patrick Bender, M.D.,‡ Adam Lerner, M.D.,§ Peter Panzica, M.D.,§ Feroze Mahmood, M.D.,§
Atul Malhotra, M.D.,‖ Daniel Talmor, M.D., M.P.H.#

Anesthesiology 2011;114:1102

Ozge Koner
Serdar Celebi
Huriye Balci
Gurkan Cetin
Kamil Karaoglu
Nahit Cakar

Effects of protective and conventional mechanical ventilation on pulmonary function and systemic cytokine release after cardiopulmonary bypass

Intensive Care Med 2004;30:620

TV (6 *vs* 10 ml/kg), PEEP (5 cmH2O) RM (-)

İnflammatuvar yanıt: Fark ∅ / minimal

Klinik sonuç: Oksijenasyon, akc mekanikleri ve ekstübasyon süresi
Fark ∅

Mechanical ventilation affects inflammatory mediators in patients undergoing cardiopulmonary bypass for cardiac surgery: A randomized clinical trial

Enrico Zupancich, MD,[a]†‡ Domenico Paparella, MD,[b]*‡ Franco Turani, MD,[a,c] Christopher Munch, MD,[a] Alessandra Rossi, MD,[a] Simone Massaccesi, MD,[a] and V. Marco Ranieri, MD[b]

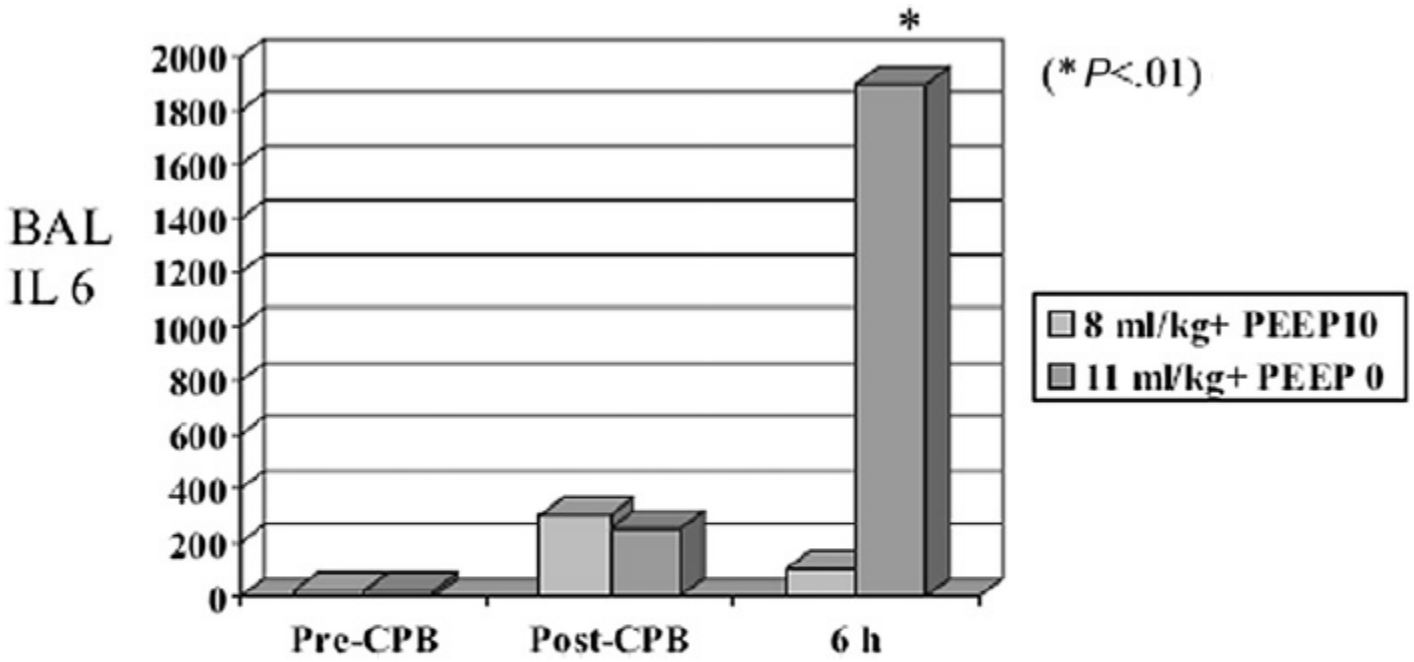


Fig. 5. Bronchoalveolar lavage (BAL) levels of cytokines, such as IL-6, were significantly increased 6 hours after CPB for cardiac surgery in patient's ventilated post-CPB with larger V_{TS} and lower levels of PEEP. (*Data from* Zupancich E, Paparella D, Turani F, et al. Mechanical ventilation affects inflammatory mediators in patients undergoing cardiopulmonary bypass for cardiac surgery: a randomized clinical trial. J Thorac Cardiovasc Surg 2005;130:378–83.)

