ARDS and Respiratory Management

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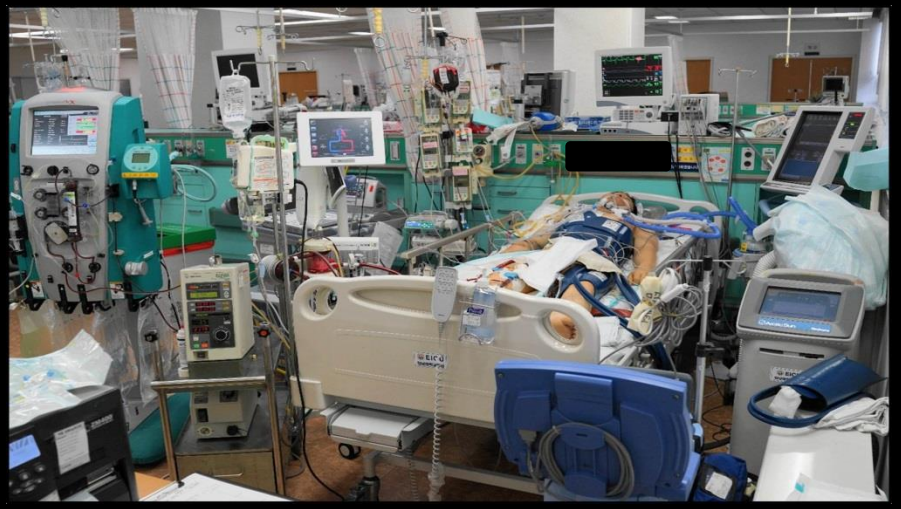
Who receive respiratory care ?

- Acute respiratory failure
- Major post-operative state
- Pneumonia
- Congestive heart failure
- Sepsis
- Trauma
- Acute respiratory distress syndrome (ARDS)



Dawn age

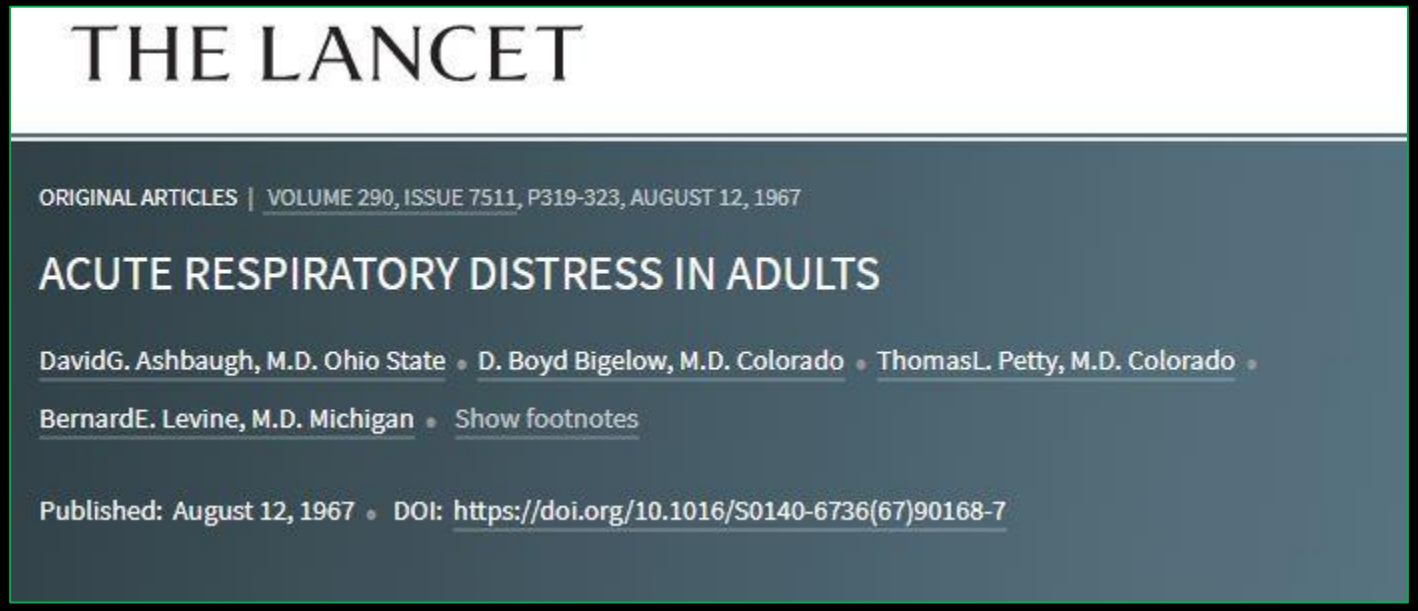
- 1928: noninvasive negative-pressure ventilator widely used during the polio
- 1949: John Haven Emerson developed a mechanical assister for anesthesia
- 1971: first SERVO 900 ventilator
- 1982: Dräger developed monitoring the patient's breathing curve on the monitor

