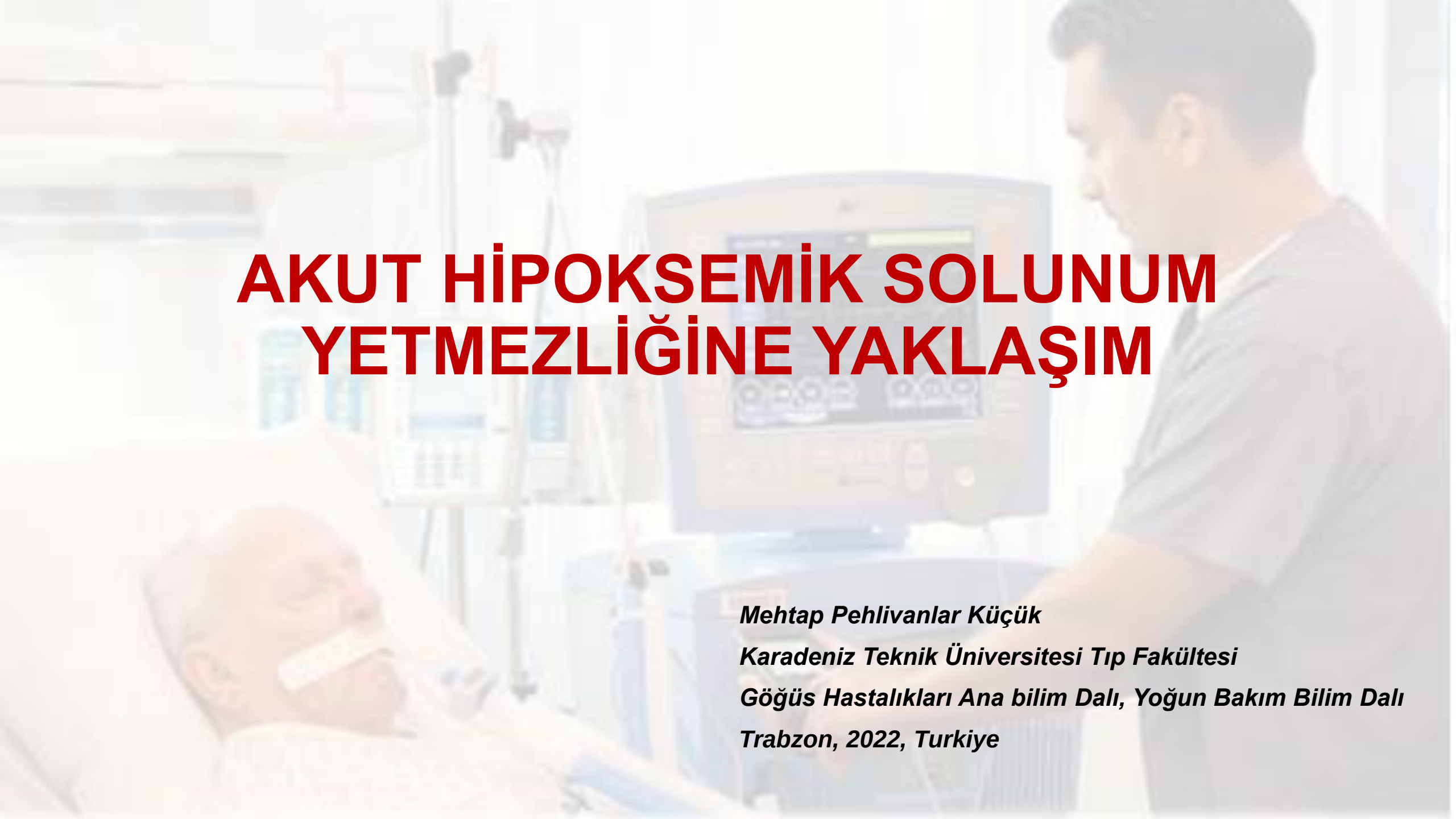


AKUT HİPOKSEMİK SOLUNUM YETMEZLİĞİNE YAKLAŞIM

Mehtap Pehlivanlar Küçük

Karadeniz Teknik Üniversitesi Tıp Fakültesi

Göğüs Hastalıkları Ana bilim Dalı, Yoğun Bakım Bilim Dalı

Trabzon, 2022, Turkiye

AMAÇ

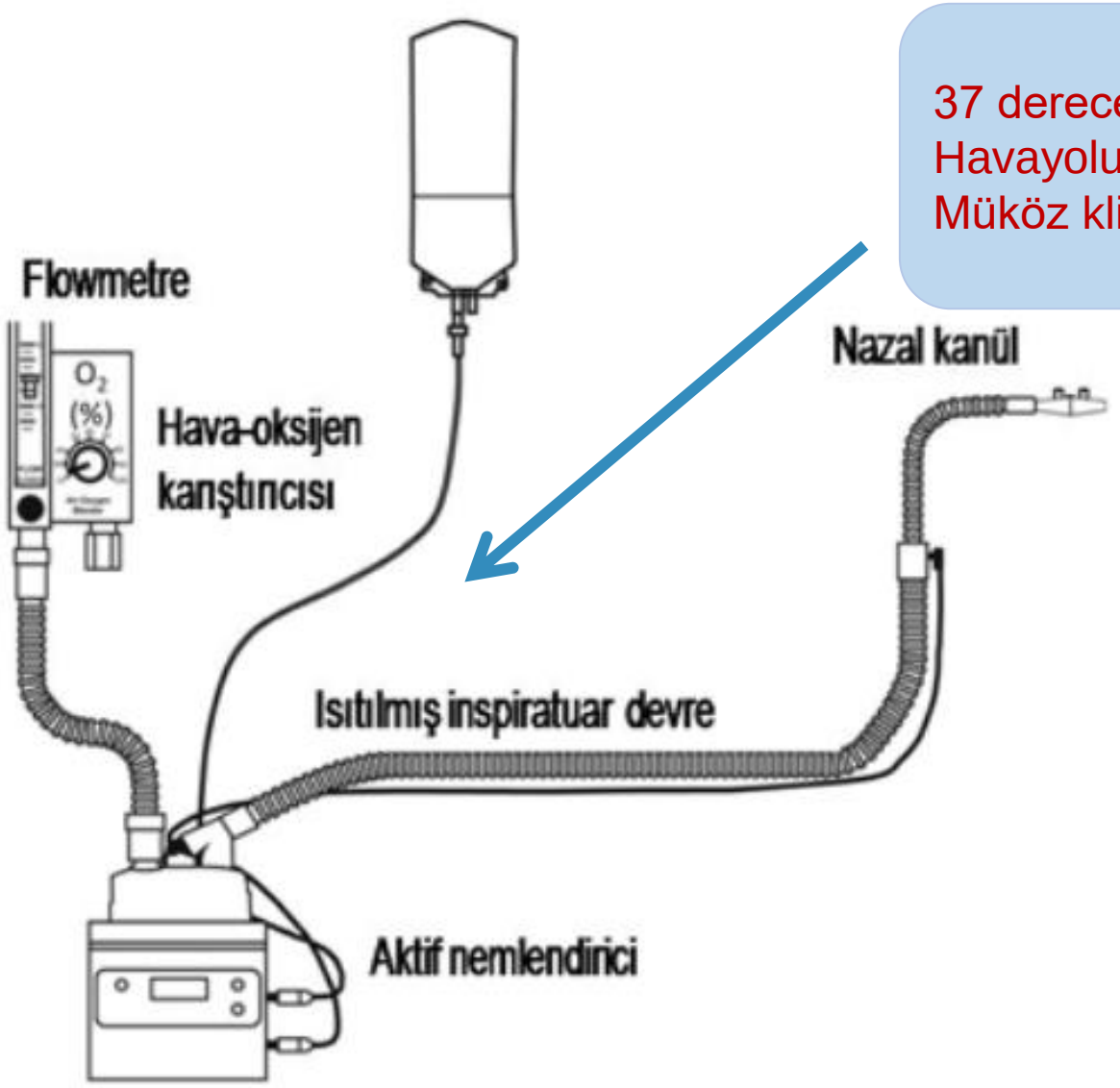
Hipoksemik hastada solunumsal destek uygulamalarını özetlemek

SUNU PLANI

- ✓ Temel Solunumsal Destek Sistemleri
- ✓ARDS Tanımı
- ✓ Mekanik Ventilasyonda Hedef
- ✓ PEEP Ayarı Nasıl Yapılır?
- ✓ ARDS de temel uygulama önerileri

HİPOKSİK HASTANIZ HANGİSİ?