ORIGINAL ARTICLE

Minerva Anesthesiol 2012;78:790

Positive end-expiratory pressure following coronary artery bypass grafting

D. A. DONGELMANS [1], S. N. HEMMES [1, 2], A. C. KUDOGA [1]
D. P. VEELO [1], J. M. BINNEKADE [1], M. J. SCHULTZ [1 2, 3]

ORIGINAL ARTICLE

Dl Borges, et al .Res Bras Cir Cardiovasc 2013;28:380

Effects of different PEEP levels on respiratory mechanics and oxygenation after coronary artery bypass grafting

Farklı PEEP düzeyleri ⇒

Erken postoperatif dönemde oksijenasyon ve akc mekanikleri

10 cmH_2O PEEP > 5 ve 8 cmH_2O PEEP

Alveolar recruitment strategy during CPB does not improve postoperative gas exchange and lung function

- Prospektif, randomize, n= 32, CABG + CPB
  - Grup 1: PEEP 5 cm H2O
  - Grup 2: PEEP 5 + ↑ 14 cm H_2O_2 min / her 20 dk.da bir, Xklemp süresince
- Ölçüm: Preop – Postop 6. gün
- FARK ∅
  - Postop kan gazları
  - EVLW
  - Akciğer fonksiyonu
    - Postop ölçülen < ilk ölçülen değerler

KPB sırasında

Preoperative pulmoner fonksiyonu normal kardiyak cerrahi hastalarında, alveolar "Recruitment" stratejisi uygulaması postop akciğer fonksiyonu ve gaz değişiminde bir iyileşme sağlamamaktadır

M Scherrer, et al Cardiovasc Eng 2009 Mar;9:1

Effects of Alveolar Recruitment on Arterial Oxygenation in Patients After Cardiac Surgery: A Prospective, Randomized, Controlled Clinical Trial

Leonid Minkovich, MD, PhD, George Djaiani, MD, FRCA, Rita Katznelson, MD, Fergal Day, MD, Ludwik Fedorko, MD, PhD, Jens Tan, MD, Jo Carroll, RN, Davy Cheng, MD, FRCPC, and Jacek Karski, MD, FRCPC

- N=95 elektif CABG ve kapak cer
- Kontrol vs VCM
  - 35 cmH_2O, 15 s KBP sonrası
  - 30 cmH_2O, 5 s ICU

Table 2. Comparison of Intubation Times and Length of Stay Between the C-VCM and Control Groups

	C-VCM Group (n = 47)	Control Group (n = 48)	*p* Value
Intubation time (h)	5.2 (2-19)	6.0 (3-32)	0.28
ICU-LOS (h)	22.0 (13-48)	22.5 (18-72)	0.06
Hospital-LOS (d)	7.0 (4-11)	7.1 (5-21)	0.36

NOTE. Data are presented as median (range).
Abbreviations: LOS, length of stay; ICU, intensive care unit; NS, not significant.

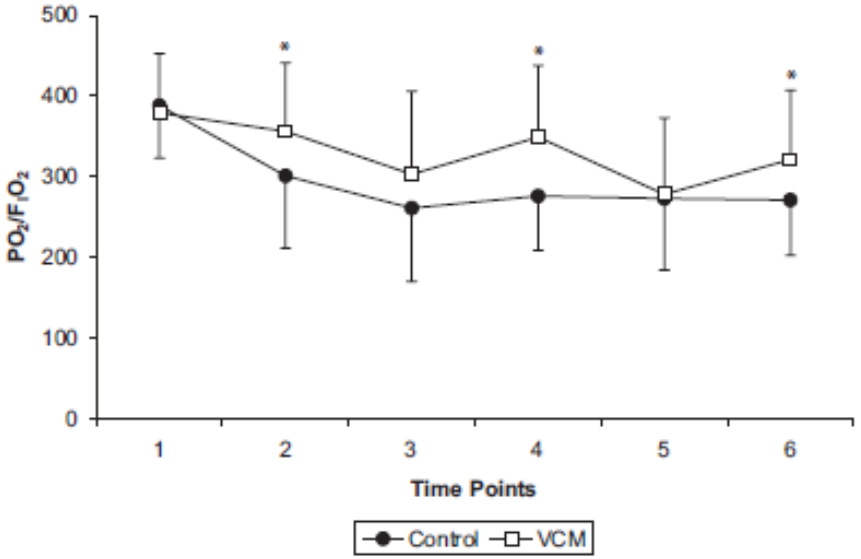
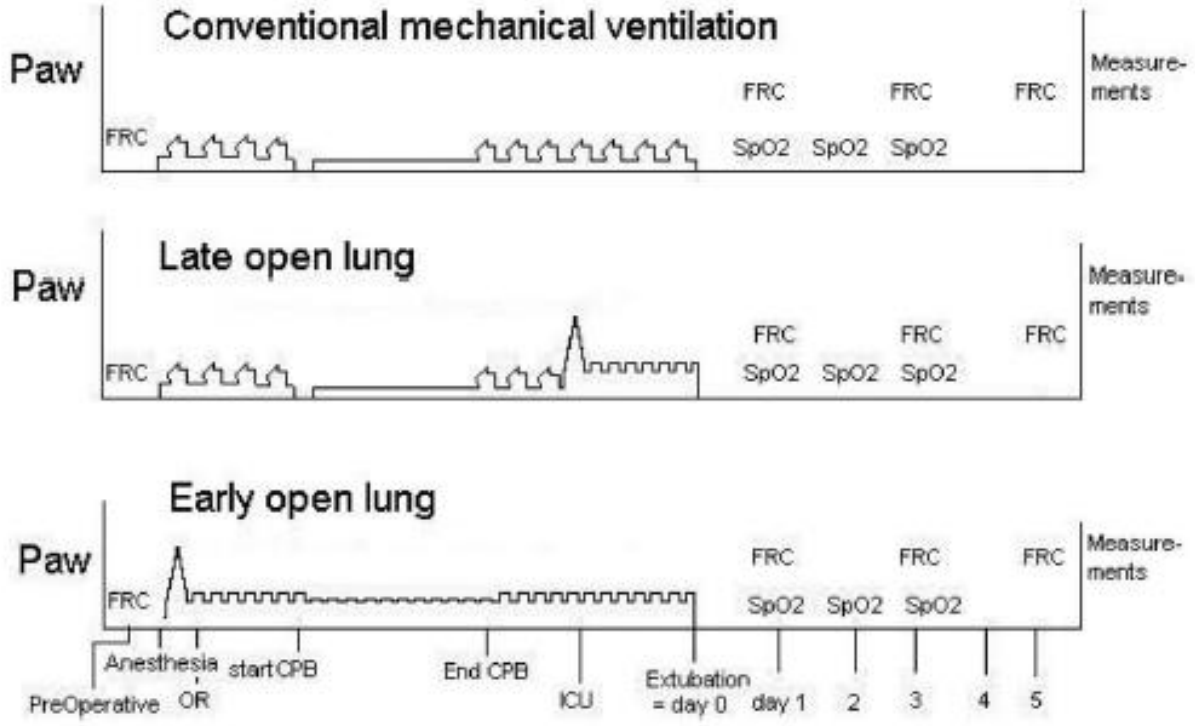