In Korea

- In Korean ICU : ARDS ??, pneumonia 29.1%
- Intubated patients : VAP incidence (3 -10 folds)
- Overall hospital mortality : 40.0%
- Management of Severe sepsis in Asia's Intensive Care Units (MOSAICS) : mortality – 57%
- Socioeconomic cost : 28%

Korean J Healthc Assoc Infect Control Prev 2016;21(2):37-49.

Beginning



THE LANCET

ORIGINAL ARTICLES | VOLUME 290, ISSUE 7511, P319-323, AUGUST 12, 1967

ACUTE RESPIRATORY DISTRESS IN ADULTS

DavidG. Ashbaugh, M.D. Ohio State • D. Boyd Bigelow, M.D. Colorado • ThomasL. Petty, M.D. Colorado • BernardE. Levine, M.D. Michigan • Show footnotes

Published: August 12, 1967 • DOI: https://doi.org/10.1016/S0140-6736(67)90168-7

- 12 Patients (Trauma:7, Viral Pneumonia:4, Pancreatitis:1)
- Symptom
  - Tachypnea, cyanosis
  - Decreased lung compliance
  - Diffuse infiltrate on CXR

Definition

	AECC Definition	AECC Limitations	Addressed in Berlin Definition
Timing	Acute onset	No definition of acute[4]	Acute time frame specified
ALI category	All patients with PaO_2/FIO_2 <300 mm Hg	Misinterpreted as PaO_2/FIO_2 = 201-300, leading to confusing ALI/ARDS term	3 Mutually exclusive subgroups of ARDS by severity ALI term removed
Oxygenation	PaO_2/FIO_2 ≤300 mm Hg (regardless of PEEP)	Inconsistency of PaO_2/FIO_2 ratio due to the effect of PEEP and/or FIO_2[5-7]	Minimal PEEP level added across subgroups FIO_2 effect less relevant in severe ARDS group
Chest radiograph	Bilateral infiltrates observed on frontal chest radiograph	Poor interobserver reliability of chest radiograph interpretation[8,9]	Chest radiograph criteria clarified Example radiographs created[a]
PAWP	PAWP ≤18 mm Hg when measured or no clinical evidence of left atrial hypertension	High PAWP and ARDS may coexist[10,11] Poor interobserver reliability of PAWP and clinical assesments of left atrial hypertension[12]	PAWP requirement removed Hydrostatic edema not the primary cause of respiratory failure Clinical vignettes created[a] to help exclude hydrostatic edema
Risk factor	None	Not formally included in definition[4]	Included When none identified, need to objectively rule out hydrostatic edema

JAMA. 2012;307:2526-33.

Classification

	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

JAMA. 2012;307:2526-33.

Risk factor

Direct lung injury	Indirect lung injury
• Pneumonia	• Sepsis
• Aspiration	• Severe trauma
• Inhalation injury	• Massive transfusion
• Pulmonary contusion	• Severe burn
• Fat emboli	• Drug
• Drowning	• Acute pancreatitis

Differential diagnosis

- Cardiogenic pulmonary edema
- Diffuse pneumonia
- Alveolar hemorrhage
- Pulmonary embolism
- Transfusion reaction
  - Transfusion related acute lung injury (TRALI)
  - Transfusion-associated circulatory overload (TACO)

Differential diagnosis

Fea	*Pneumonia*	*ARDS*	iogenic lema
	(At least three of the following must be present)	***(All three must be present)***	
Acute	Leukocytosis (WBC>10000/mm^3 or <3000/mm^3	$PaO_2/FiO_2 = 200$	O
Fever	Fever (>38.5° C)	Pan Pulmonic infiltration	△
Bilater involve	Purulent sputum	Pulmonary wedge pressure ≤ 20 mmHg	O
Decre P/F ra	Persistent infiltrate on Chest X-ray (>48 hours)		X
BNP	Pathogenic bacteria from endotracheal aspirate		) pg/mL

Definition established by the American and European Consensus Conference Guidelines for the Diagnosis of Pneumonia and ARDS.
ARDS: Acute respiratory distress syndrome, WBC: White blood cells