Yüksek Akışlı Nazal Kanül (YANK)



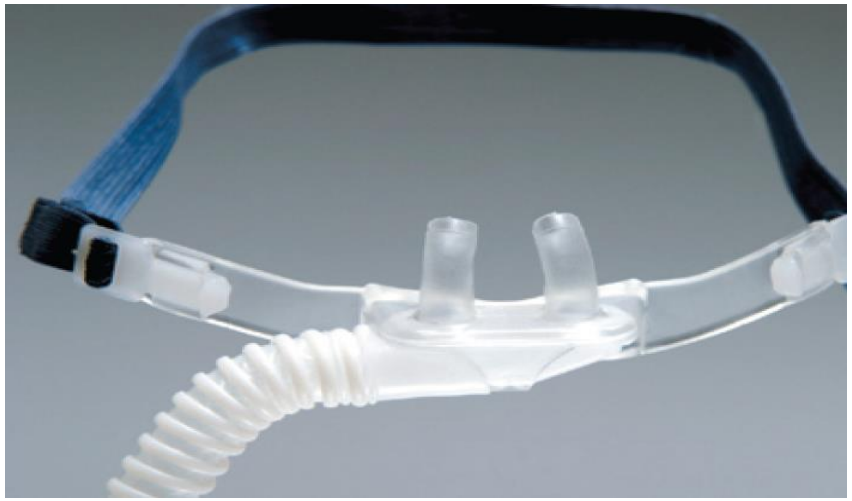
37 dereceye kadar ısıtabilir
Havayolu enflamasyonu azalır
Müköz klirensi arttırır

- ✓ Nemlendiriciye bağlı bir debimetre ve oksijen-hava karıştırıcısından oluşur
- ✓ Isıtılmış bir devre ile burun kanülüne iletilir

Yüksek Akışlı Nazal Kanül (YANK)

Ayarlanan Parametreler

- ✓ **Akım hızı;** Yüksek akım (up to 60 L/dk)
- ✓ **FiO2;** Up to 100 %
- ✓ **Isı:** (37 °C, 100 % HR, 44 mg H_2O/L)



Akut Hipoksemik Solunum Yetmezliği

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure

Standart O_2 → YANK → **NIV**

FLORALI Trial

SYSTEMATIC REVIEW

High flow nasal cannula compared with conventional oxygen therapy for acute hypoxemic respiratory failure: a systematic review and meta-analysis

Intensive Care Med 2019

B. Rochwerg[1,2,22*], D. Granton[1], D. X. Wang[3], Y. Helviz[4], S. Einav[4,5], J. P. Frat[6,7,8], A. Mekontso-Dessap[9,10], A. Schreiber[11], E. Azoulay[12,13], A. Mercat[14], A. Demoule[15,16], V. Lemiale[12,13], A. Pesenti[17,18], E. D. Riviello[19], T. Mauri[17,18], J. Mancebo[20], L. Brochard[21] and K. Burns[21]

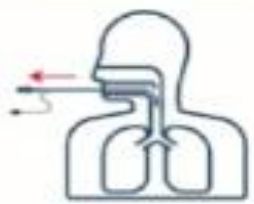
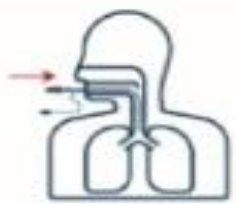
- ✓ 9 RCTs, 2093 hasta
- ✓ Akut hipoksemik solunum yetmezliğinde;
- ✓ Mortaliteyi azaltmaz
- ✓ Entübasyon ihtiyacını azaltır

- ✓ Hasta dispne ve konforunda iyileşme

Given that HFNC is less invasive, it has been hypothesized that the risk for nosocomial complications, such as pneumonia, clot and delirium, is also lower in HFNC as compared to NIV or invasive mechanical ventilation. Finally, the costs and resources associated with HFNC use are hypothesized to be lower than those associated with more invasive forms of oxygen therapy, although comprehensive cost-effectiveness data are lacking. This

The role for high flow nasal cannula as a respiratory support strategy in adults: a clinical practice guideline

Bram Rochwerg[1,2], Sharon Einav[3,4], Dipayan Chaudhuri[1], Jordi Mancebo[5], Tommaso Mauri[6,7], Yigal Helviz[3], Ewan C. Goligher[8,9], Samir Jaber[10], Jean-Damien Ricard[11,12], Nuttapol Rittayamai[13], Oriol Roca[14,15], Massimo Antonelli[16,17], Salvatore Maurizio Maggiore[18], Alexandre Demoule[19,20], Carol L. Hodgson[21,22], Alain Mercat[23], M. Elizabeth Wilcox[8,9], David Granton[1], Dominic Wang[1], Elie Azoulay[24], Lamia Ouanes-Besbes[25,26], Gilda Cinnella[27], Michela Rauseo[27], Carlos Carvalho[28], Armand Dessap-Mekontso[29,30], John Fraser[31,32], Jean-Pierre Frat[33], Charles Gomersall[34], Giacomo Grasselli[6,7], Gonzalo Hernandez[35], Sameer Jog[36], Antonio Pesenti[37], Elisabeth D. Riviello[38], Arthur S. Slutsky[9,39,40], Renee D. Stapleton[41], Daniel Talmor[42], Arnaud W. Thille[43], Laurent Brochard[9,40] and Karen E. A. Burns[2,9,40*]

Hypoxemic respiratory failure *(moderate certainty)*	Following extubation *(moderate certainty)*	Postoperative HFNC in high risk and/or obese patients following cardiac or thoracic surgery *(moderate certainty)*	Peri-intubation period *(moderate certainty)*
			
Strong recommendation	**Conditional recommendation**	**Conditional recommendation**	**No recommendation**

Guideline for the management of COVID-19 patients during hospital admission in a non-intensive care setting

Klaus Nielsen Jeschke[a], Barbara Bonnesen [b], Ejvind Frausing Hansen[a], Jens-Ulrik Stæhr Jensen[b], Therese Sophie Lapperre[c], Ulla Møller Weinreich [d] and Ole Hilberg[e]

ROX İNDEKSİ

$$\frac{\frac{SpO_2}{FIO_2}(\%)}{respiratory\ rate}$$

ROX index > 4.88 HFNC devam edilebilir

ROX	
≥4.88	Little risk of intubation
3.85-4.87	close monitoring due to increased risk of intubation
2.85-3.84	Monitoring in the ICU if possible. Highly increased risk of intubation
<2.85	Consider intubation

Prediction of outcome of nasal high flow use during COVID-19-related acute hypoxemic respiratory failure

Noémie Zucman[1], Jimmy Mullaert[2], Damien Roux[3], Oriol Roca[4], Jean-Damien Ricard[1*] and Contributors

- **HFNC COVID-19 ile ilişkili AHRF sırasında birinci basamak solunum desteği olarak erken uygulanması, vakaların 1/3 ünde entübasyon ihtiyacını ortadan kaldırmış**

- **HFNC başlamasından sonraki ilk 4 saat içinde ölçülen ROX indeksi, erken solunumsal yanıt**

NIMV'nin 30. Yıldönümü Kutlu Olsun!

Noninvasive Mechanical Ventilation in Acute Respiratory Failure

Happy 30-Year Anniversary!

G. Umberto Meduri, MD
Memphis, TN
Craig C. Conoscenti, MD, FCCP
Ridgefield, CT
Phillip Menashe, MD
Phoenix, AZ

CHEST

- In April 1989, Drs Meduri, Conoscenti, Menashe, and Nair published the first report on noninvasive (intermittent) positive-pressure (mechanical) ventilation (NPPV) in patients with acute respiratory failure (ARF) in CHEST.

- Six patients with hypercapnic ARF (all from COPD) and four with hypoxemic ARF (two from acute decompensated heart failure [ADHF] and two from ARDS) met clinical and objective criteria for mechanical ventilation, which was delivered with pressure control or pressure support via a tightly strapped, clear anesthesia face mask.

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Yeni başlayan akut solunum yetmezliğinde NIV kullanılmalı mı?

- ✓Hipoksemik solunum yetmezliği
- ✓Hipoksemi PaO2/FIO2 ⩽200)
- ✓Takipne solunum sayısı >30–35
- ✓KOAH dışı (pnömoni, ARDS)

Recommendation

Given the uncertainty of evidence we are unable to offer a recommendation on the use of NIV for *de novo* ARF.

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Yeni başlayan akut solunum yetmezliğinde NIV kullanılmalı mı?

- ✓Toplum kökenli pnömoni ya da erken ARDS ‘de
- ✓Deneyimli ekip
- ✓Dikkatli seçilmiş hastalar (mental durumu iyi, organ yetmezliği gelişmemiş)
- ✓Başlandıktan sonra sık değerlendirmeler yapılarak
- ✓Yoğun bakımda yakın monitörizasyon ile

Ferrer M, et al.,Am J Respir Crit Care Med 2003; 168: 1438–1444.

Is there still a place for noninvasive ventilation in acute hypoxemic respiratory failure?

Intensive Care Med (2018) 44:2248–2250

Audrey De Jong[1*], Gonzalo Hernandez[2] and Davide Chiumello[3,4]

Indications for NIV use
Acute exacerbation of COPD
Acute cardiogenic pulmonary edema
Hypoxemia post-abdominal surgery
Chest trauma
Preoxygenation before intubation
Against NIV use
(Late or moderate–severe) ARDS
High tidal volumes during the NIV session
Leaks during the NIV session despite changes of interface
Lack of patient adherence
Dyspnea during NIV sessions
Impossibility of close monitoring
Absence of rapid clinical improvement (signs of respiratory distress including elevated respiratory rate) and gas exchange improvement after 1 h of NIV session

Akut Solunum yetmezliğinde NIV başarısızlığı mortalite için bağımsız risk faktörü

Schnell D, et al.. Intensive Care Med 2014; 40: 582–591.