Fig 1. Comparison of PaO_2/F_IO_2 ratio between the repeated vital capacity maneuver (C-VCM) and control groups. Measurements were taken at the following predetermined time intervals: (1) operating room after tracheal intubation, (2) 10 to 15 minutes after separation from cardiopulmonary bypass, (3) after arrival in the ICU, (4) 3 hours after ICU admission, (5) 30 minutes after tracheal extubation, and (6) immediately before ICU discharge. *Significant differences.

Open lung ventilation improves functional residual capacity after extubation in cardiac surgery*

Dinis Reis Miranda, MD; Ard Struijs, MD, PhD; Peter Koetsier, MD; Robert van Thiel, MD; Ronald Schepp, MD; Wim Hop, PhD; Jan Klein, MD, PhD; Burkhard Lachmann, MD, PhD; Ad J. J. C. Bogers, MD, PhD; Diederik Gommers, MD, PhD

Crit Care Med 2005;33:2253



Erken RM (entübasyon sonrası) *vs* Geç RM (cerrahi sonrası)

- İnflammatuvar yanıt daha az
- FRC daha yüksek, hipoksemi epizotları daha nadir

The Pulmonary and Hemodynamic Effects of Two Different Recruitment Maneuvers After Cardiac Surgery

Serdar Celebi, MD*
Özge Köner, MD†
Ferdi Menda, MD*
Kubilay Korkut, MD‡
Kaya Suzer, MD‡
Nahit Cakar, MD§

N = 60

CABG

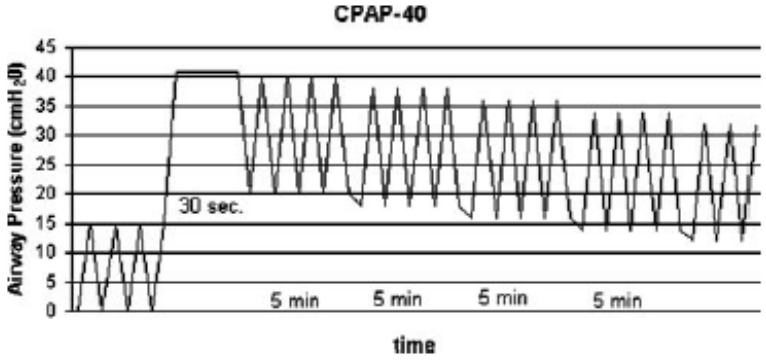


Figure 1. Diagram of the RM applied with continuous positive airway pressure (CPAP) held at 40 cm H_2O for 30 s, then a decremental PEEP trial was used to determine the optimal PEEP value by 2 cm H_2O decrements every 5 min. RM, recruitment maneuver; PEEP, positive end-expiratory pressure.