Cause

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- A

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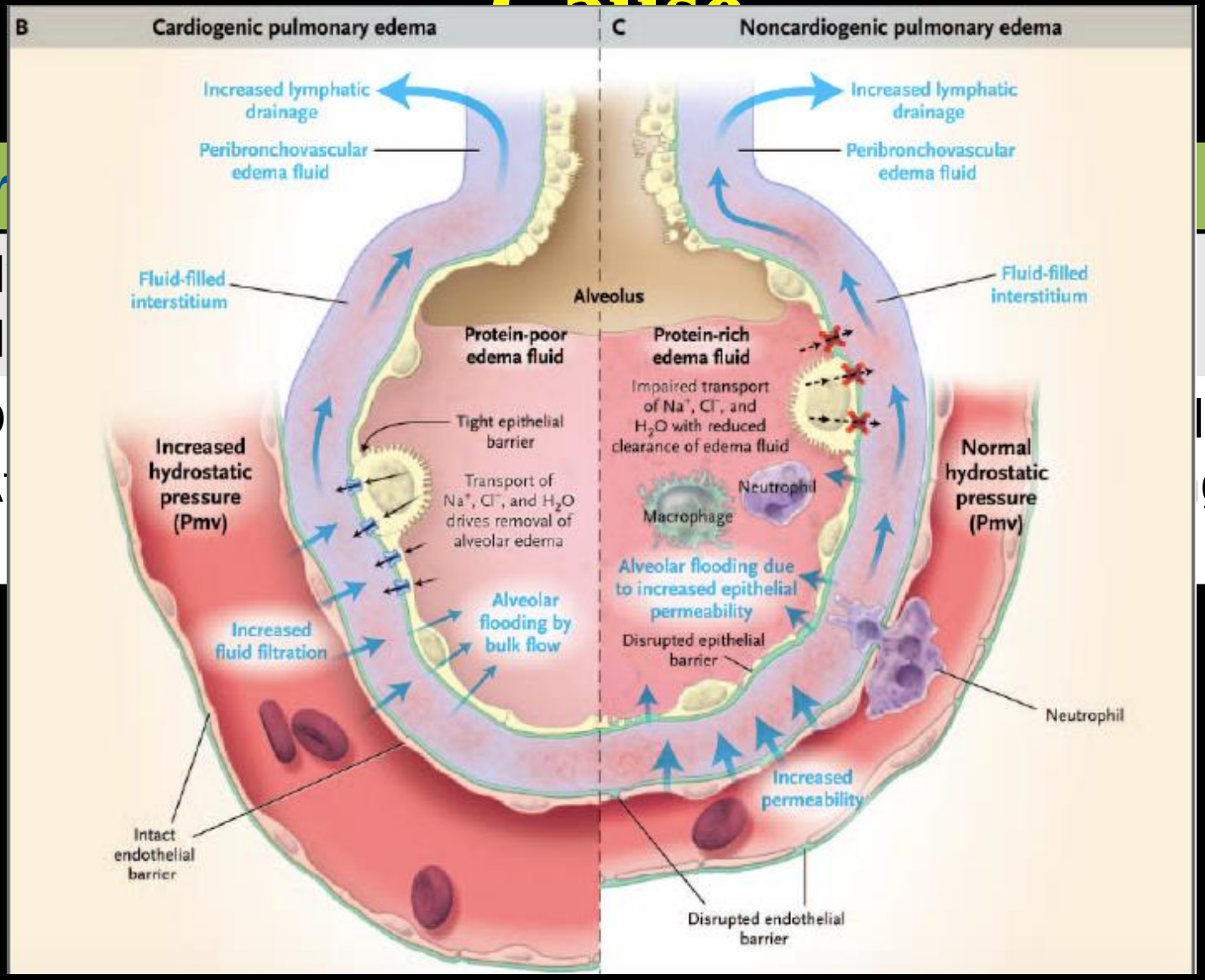


Permeability edema : refractory hypoxemia

N Engl J Med 2000;342:1334-49.