ONLINE FIRST

Acute Respiratory Distress Syndrome
The Berlin Definition

JAMA. 2012;307(23):doi:10.1001/jama.2012.5669

The ARDS Definition Task Force*

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

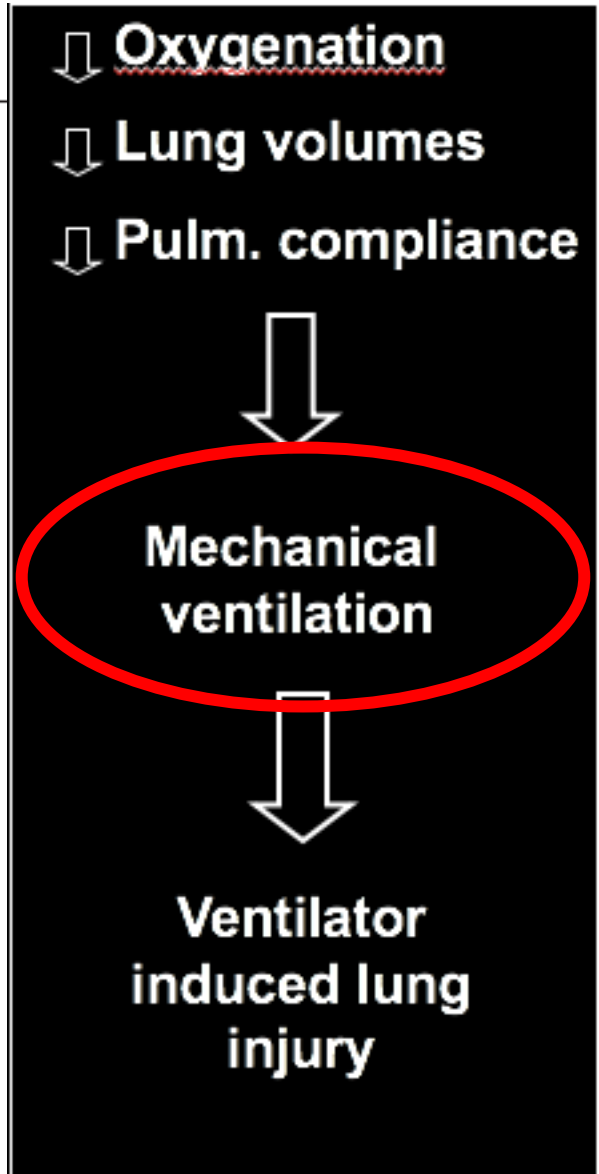
	Acute Respiratory Distress Syndrome
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging[a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation[b]	
Mild	200 mm Hg < Pao_2/Fio_2 ≤ 300 mm Hg with PEEP or CPAP ≥5 cm H_2O[c]
Moderate	100 mm Hg < Pao_2/Fio_2 ≤ 200 mm Hg with PEEP ≥5 cm H_2O
Severe	Pao_2/Fio_2 ≤ 100 mm Hg with PEEP ≥5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; Fio_2, fraction of inspired oxygen; Pao_2, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

[a] Chest radiograph or computed tomography scan.

[b] If altitude is higher than 1000 m, the correction factor should be calculated as follows: [Pao_2/Fio_2 × (barometric pressure/760)].

[c] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.



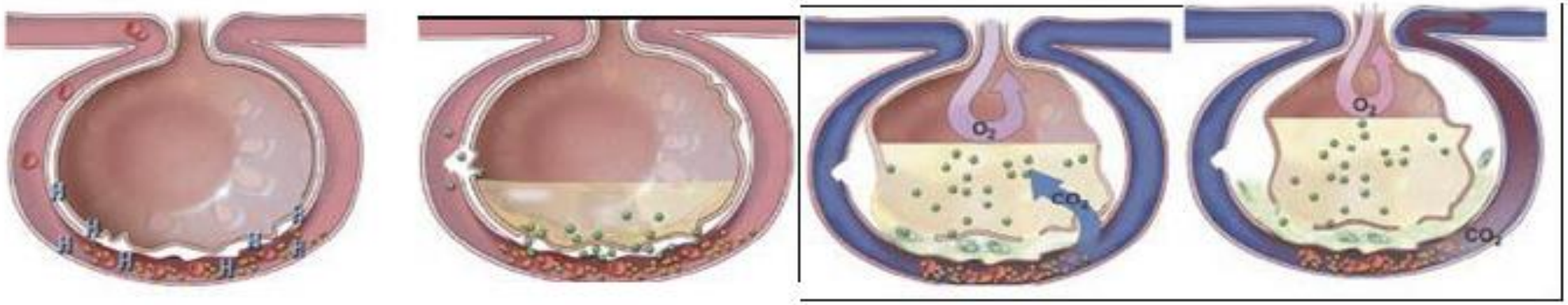
A Chest radiograph of a patient with ARDS

B Computed tomography scan of a patient with ARDS

Alveolo- kapiller membran permeabilitesinde artma

Proteinden zengin sıvının akümülasyonuna bağlı alveolar ödem

Diffüz alveolar hasar



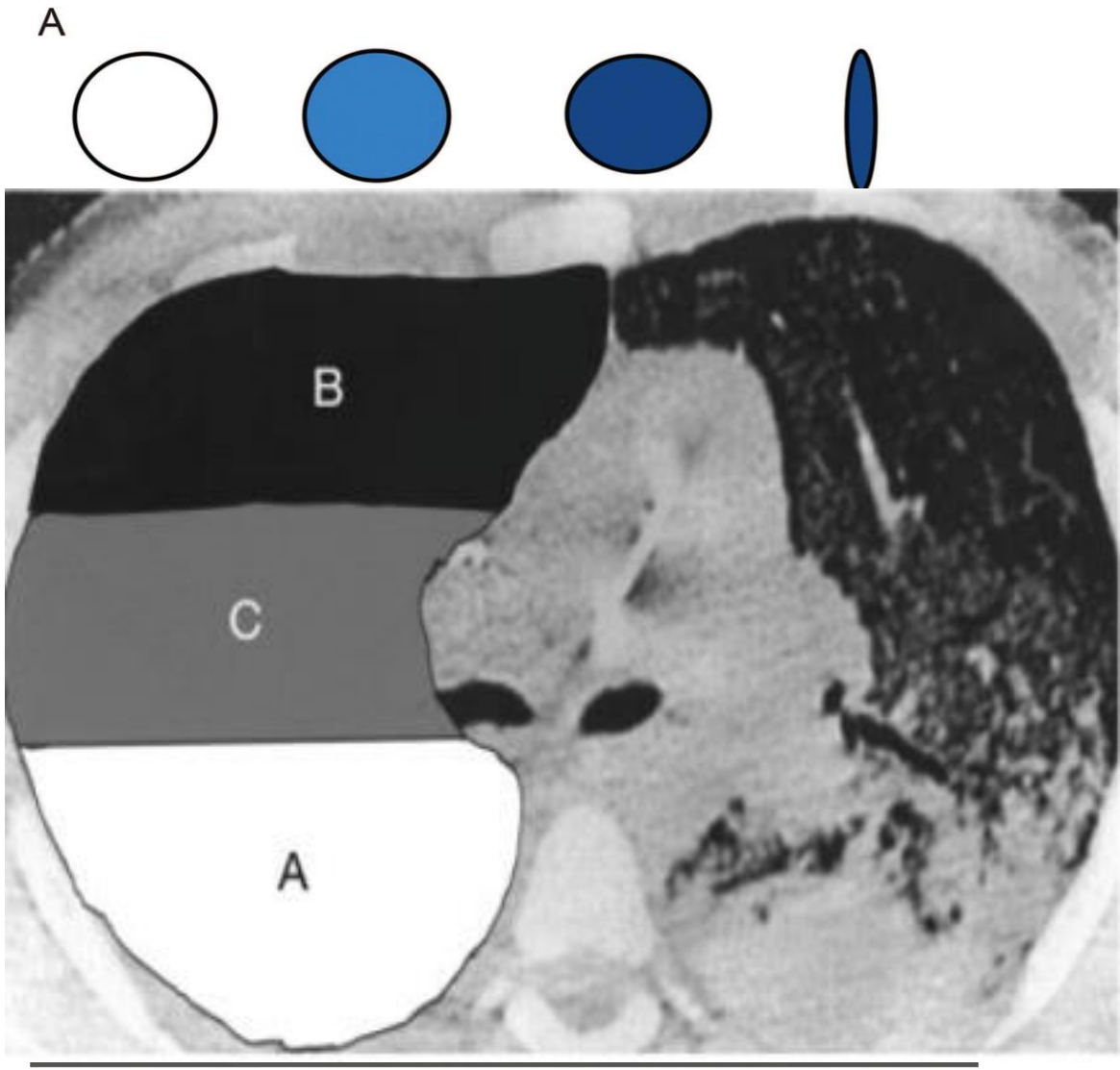
Mekanik Ventilasyonda Hedef

- ARDS de akciğer dokusu heterojen

- **Oksijenizasyonu saglanmasi (SpO2 >88-90%)**
- **Yeterli ventilasyonun sağlanmasi**
- **Solunum kaslarinin dinlendirilmesi**