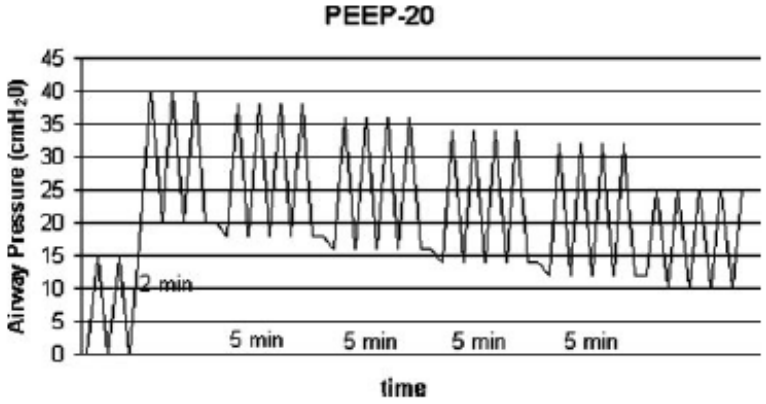
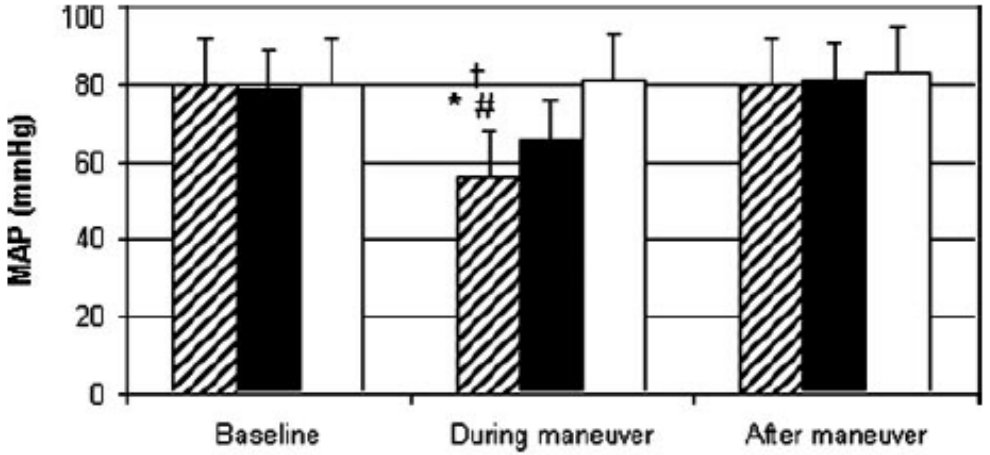
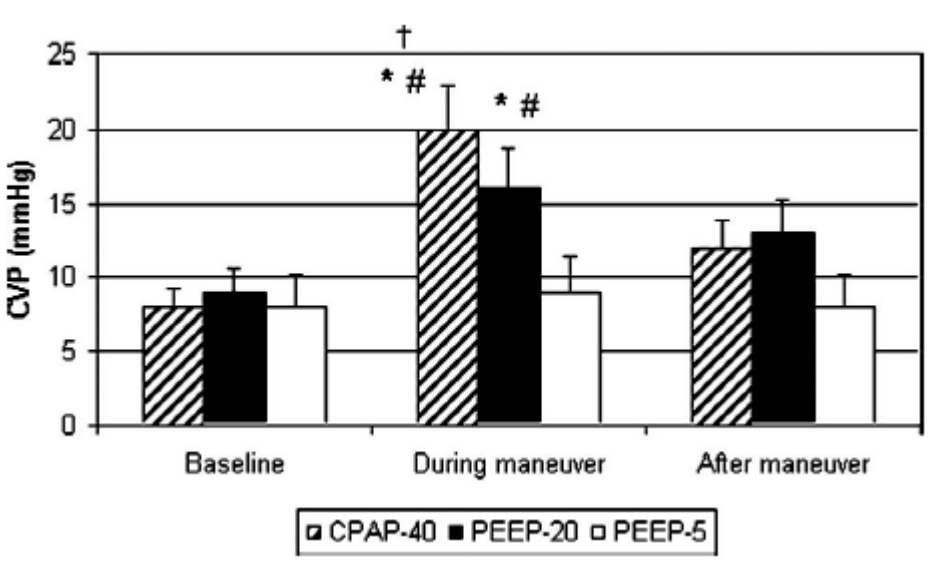


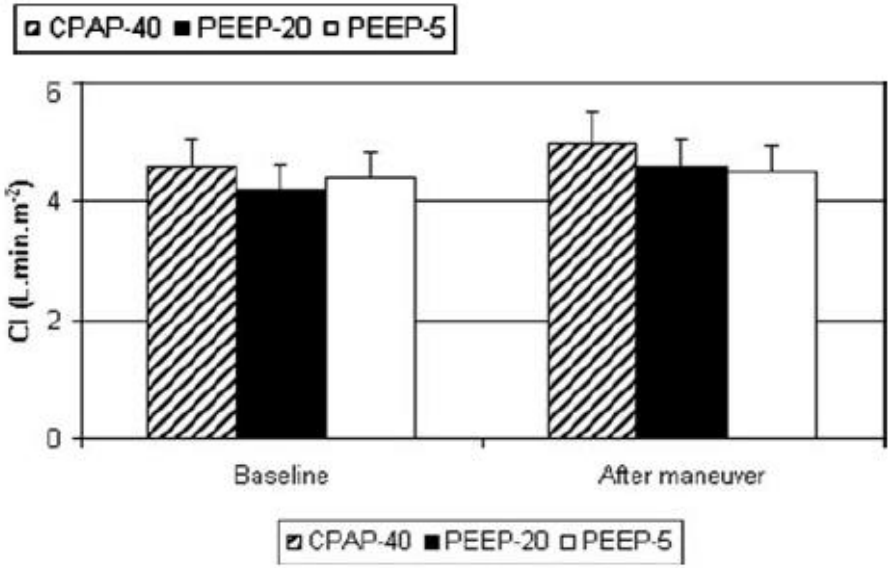
Figure 2. Diagram of the RM applied with high (20 cm H_2O) positive end-expiratory pressure (PEEP). The maneuver was applied on volume-controlled ventilation up to a peak inspiratory airway pressure of 40 cm H_2O for 2 min, then a decremental PEEP trial was used to determine the optimal PEEP value with 2 cm H_2O decrements every 5 min. RM, recruitment maneuver; PEEP, positive end-expiratory pressure.

Anesth Analg 2007;104:384

The Pulmonary and Hemodynamic Effects of Two Different Recruitment Maneuvers After Cardiac Surgery