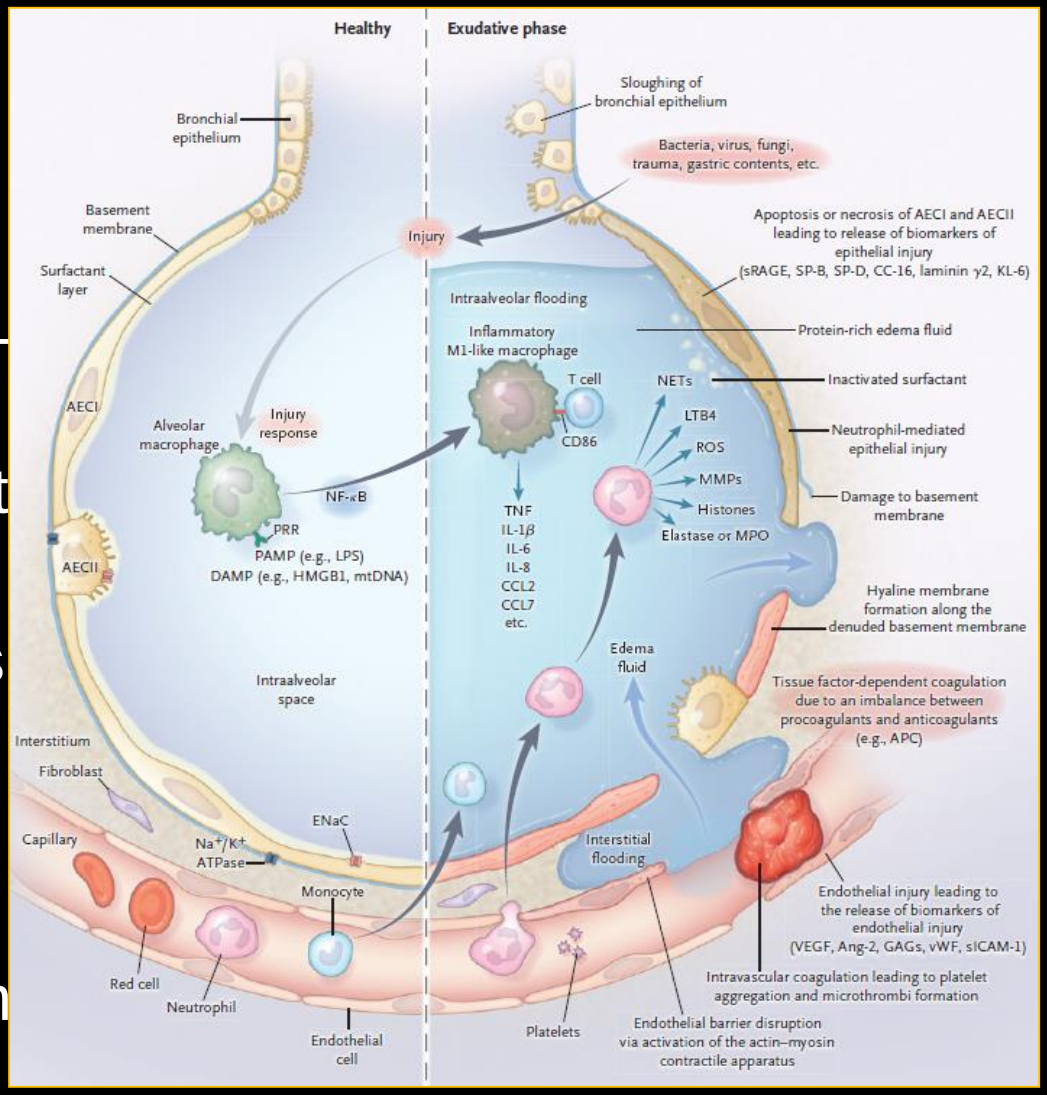
Course

- Exudative phase (onset – 7 days)
  - Edema
  - Hyaline membrane formation
- Proliferative phase (7 – 21 days)
  - Interstitial Inflammation
- Fibrotic phase (21 days -)
  - Fibrosis

N Engl J Med. 2017;377:562-72.