- **ARDS'de 'aç ve açık tut' ilkesi ile birlikte düşük ventilasyon basıncı kullanımı**

- **Volütravma, barotravma ve atelektotravmadan korunmak**



AKCİĞER KORUYUCU MEKANİK VENTİLASYON

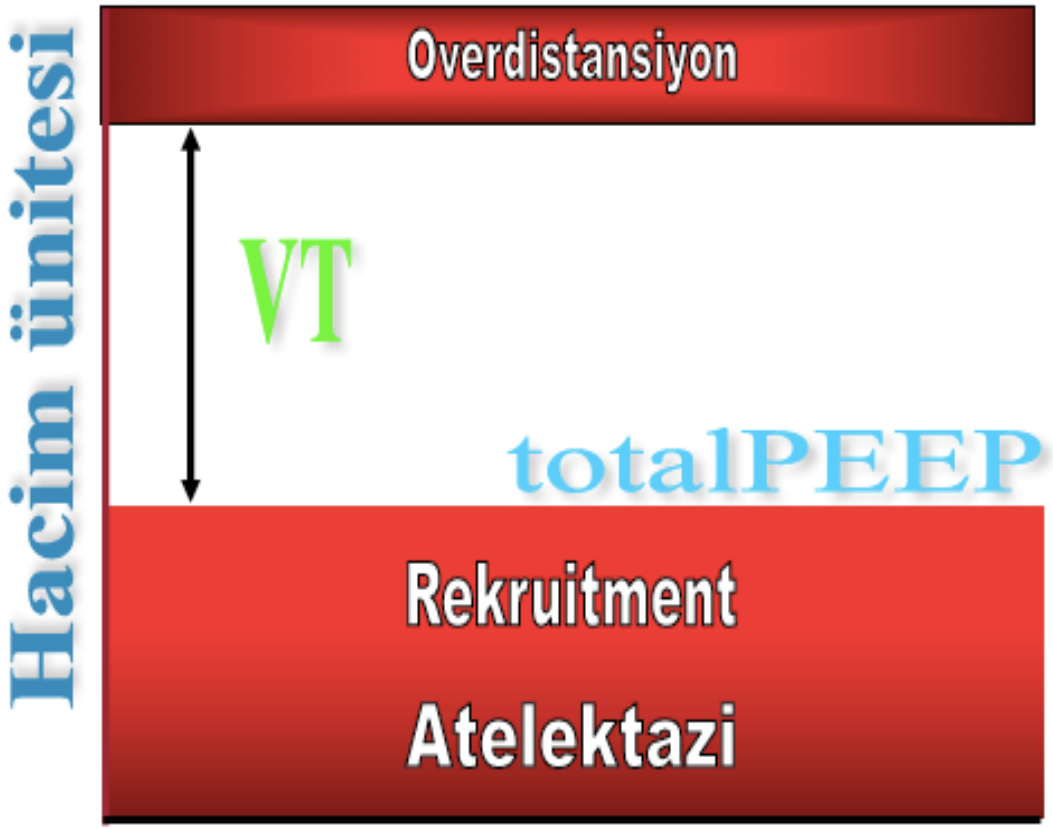
Normal

5 dk ventilasyon, sol apeks atelektatik

45 cm H2O Ppik ile 20 dk ventilasyon

VENTİLATE GENTLY

HEDEF: Dusuk VT ≤ 6 ml/kg ve Pplat ≤ 30 cm H_2O



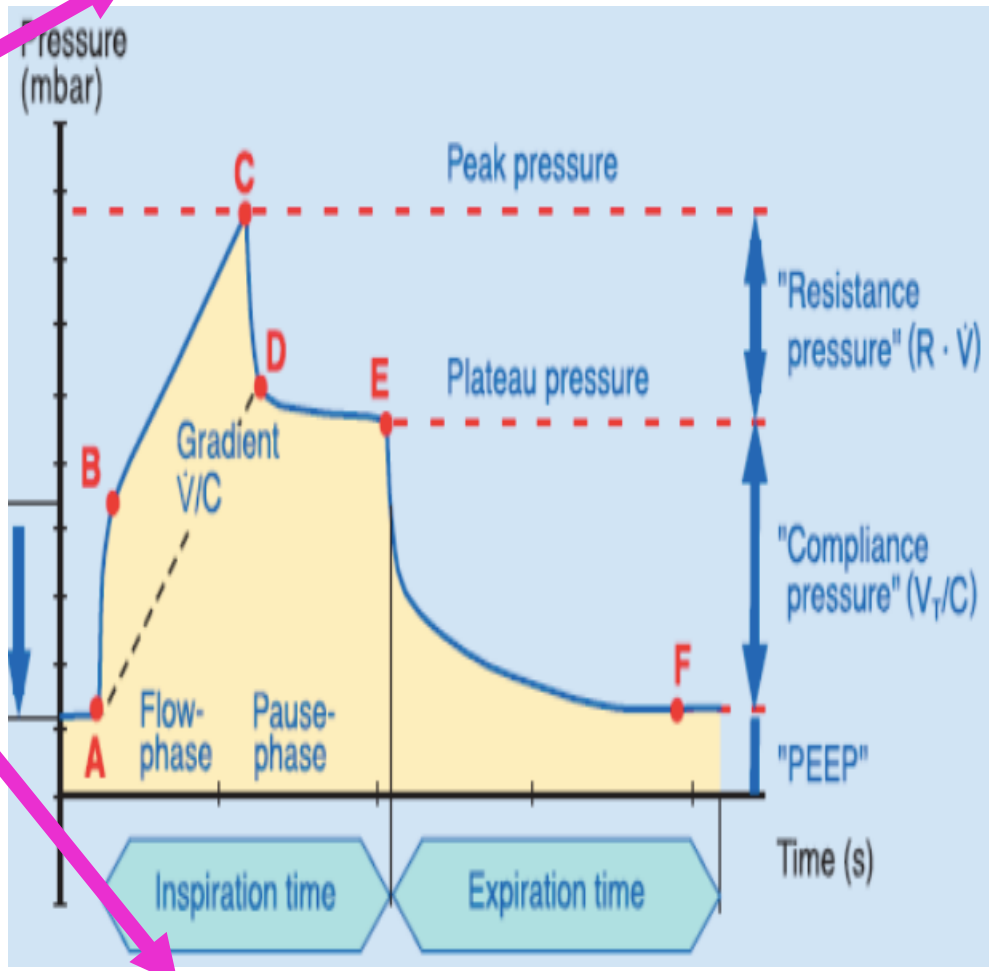
Dreyfuss D et al. Am J Respir Crit Care Med 1998; 157:294-323

Oksijenasyonu Hangi Ayarlarla İyileştirebilirim?

✓PEEP	Doğru limite kadar yüksek PEEP ?
✓ FİO2	FiO2: Başlangıçta %100, ilk düşülecek değer
✓ I/E	İNSPİRYUM ağırlıklı ayarlar (I/E:1:1,5 , 1:1,3)
✓ SS	SS: TV düşük olduğu için hedef MVV için yüksek tut
✓Akım Hızı	Değeri: 60-120 L/dakika, Daha yavaş akımlar insp uzatır, exp kısaltır

Tidal Volüm → **4-6 ml/IBW, Pplato < 30cmH2O**

- P pik: Sistemin tüm basıncı



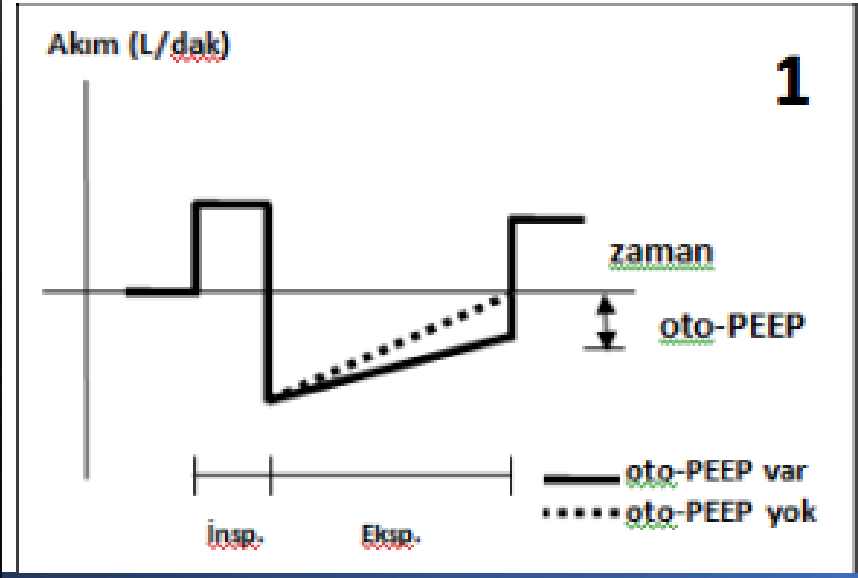
- P plato: Alveole yansıyan gerçek basınç

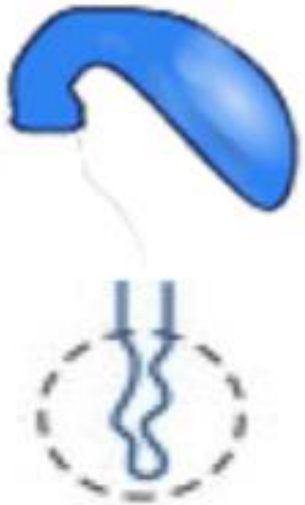
MV deki her ayar Pplato güvenli olacak şekilde yapılır
MV deki her ayar hemodinamiyi etkiler
Sadece Akciğere Bakma !