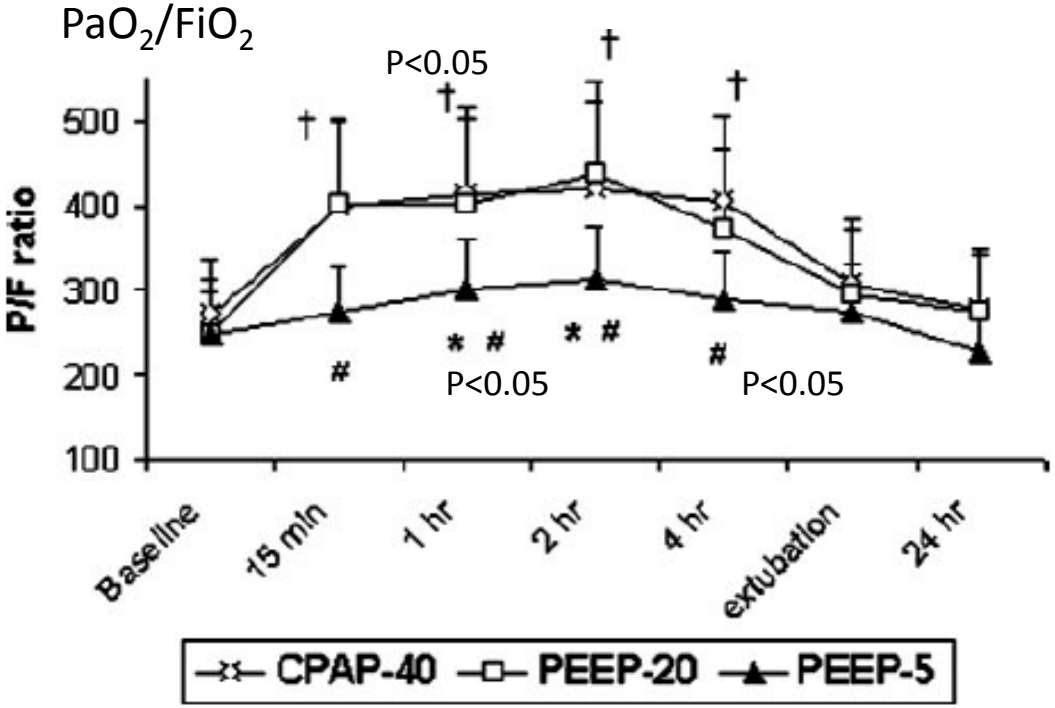






No changes in HR, MPAP, PCWP, SVRI and PVRI

The Pulmonary and Hemodynamic Effects of Two Different Recruitment Maneuvers After Cardiac Surgery



Atelektazi skoru
(Postop 1. gün)

Grup:
PEEP-5 (1.3 ± 0.9)
CPAP-40 (0.65 ± 0.6; *P < 0.01)*
PEEP-20 (0.65 ± 0.5; P < 0.01)

Sonuç: RM + PEEP uygulaması benzer oranda oksijenasyonda artış ve atelektazi oranında azalma sağlamaktadır. Ancak, RM+ PEEP-20 uygulaması ile CPAP'a göre daha stabil bir hemodinamik seyir elde edilir

Anesth Analg 2007;104:384

MV – İstenmeyen Etkileri

Koruyucu ventilasyon (PEEP, RM)

- ↓ Ventriküler dolum
- ↑ RV afterload
- ↓ RV preload
- ↓, → Kontraktilite
- ↑ ICP

JE Berglund et al. Intensive Care Medicine, 1994;20:174
T Dyhr et al. Acta Anaesthesiologica Scandinavica, 2002;46:717
DR Miranda et al. Br J Anaesth 2004;93:27–332
M Duggan et al. Am J Resp and Crit Care Med, 2003;167:1633
J Nielsen et al. Intensive Care Medicine, 2005;31:1189
SC Lim et al. Crit Care Medicine, 2004;32:2378–2384

NIV

Preventif NIV / CPAP

Postop solunum yetmezliği riski yüksek hastalara uygulandığında

- Gaz değişimi, oksijenasyon ve alveoler ventilasyonunda iyileşme
- ↓ Solunum işi
- ↓ Atelektazi ve PPK
- ↓ Re-entübasyon oranı
- ↓ Hastane ve YB'da kalış süresi
- ↓ YB'a yeniden yatış

P Matte, et al. Acta Anaesth Scand, 2000;44:75
A Zarbock, et al. Chest, 2009;135:1252
P Pasquina, et al. Anesth Analg 2004;99:1001
E Al Jaaly, et al. J Thorac Cardiovasc Surg 2013;146:912
L Cabrini, et al. *Heart, Lung and Vessels* 2013;5,137–141
M Garcia-Delgado, et al. J Cardiothorac Vasc Anesth 2012;26:443

Cardiac Surgery - MV

- Intraoperatif MV
  - Yüksek TV (10-12 ml/kg)
    - ↓ Atelektazi
  - Minimal PEEP
    - ↓ Hemodinamik stabilite
- KPB sırasında
  - Ventilasyon ∅
    - Düşük değerlerde CPAP
    - Ventilatörden tamamen ayırma

KPB Sırasında

European Journal of Cardio-Thoracic Surgery 44 (2013) 282–287
doi:10.1093/ejcts/ezs659 Advance Access publication 31 December 2012

ORIGINAL ARTICLE

Continued mechanical ventilation during coronary artery bypass graft operation attenuates the systemic immune response

Lucian Beer[a,b,†], Tamás Szerafin[c,†], Andreas Mitterbauer[a,b], Tamás Debreceni[c], Tamás Maros[c], Martin Dworschak[d], Georg A

Ventilation During Cardiopulmonary Bypass: Impact on Cytokine Response and Cardiopulmonary Function

(Ann Thorac Surg 2008;85:154–62)

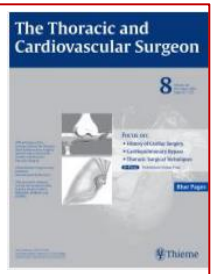
Calvin S. H. Ng, MD, Ahmed A. Arifi, MD, Song Wan, MD, PhD, Anthony M. H. Ho, MD, Innes Y. P. Wan, MD, Eric M. C. Wong, MS, and Anthony P. C. Yim, MD