Early stage

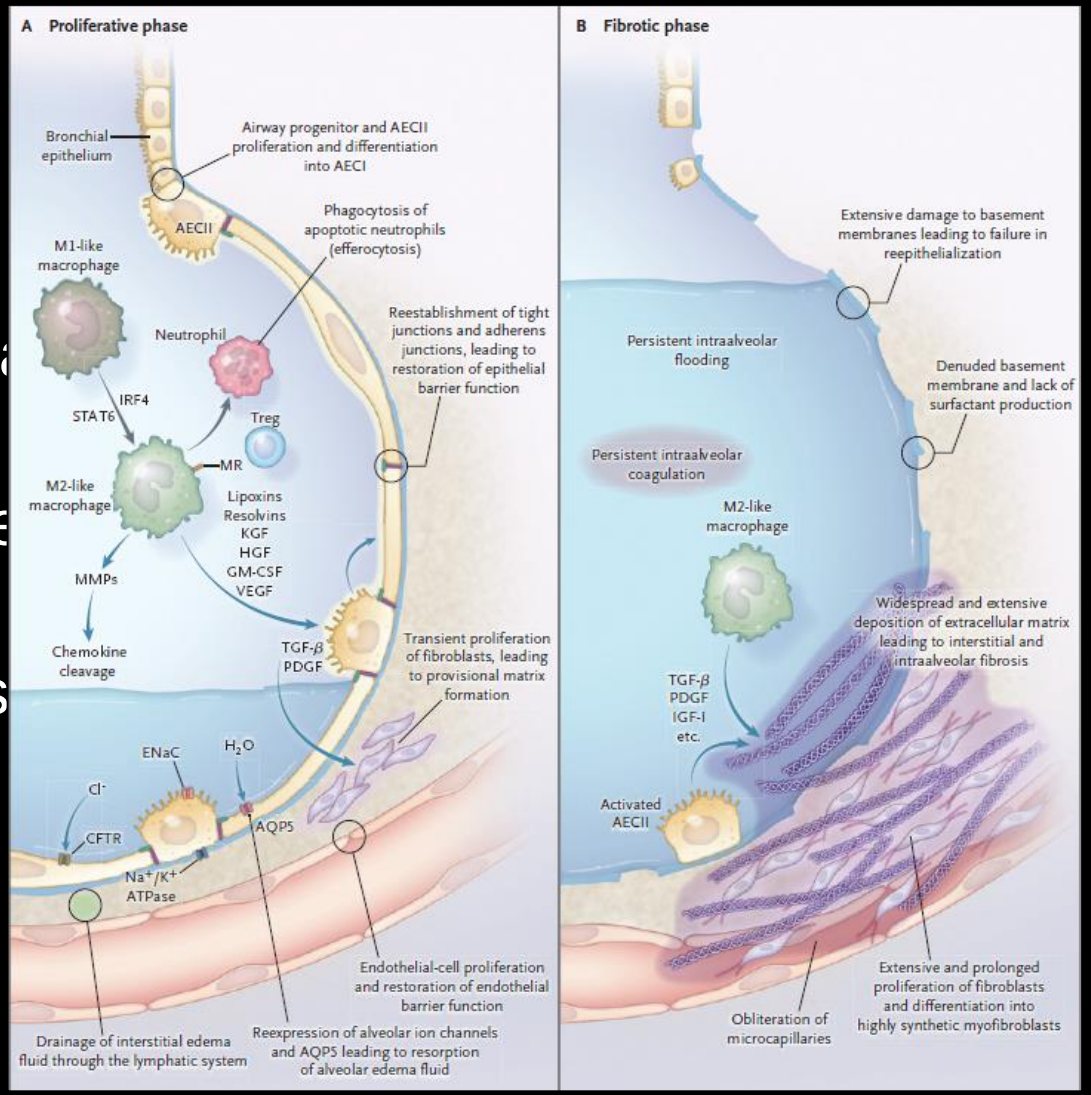
- Pulmonary edema
- Cytokines (TNF, IL-1, IL
- Reduction and inactivat
- Widespread atelectasis
- Structure damage
- Edema fluid into the lun



N Engl J Med. 2017;377:562-72.

Advanced stage

- Chronic inflammation
- Cellular infiltration of a
- Fibrosis of alveolar se
- Traction bronchiectas
- Alveolar duct fibrosis



N Engl J Med. 2017;377:562-72.

Diagnosis

- Clinical criteria
  - Parameters
  - Onset timing
- BAL
  - ARDS > neutrophil > 80%
  - Protein (lavage/serum) <0.5 = Hydrostatic edema
  - Protein (lavage/serum) >0.7 = Lung inflammation
- Lung ultrasound

Murray score

- Mu
  - _
  - _
  - _
  - _
  - _
- Dis
  - _
  - _

Murray score

= average score of all 4 parameters

Parameter / Score	0	1	2	3	4
PaO2/FIO2 (On 100% Oxygen)	≥300mmHg ≥40kPa	225-299 30-40	175-224 23-30	100-174 13-23	<100 <13
CXR	normal	1 point per quadrant infiltrated			
PEEP	≤5	6-8	9-11	12-14	≥15
Compliance (ml/cmH2O)	≥80	60-79	40-59	20-39	≤19

Ann Intensive Care. 2014; 4: 4.