- ✓ Pplato ölçümü İnsp hold manevrası ile yapılır
- ✓ Ppik ile Pplato arasında ortalama 5-7 cm H2O fark vardır

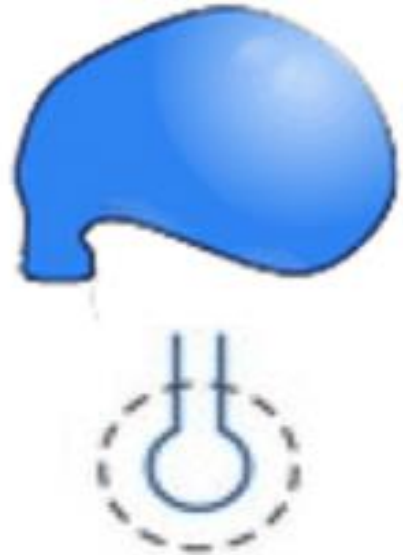
PEEP (POZİTİF END EXPİRATUAR PRESSURE

- ✓Ekspiryum sonunda havayollarına pozitif basınç uygulanması
- ✓ ARDS'de 8-20 cmH2O





End Expiration



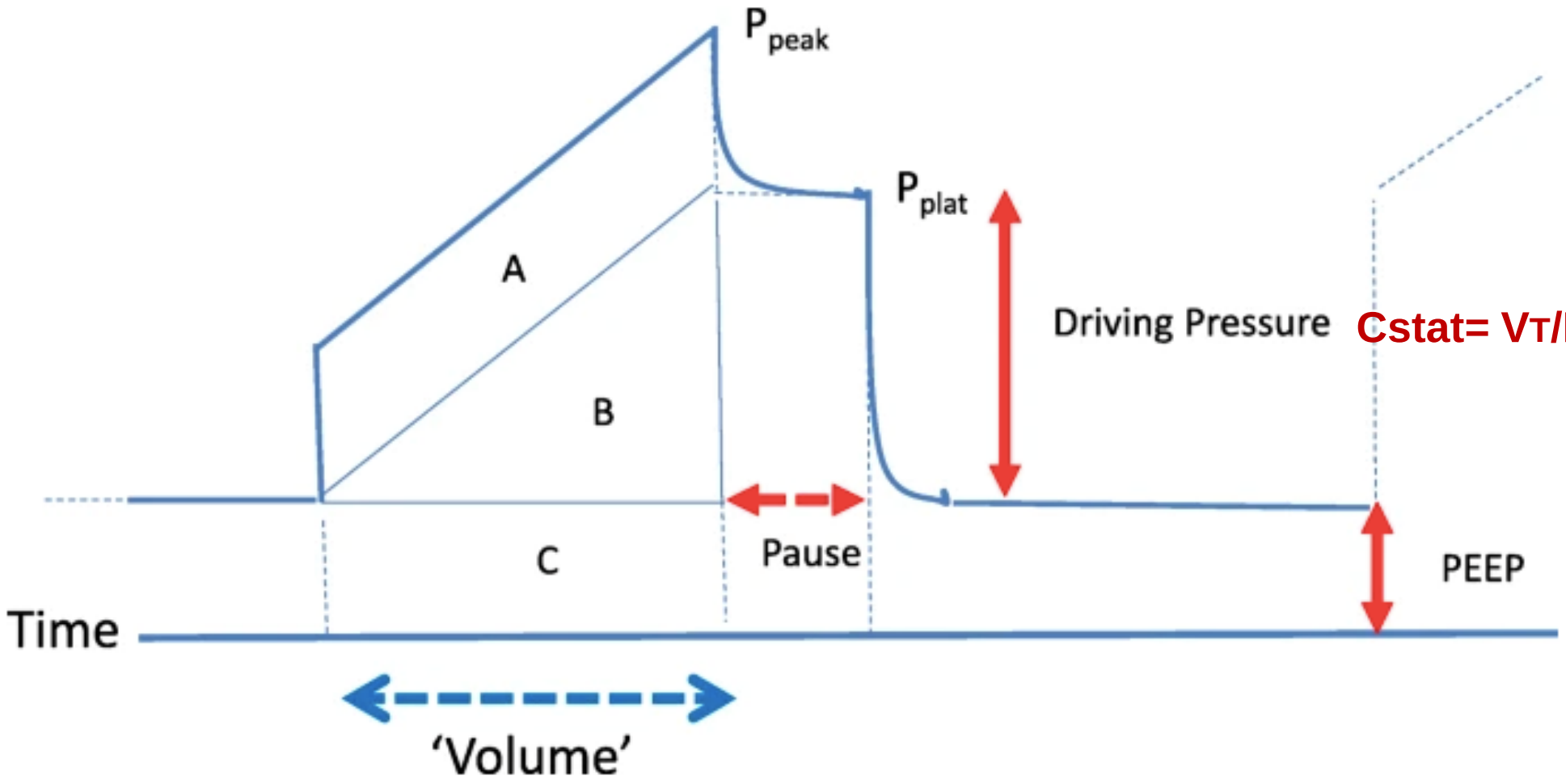
PEEP too low and alveoli collapse/atelectasis decreasing oxygen diffusion (less surface area) and more pressure will be needed to re-expand alveoli leading to atelectotrauma.

Optimal PEEP=alveoli remain open (more alveolar surface area), facilitating oxygen diffusion and less pressure needed to expand the lung.

End Inspiration

PEEP ile Hedeflenen

- ✓ Alveolar recruitment yaparak akciğer ünitelerinin stabilizayonu
- ✓ FRC artış
- ✓ Fizyolojik şantta azalma
- ✓ Arteriyel oksijenizasyonda düzelme
- ✓ Atelektazilerin azalmasıyla –VIP azalması



✓Sürücü basınç **DP (Pplato-PEEP) ≤15 cmH2O**, 4-6 ml/TV

✓Akciğeri koruma konusunda önemli bir parametre

Düşük TV, YÜKSEK PEEP → **« Permisif Hiperkapni »**

İlk Soru - Akciğer Recruitable mı?

Recruitment: Kapalı alveollerin açılması

Recruitabilite şunlara dayanır

- ARDS Tipi
  - Ekstrarespiratuar > Respiratuar
  - Non lober > lober
- Hastalığın başlangıç zamanı erken > geç başlangıçlı
- Göğüs Duvarı Kompliyansı

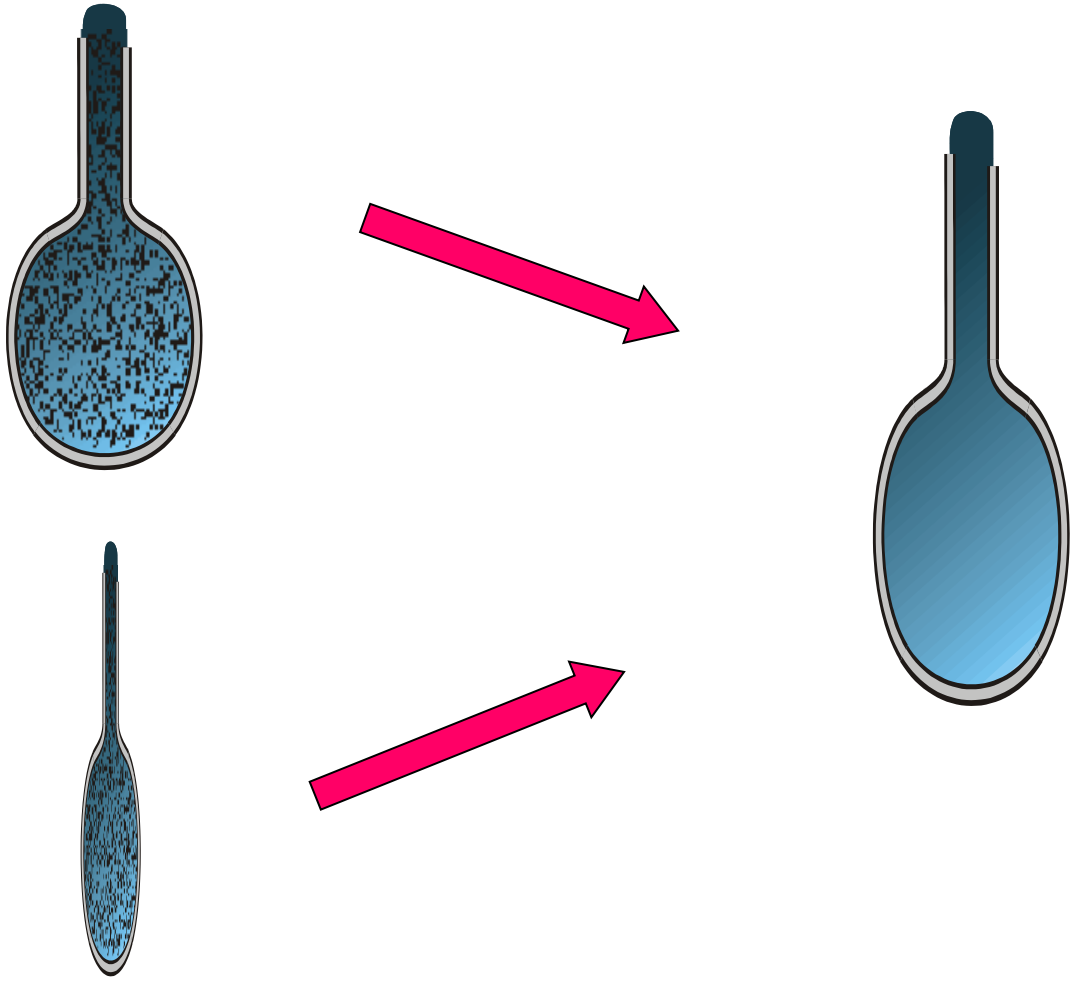
Recruitmentta amaç ?