Intraoperative ventilation strategy during cardiopulmonary bypass attenuates the release of matrix metalloproteinases and improves oxygenation

Lucian Beer, MD,[a,b,1] Joanna Maria Warszawska, MD, PhD,[c,1] Peter Schenk, MD,[d] Tamás Debreceni, MD,[e] Martin Dworschak, M Georg A. Roth, M[c] Tamás Szerafin, M[e,1]

JOURNAL OF SURGICAL RESEARCH 195 (2015) 294–302

Low Tidal Volume Ventilation during Cardiopulmonary Bypass Reduces Postoperative Chemokine Serum Concentrations



Lucian Beer[1, 2, *], Tamás Szerafin[3, *], Andreas Mitterbauer[1, 2], Tamás Debreceni[3], Tamás Maros[3], Martin Dworschak[4], Georg A. Roth[4], Hendrik Jan Ankersmit[1, 2]

Thorac cardiovasc Surg 2014; 62(08): 677-682

Effects of ventilation and nonventilation on pulmonary venous blood gases and markers of lung hypoxia in humans undergoing total cardiopulmonary bypass.

Loer, S; Kalweit, G; Tarnow, J

	A. Radialis	V. Pulmonalis Ventilated Lung	V. Pulmonalis Nonventilated Lung	*p* Value
Beginning of total cardiopulmonary bypass				
Po_2 (torr)	286 ± 38	153 ± 31	149 ± 29	.86
Pco_2 (torr)	38 ± 6	42 ± 6	41 ± 5	.67
Lactate (mmol/L)	3.5 ± 1.2	3.6 ± 1.4	3.5 ± 1.3	.28
LDH (U/L)	101 ± 15	108 ± 12	109 ± 14	.63
Endothelin-1 (fmol/mL)	0.63 ± 0.32	0.54 ± 0.36	0.64 ± 0.31	.17
Big-endothelin (fmol/mL)	0.66 ± 0.28	0.63 ± 0.35	0.68 ± 0.29	.33
Thromboxane B_2 (pg/mL)	376 ± 89	360 ± 84	356 ± 62	.82
End of total cardiopulmonary bypass				
Po_2 (torr)	244 ± 34	103 ± 23	57 ± 15	<0.01
Pco_2 (torr)	39 ± 5	35 ± 4	49 ± 8	<0.01
Lactate (mmol/L)	3.4 ± 1.0	3.6 ± 0.6	3.8 ± 0.6	0.41
LDH [U/L]	161 ± 33	172 ± 42	186 ± 41	0.17
Endothelin-1 (fmol/mL)	0.65 ± 0.32	0.77 ± 0.32	0.81 ± 0.37	0.46
Big-endothelin (fmol/mL)	0.69 ± 0.21	0.73 ± 0.38	0.77 ± 0.28	0.59
Thromboxane B_2 (pg/mL)	450 ± 99	434 ± 92	488 ± 95	0.03

Data represent mean ± SD of measurements in 12 patients. *p* values refer to differences between ventilated and nonventilated lungs. LDH, lactate dehydrogenase.

To convert torr to kPa, multiply value by 0.1333.

Critical Care Medicine 2000;28:1336

KPB Sırasında

Ventilasyon Stratejileri

- Kontrole ventilasyon
  - Nr / Düşük TV
  - Düşük solunum sayısı
- CPAP
- HFV
- RM - VCM

L Beer, et al. Thorac Cardiovasc Surg 2014;62:677
Davuodi, et al. J Tehran Univ Heart Center 2010;5:128
LCH John, et al. Interact Cardiovasc Thoracic Surg, 2008;7:14

H Imura, et al. J Thorac Cardiovasc Surg. 2009;137:1530

A Loeckinger, et al. Anesth Analg 2000;91:522
Berry CB, et al. Br J Anaesth 1993;71:864

D Zabeeda, et al. J Cardiothoracic Vasc Anesth, 2003:17;40

Inflamasyonda ↓, oksijenasyon, akc mekanikleri ve şant fraksiyonunda iyileşme

The Effect of High-Frequency Ventilation of the Lungs on Postbypass Oxygenation: A Comparison With Other Ventilation Methods Applied During Cardiopulmonary Bypass

Deeb Zabeeda, MD, Revaz Gefen, MD, Beniamin Medalion, MD, Vadim Khazin, MD, Arie Shachner, MD, and Tiberiu Ezri, MD

Objective: To compare the effect of high-frequency ventilation versus other ventilation methods applied during cardiopulmonary bypass on postbypass oxygenation.

Design: Prospective, randomized study.

Setting: University hospital.

Participants: Seventy-five patients undergoing coronary artery bypass graft surgery.

Interventions: Patients were allocated to 5 equal groups of different ventilation methods during bypass. Groups 1 and 2 received high-frequency, low-volume ventilation with 100% and 21% oxygen, respectively. Groups 3 and 4 received 5 cm H_2O of continuous positive airway pressure (CPAP) with either 100% or 21% oxygen. Patients from group 5 were disconnected from the ventilator during the bypass period.

Measurements and Main Results: Spirometry data, blood gas analysis, oxygen saturation as measured by pulse oximetry, and end-tidal carbon dioxide were recorded 5 minutes before chest opening, 5 minutes before bypass, 5 minutes after bypass, 5 minutes after chest closure and 6, 12, 18, and 24 hours after surgery. There were no differences in compliance and mean airway pressures. Alveolar-to-arterial oxygen gradients increased, and PaO_2 decreased significantly ($p < 0.05$) in all groups 5 minutes after bypass and this trend continued in the postoperative period. Patients from group 3 had higher PaO_2 and lower alveolar-to-arterial oxygen gradients, 5 minutes after weaning from bypass ($p < 0.05$). Extubation times were similar in all groups.