Barrier

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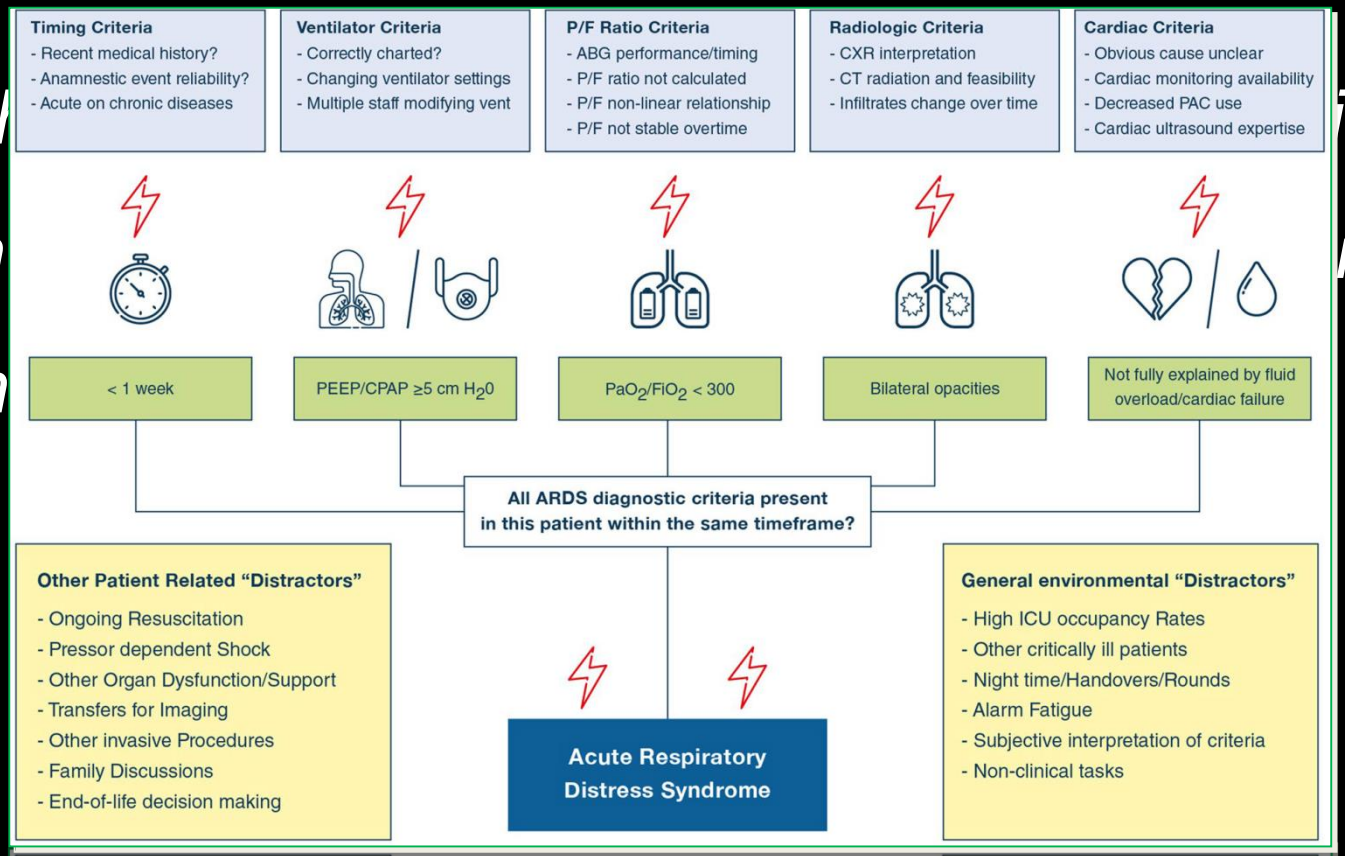
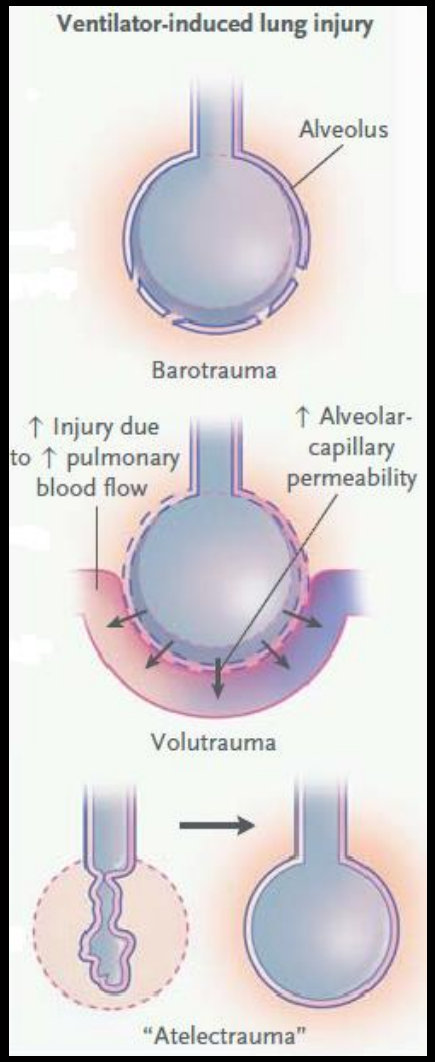


Intensive Care Med. 2020 Jun;46(6):1180-3.