Konsolidasyon:

Kollabe olmayan hava yollarının sıvı ile dolması

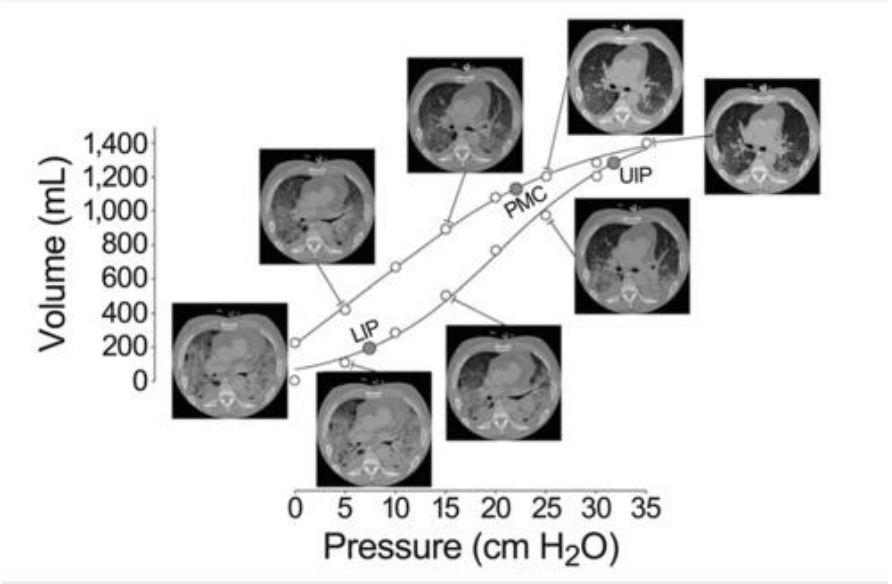
Atelektazi:

Kollabe olmuş alveoller / hava yolları



Recruitabilite Değerlendirilmesi

- **Altın standart: CT scan**



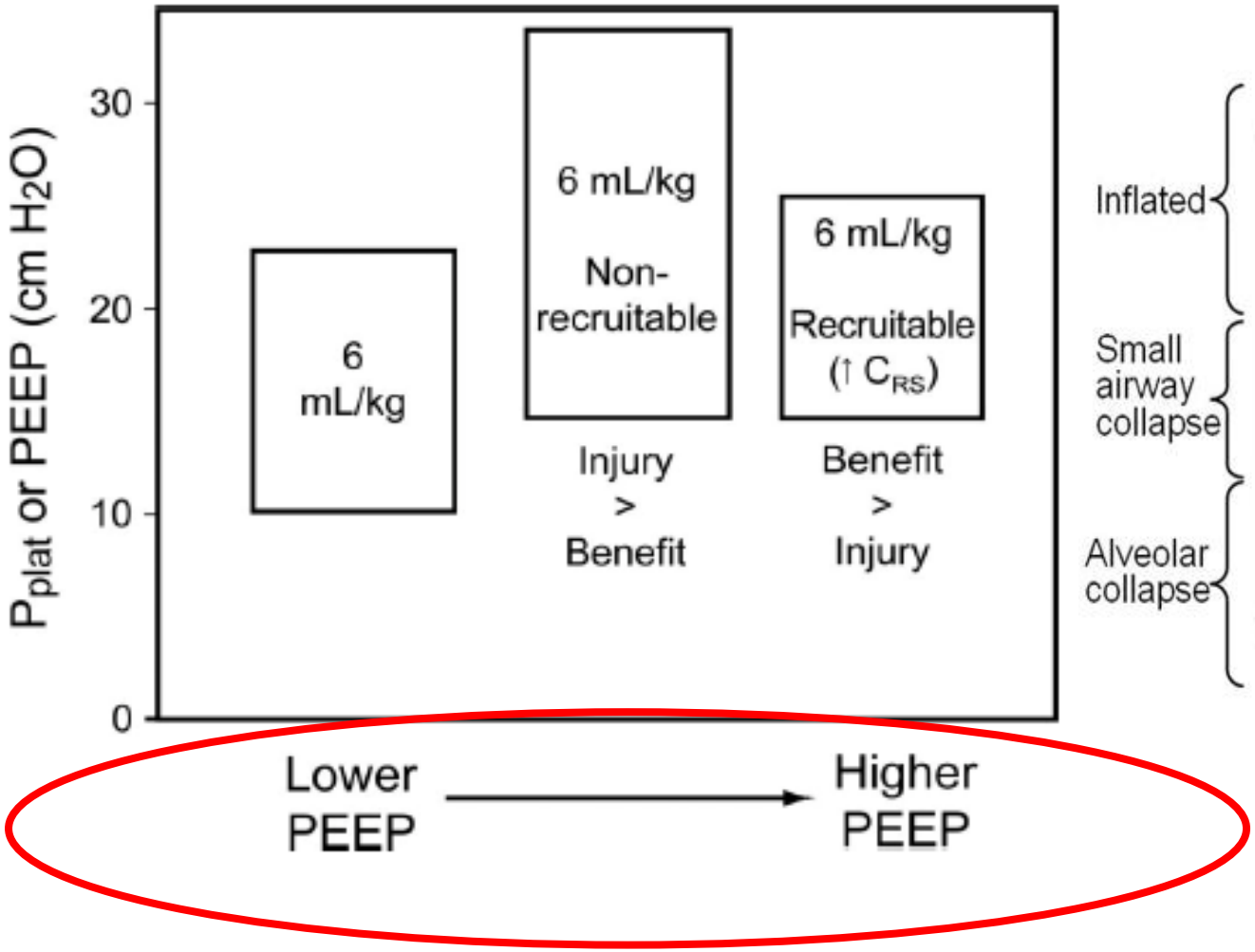
- Diğer görüntüleme yöntemleri: Akciğer ultrasonografisi, EIT*

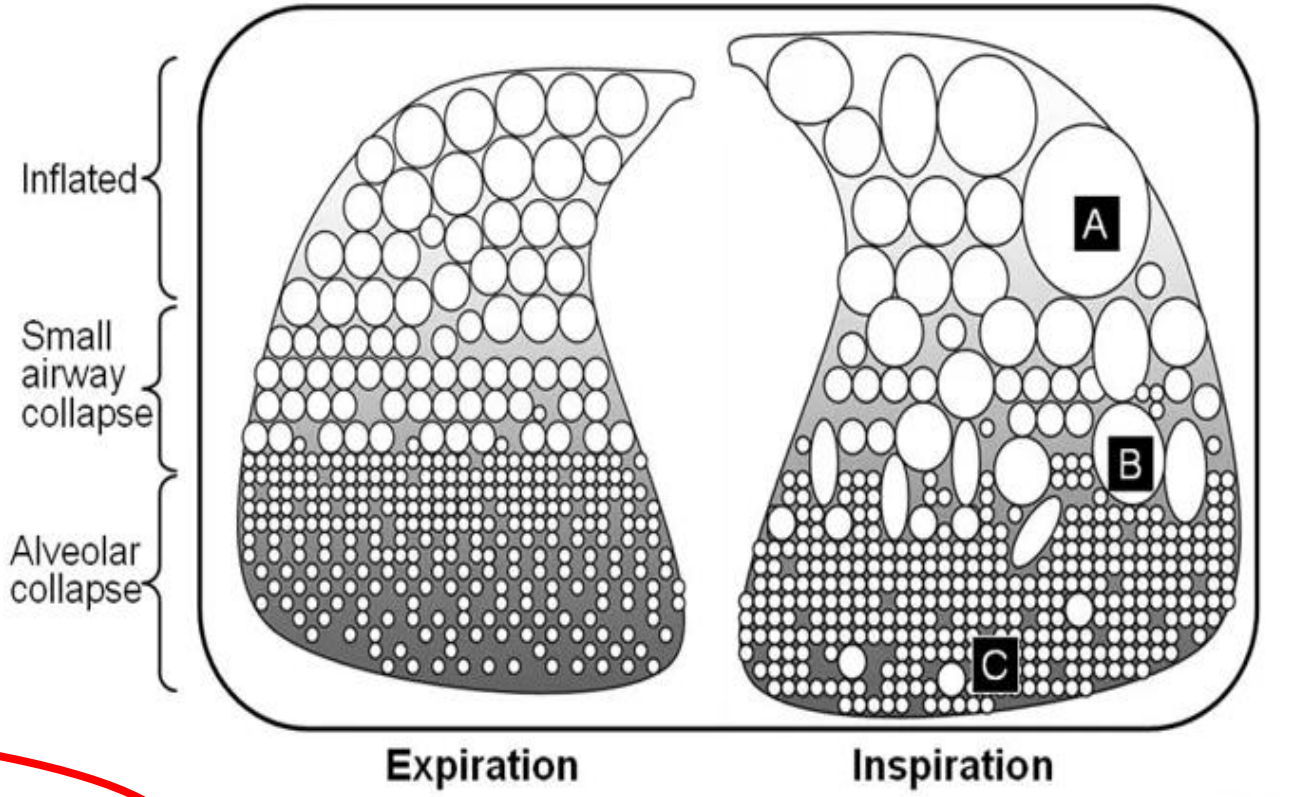
- Yatak başı değerlendirme yöntemi: PV curve