Conclusions: The alveolar-arterial oxygen gradient was lower, and the PaO_2 was higher 5 minutes after bypass in patients receiving CPAP (100% O_2) as compared with those ventilated with high-frequency ventilation.

KEY WORDS: High-frequency ventilation, cardiopulmonary bypass, oxygenation, pulmonary complications

Sonuç: 5 cmH_2O CPAP ile klinik sonuç daha iyi

KPB sonrası sadece ilk 5 dakika içinde oksijenasyonda iyileşme

Klinik önemi ?

J Cardiothoracic Vasc Anesth, 2003:17;40.

The Effect of Different Lung-Protective Strategies in Patients During Cardiopulmonary Bypass: A Meta-Analysis and Semiquantitative Review of Randomized Trials

Jan-Uwe Schreiber, MD, PhD,* Marcus D. Lancé, MD,* Marcel de Korte, MD,* Thorsten Artmann, BS,†
Ivan Aleksic, MD, PhD, FETCS,‡ and Peter Kranke, MD, PhD, MBA†

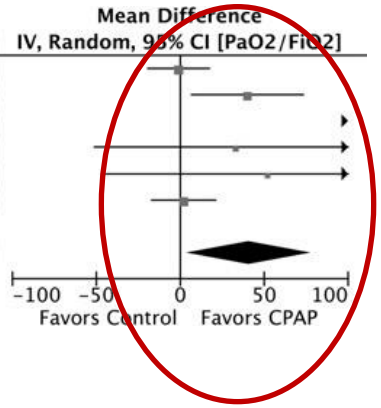
JCTVA 2012;26:448

- N=814 patients, 16 RKÇ
- CPAP: 5-10cmH_2O, FiO_2: 0,21-0,5; KPB'dan ayrıldıktan sonra

PaO_2/FiO_2

	Experimental			Control				Mean Difference	Mean Difference
Study or Subgroup	Mean [PaO2/FiO2]	SD [PaO2/FiO2]	Total	Mean [PaO2/FiO2]	SD [PaO2/FiO2]	Total	Weight	IV, Random, 95% CI [PaO2/FiO2]	IV, Random, 95% CI [PaO2/FiO2]
Ayad 2003	351	34	20	352	29	29	22.4%	-1.00 [-19.26, 17.26]	
Boldt 1990	400	53	15	360	39	15	19.9%	40.00 [6.70, 73.30]	
Cogliati 1996	467	85	10	309	28	10	15.5%	158.00 [102.53, 213.47]	
Figueiredo 2008	256	83	15	223	144	15	10.7%	33.00 [-51.11, 117.11]	
Loeckinger 2000	404	89	7	352	97	7	9.0%	52.00 [-45.52, 149.52]	
Zabeeda 2003	327	33	15	325	18	15	22.3%	2.00 [-17.02, 21.02]	
Total (95% CI)			**82**			**91**	**100.0%**	**40.99 [3.74, 78.24]**	

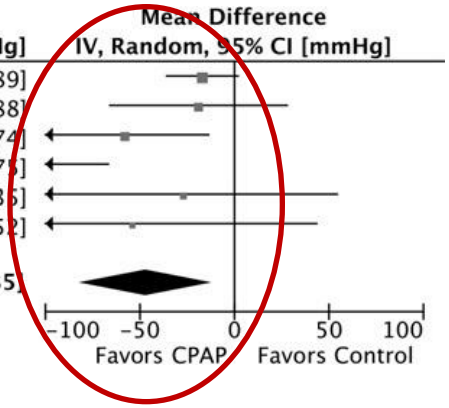
Heterogeneity: $Tau^2 = 1523.73$; $Chi^2 = 33.13$, df = 5 ($P < 0.00001$); $I^2 = 85\%$
Test for overall effect: Z = 2.16 (P = 0.03)



$AaDO_2$

	Experimental			Control				Mean Difference	Mean Difference
Study or Subgroup	Mean [mmHg]	SD [mmHg]	Total	Mean [mmHg]	SD [mmHg]	Total	Weight	IV, Random, 95% CI [mmHg]	IV, Random, 95% CI [mmHg]
Altmay 2006	223	47	60	240	58	60	24.3%	-17.00 [-35.89, 1.89]	
Ayad 2003	241	80	20	260	71	20	17.8%	-19.00 [-65.88, 27.88]	
Berry 1993	266	78	22	324	63	17	18.4%	-58.00 [-102.26, -13.74]	
Cogliati 1996	248	43	10	352	42	10	20.2%	-104.00 [-141.25, -66.75]	
Figueiredo 2008	352	79	15	379	140	15	10.8%	-27.00 [-108.35, 54.35]	
Loeckinger 2000	222	89	7	276	97	7	8.6%	-54.00 [-151.52, 43.52]	
Total (95% CI)			**134**			**129**	**100.0%**	**-46.69 [-81.52, -11.85]**	

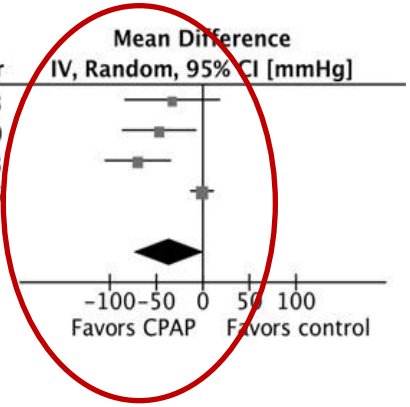
Heterogeneity: $Tau^2 = 1206.05$; $Chi^2 = 18.32$, df = 5 ($P = 0.003$); $I^2 = 73\%$
Test for overall effect: Z = 2.63 (P = 0.009)