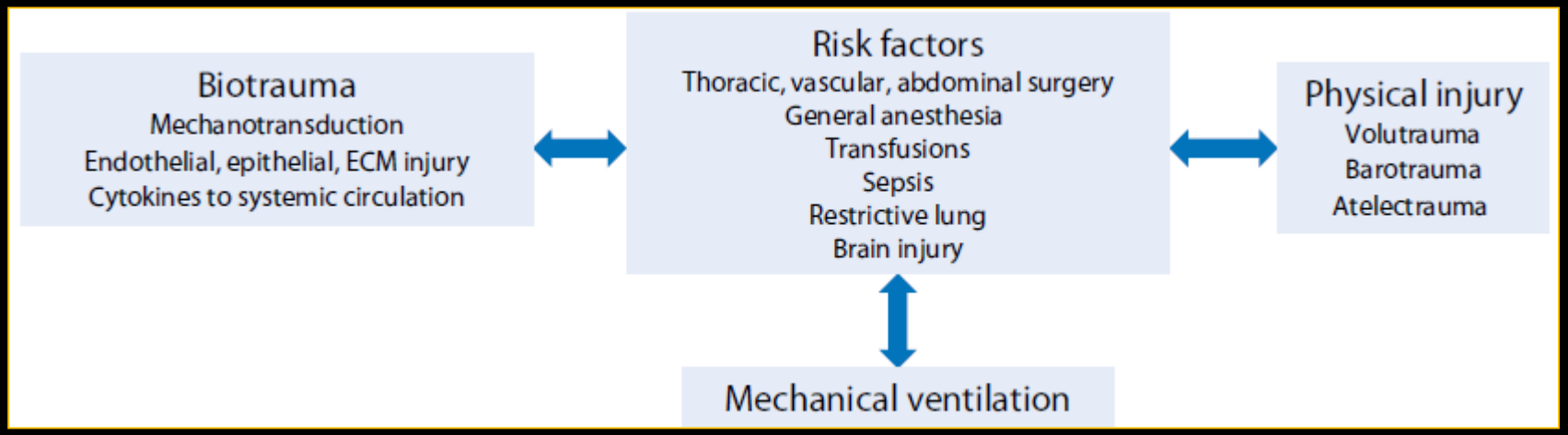
Problems



- Barotrauma
- Volutrauma
- Atelectrauma
- Biotrauma
- Oxygen

VILI

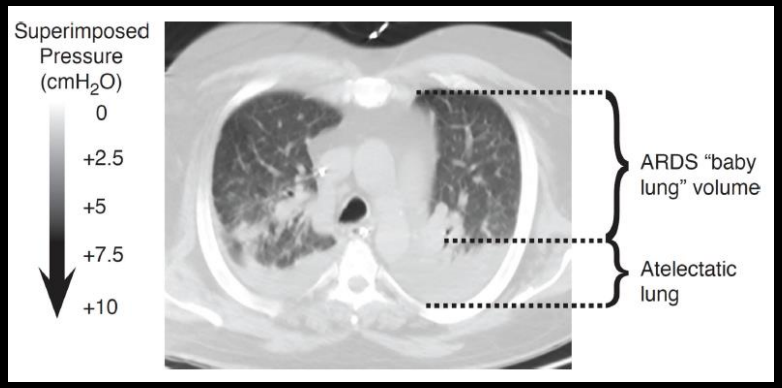
- Barotrauma
  - High inspiratory pressure induced lung injury
- Volutrauma
  - High tidal volume
  - Alveolar overdistension