**Mongodi S et al. Intesive Care Med 2016, May; 42(5): 912-3*
**Le Neindre A et al. J Crit Care 2016 Feb; 31(1): 101-9*

Recruitment Maneuvers and PEEP Titration

Dean R Hess PhD RRT FAARC





PEEP’i nasıl ayarlayalım?

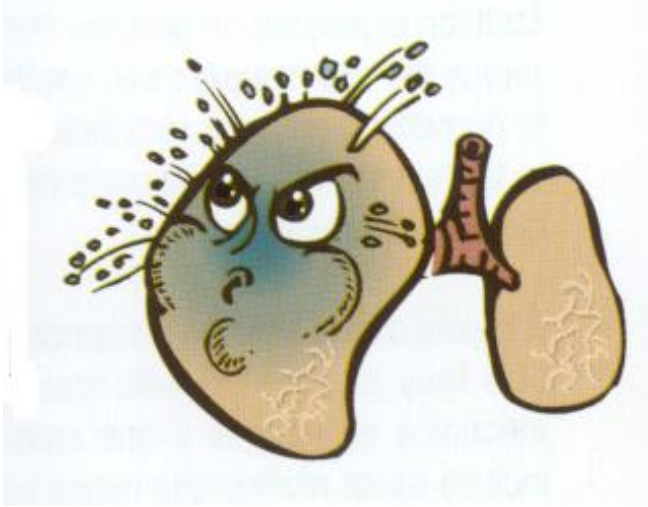


Table 2. Methods for Setting PEEP in Patients With ARDS

Gas exchange
Compliance
Pressure-volume curve
Stress index
Esophageal manometry
Lung volume
Imaging

- Önceden expanse olmuş alveollerin kapanmasını/derecruitmentını önler

Gaz değişimine göre PEEP Ayarı

- ✓ **Her 5-10 dk da bir PEEP düzeyinde kademeli 2 cmH2O artış**
- ✓ **Her artışta** Pplato ölç < 30 mmHg olacak şekilde
- ✓ DP takip edilebilir (Pplat-PEEP)

- ✓ **Vt 6 ml/PBW, en kısa sürede ilk olarak FiO2 <60 olması hedeflenir**

- ✓ **ARDS hastalarında 1 saatten daha uzun süre kalıcı pH <7.20 SS ve TV 8 (mL / kg) kadar arttırılır**

- ✓ **Oksijenasyonda iyileşme yok, hemodinamik olarak instabilte var ise yüksek PEEP stratejisi önerilmiyor**

Gaz değişimine göre PEEP Ayarı

PEEP titrasyonu ile ölü boşluk ventilasyonunda artış!!

Permisif hiperkapni

Venoz donuste azalma

Kardiyak output'ta azalma

Endtidal CO2 takibi

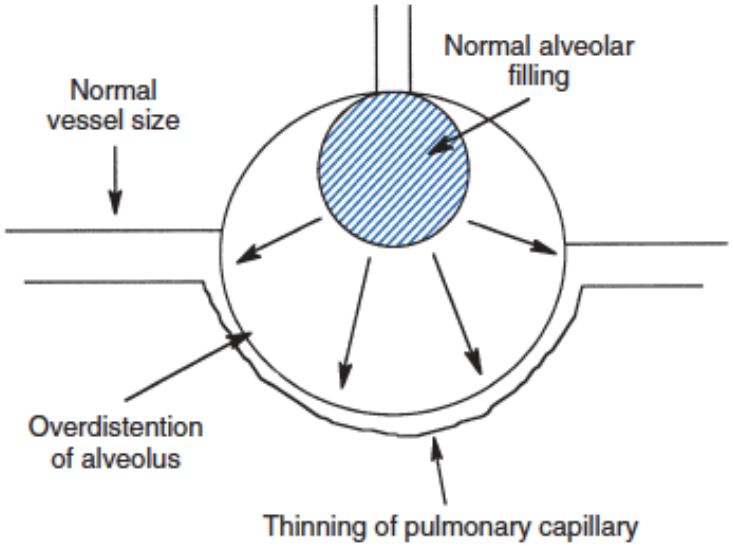
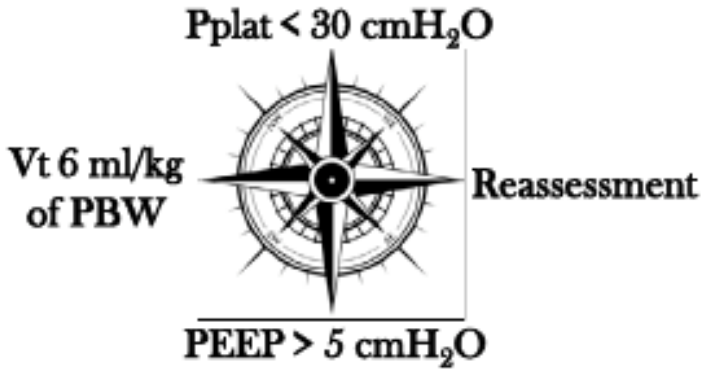


Fig. 16-3 Overfilling of an alveolus. The result is thinning and compression of the pulmonary capillary. Pulmonary vascular resistance is increased.

Lower PEEP/Higher F_{IO_2}														
F_{IO_2}	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18–24

Higher PEEP/Lower F_{IO_2}															
F_{IO_2}	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	0.9	1.0	1.0
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22	22	24

Early management of ARDS in 2019



P/F < 80 — Discuss VV-ECMO

P/F < 150 — Neuromuscular blockers
Prone positioning

P/F < 200 — High level of PEEP if improves oxygenation

Tidal volume about 6 ml/kg of PBW
Plateau pressure < 30 cmH_2O
PEEP > 5 cmH_2O
Check for hypercapnia

Confirmed ARDS

Initiation of invasive mechanical ventilation with sedation in ICU

Tidal volume (Vt) about 6 ml/kg of PBW in the absence of severe metabolic acidosis

Systematic screening for ARDS diagnosis criteria

ARDS severity

Reassessment of ventilator settings and of the management strategy at least every 24h

Veno-venous ECMO
- ❑ In case of refractory hypoxemia or when protective ventilation can not be applied
- ❑ To be discussed with experienced ECMO centres

Neuromuscular blockers: continuous intravenous infusion
- ❑ Early initiation (within the first 48h of ARDS diagnosis)

Prone positioning methods :
- ❑ Applied for >16h a day, for several consecutive days

Moderate or severe ARDS -> High PEEP test (> 12 cmH_2O)
Use high levels if:
- ❑ Oxygenation improvement
- ❑ Without hemodynamic impairment or significant decrease in lung compliance
- ❑ Maintain Pplat < 30 cmH_2O, continuous monitoring

ARDS diagnosis criteria
- ❑ $PaO_2/FiO_2 \leq 300$ mmHg
- ❑ PEEP ≥ 5 cmH_2O
- ❑ Bilateral opacities on chest imaging
- ❑ Not fully explained by cardiac failure or fluid overload
- ❑ Within a week of a known clinical insult

Might be applied
- ➢ Inhaled Nitric Oxide (iNO), when severe hypoxemia remains despite prone positioning and before considering VV-ECMO
- ➢ Partial ventilation support after early phase to generate tidal volume about 6 ml/kg and less than 8 ml/kg

No recommendation could be made
- ➢ $ECCO_2R$
- ➢ Driving pressure
- ➢ Partial ventilation support at the early phase

Should probably not be done
- ➢ Systematic recruitment maneuvers

Should not be done
- ➢ HFOV

TV Ayarlanması	• Hafif ARDS dahil, ciddi metabolik asidoz yokluğunda mortaliteyi azaltmak için 6 ml/kg PBW TV
Plato Basıncı	• TV 6 ml/kg iken P plato sürekli monitörize edilerek < 30 cmH2O tutulmalı • Persistan hiperkapni vakaları dışında P-plato <30 ise TV arttırılması önerilmez
PEEP	• >5 cmH2O PEEP önerilmekte, yüksek PEEP orta ve ağır ARDS dışında önerilmiyor • Oksijenasyonda iyileşme ve SS kompliyansında düzelme varsa yüksek PEEP korunmalıdır
NM Blokaj	• PaO2/ FiO2 <150 ise ilk 48 saat, infüzyon şeklinde
Prone	• PaO2/ FIO2 < 150, peşpeşe 16 saatlik seanslar şeklinde mortaliteyi azaltır
ECMO	• PaO2/ FiO2 < 80, diğer yöntemler tehlike arz ediyor ve düzelme sağlanmıyorsa