$AaDO_2$, 4 hours after weaning from CPB

Study or Subgroup	Experimental Mean [mmHg]	Experimental SD [mmHg]	Experimental Total	Control Mean [mmHg]	Control SD [mmHg]	Control Total	Weight	Mean Difference IV, Random, 95% CI [mmHg]	Year
Berry 1993	182	85	22	215	86	22	20.4%	-33.00 [-83.53, 17.53]	1993
Loeckinger 2000	94	26	7	141	46	7	23.8%	-47.00 [-86.14, -7.86]	2000
Ayad 2003	220	48	20	290	63	20	25.1%	-70.00 [-104.71, -35.29]	2003
Altmay 2006	96	36	60	97	30	60	30.8%	-1.00 [-12.86, 10.86]	2006
Total (95% CI)			**109**			**109**	**100.0%**	**-35.78 [-73.92, 2.37]**	

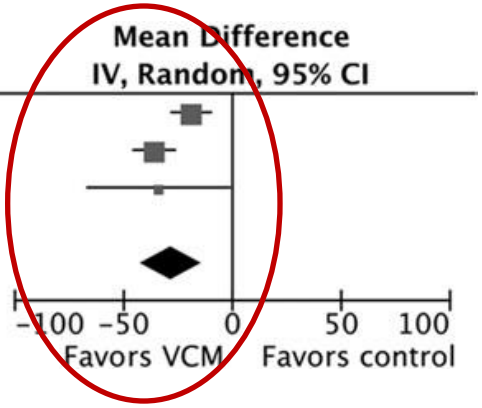
Heterogeneity: $Tau^2 = 1194.99$; $Chi^2 = 17.77$, df = 3 (P = 0.0005); $I^2 = 83\%$
Test for overall effect: Z = 1.84 (P = 0.07)



VCM 30 minutes after weaning from CPB

Study or Subgroup	VCM Mean	VCM SD	VCM Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Murphy 2001	148	13	20	167	16	20	43.7%	-19.00 [-28.03, -9.97]
Muslu 2003	117	8	11	153	14	11	42.8%	-36.00 [-45.53, -26.47]
Tschernko 2002	177	46	12	211	35	12	13.4%	-34.00 [-66.70, -1.30]
Total (95% CI)			**43**			**43**	**100.0%**	**-28.30 [-42.13, -14.47]**

Heterogeneity: $Tau^2 = 92.59$; $Chi^2 = 6.61$, df = 2 (P = 0.04); $I^2 = 70\%$
Test for overall effect: Z = 4.01 (P < 0.0001)



Sonuç: KPB sırasında CPAP veya VCM led to a significant increase in oxygenation parameters immediately after weaning from CPB, but this effect was not sustainable and did not improve patient outcome.

KPB sırasında

Postoperatif pulmoner komplikasyonları önleme

- Koruyucu mekanik ventilasyon
  - KPB sırasında MV
  - KPB sırasında MV ve akciğer perfüzyonu
- Cerrahi teknik
  - KPB ile çalışan kalpte CABG + Düşük TV ile ventilasyon
  - OPCABG
- “Fast Tracking”

FI Macedo, et al. Semin Thoracic Surg 2012;24:308
FI Macedo, et al. J Thorac Cardiovasc Surg 2010;139:234
TA Salerno et al. Heart Surg Forum 2010;13:S7
E Gologorsky, et al. Expert Rev Cardiovasc Ther 2011;9:927
U Tutun, et al. Heart Surg Forum 2011;14:E297

Open-Lung Ventilation Improves Clinical Outcomes in OPCAB Surgery: A Randomized Controlled Trial

- Prospektif, randomize, çift kör
- N=93, OPCAB
- Pulmoner fonksiyon, fonksiyonel kapasite ve klinik sonuçlar
  - Konvansiyonel MV (CMV),
  - “Open-Lung” Erken → Entübasyon sonrası
  - Geç → Cerrahi sonrası
- “Open-Lung” stratejisi
  - Pulmoner fonksiyonun korunması
  - Fonksiyonel kapasitede derlenme
  - Klinik sonuçlar açısından daha iyi
  - İki uygulama arasında bir fark saptanmamış

DW Bolzan, et al. JCTVA 2016

Son söz

Kardiyak cerrahide

- PPK patogenezinde birçok faktör rol oynar
- Önlem için birden fazla strateji ile yaklaşım gereklidir
- Bu yaklaşımların en önemlilerinden biri de PV'dir
- PV'nın yararını gösteren bir çok çalışma mevcuttur
- PV stratejisi perioperatif dönem süresince uygulanmalıdır
- KPB sırasında da ventilasyonun sürdürülmesinin yararlı etkileri olabileceği gösterilmiştir
- Spesifik bir ventilasyon stratejisi önermek için eldeki veriler ve kanıt düzeyleri henüz yetersizdir

Son söz

Kardiyak Cerrahide MV

- İntraoperatif dönemde artık bir çok anestezist düşük TV ve PEEP yaklaşımını kullanmaktadır
- Potansiyel yararlarına rağmen,
  - Günlük pratikte KPB sırasında çok az oranda akciğer koruyucu yaklaşımlar uygulanmaktadır
  - Bunun önemli nedenlerinden biri de cerrahın kendi yaklaşımını etkileyebileceğini düşünmesidir