PROTECTIVE VENTILATION NETWORK

ARDS'DE KORUYUCU MEKANİK VENTİLASYON

PaO2/FiO2 <150

Low Vt
4-6 ml/kg PBW

Minimal RR pH> 7.25

Düşük Plato basıncı < 27 cmH2O
Düşük driving pressure <13-15 27 cmH2O
Minimal PEEP (11-15 cm H2O)
Minimal SO2 (88-92)
Recruitment manevrası (sadece kurtarıcı olarak)

MP <17-20J/dk

Prone en azından 12 saat

NMB sadece ihtiyaç duyulduğunda

PaO2/FiO2 >150

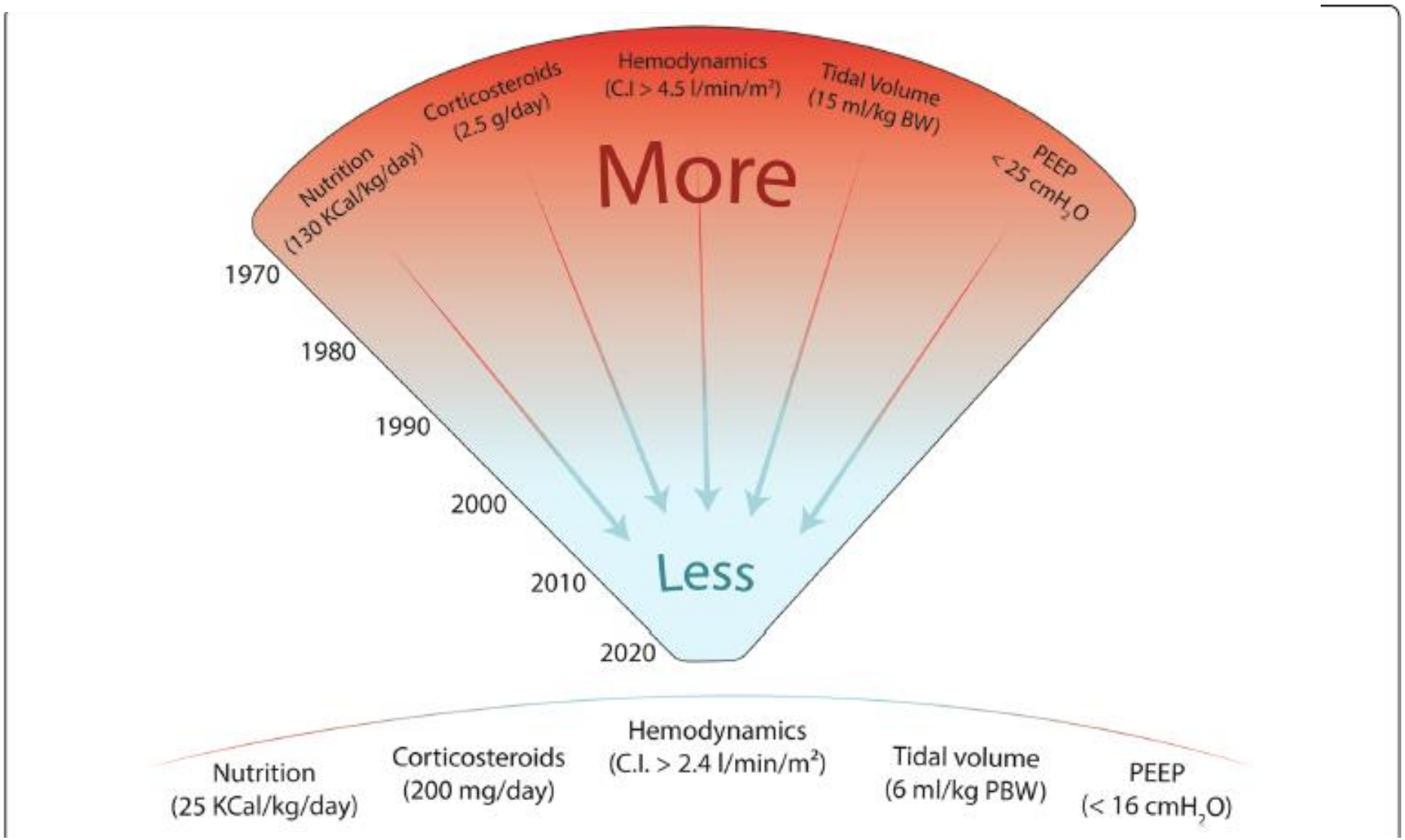
NIV < 10 ml/kg PBW

Asiste Ventilasyon
PEEP 5-10 cmH2O

$$Energy_{,RS} = \underbrace{\Delta V^2 \times [(0.5 \times E_{,RS}}_{\text{Elastic Component}} + \underbrace{RR \times (1 + I{:}E)/60 \times I{:}E \times Raw)}_{\text{Resistive Component}} + \underbrace{\Delta V \times PEEP]}_{\text{PEEP Volume}}$$

“Less is More” in mechanical ventilation

Luciano Gattinoni[1*], Michael Quintel[1] and John J. Marini[2]



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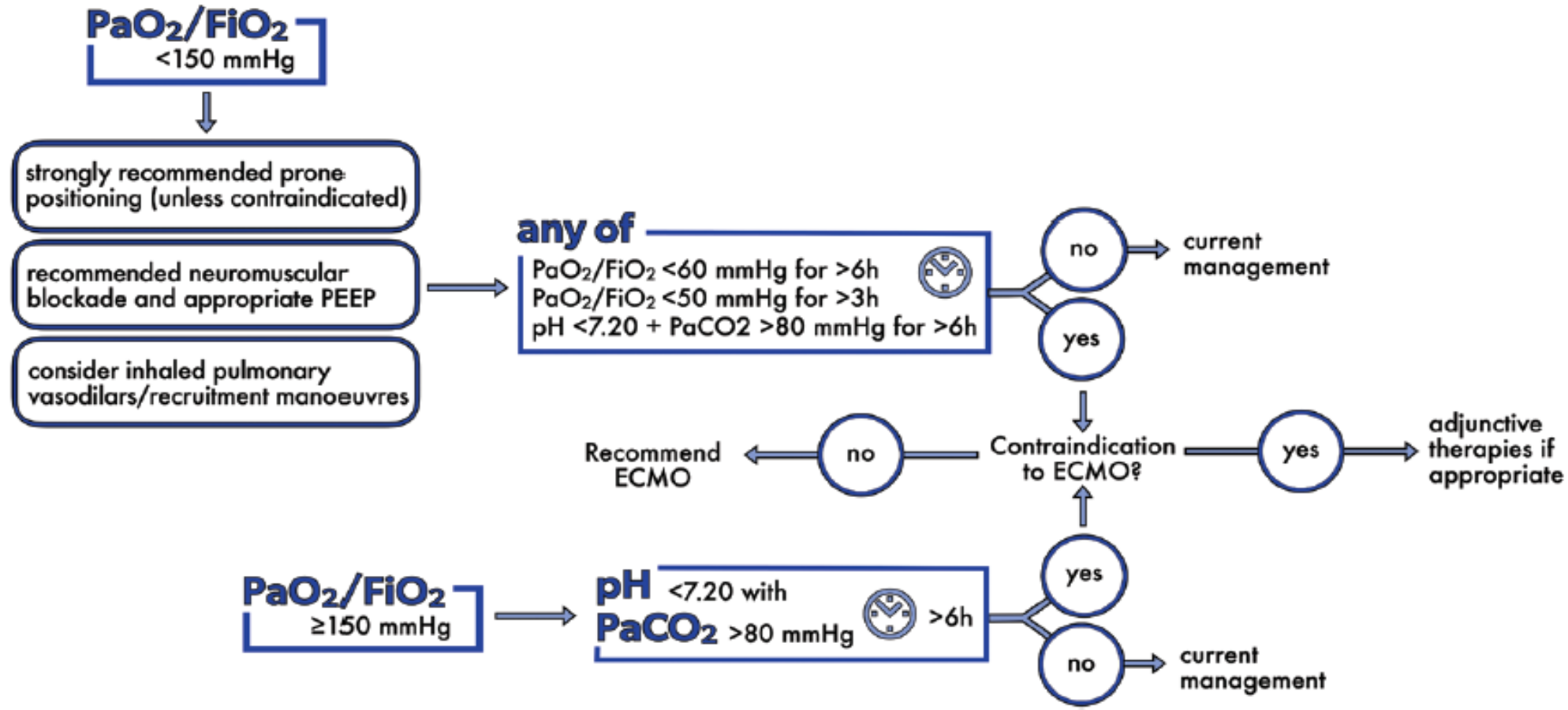


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