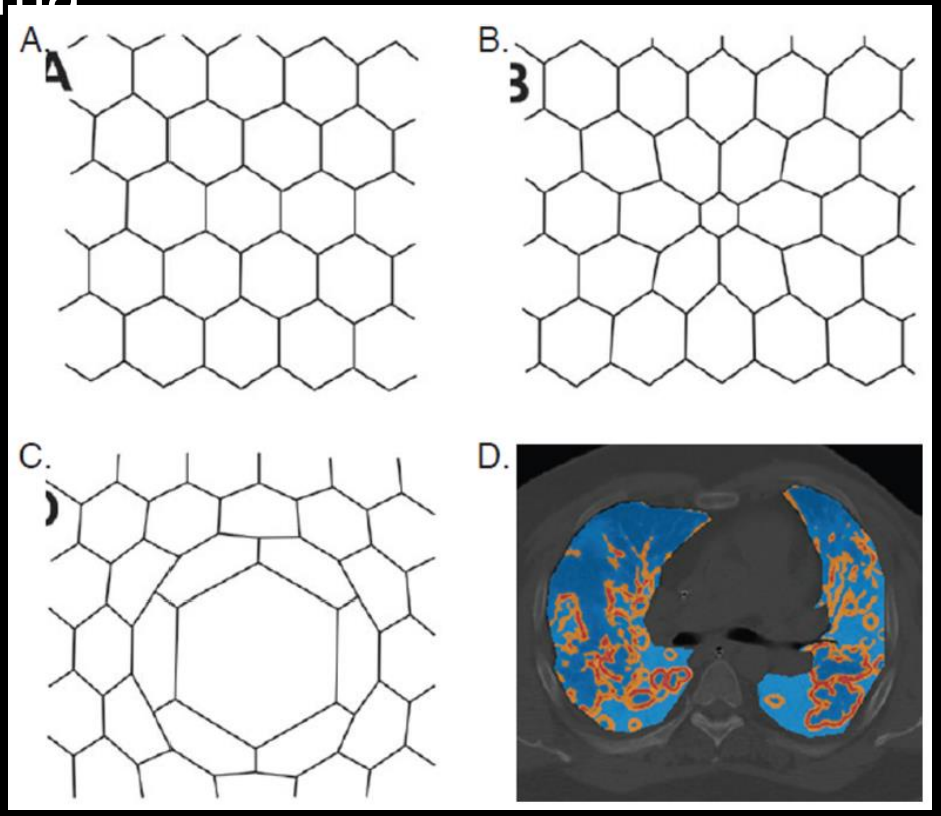


Critical Care 2014.18:211.

Atelectrauma

- Repeated opening & closing of collapsed lung units
- May be safer than volutrauma
- Cyclic atelectasis
  - shear stress
  - surfactant alteration

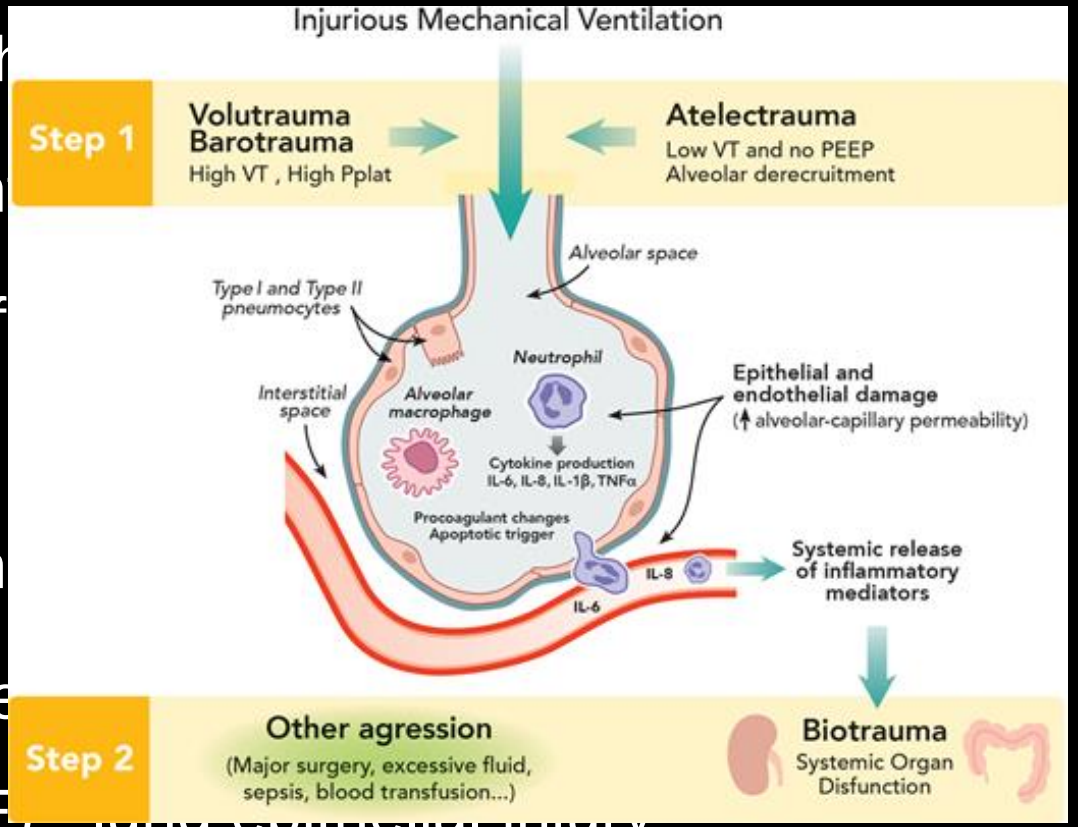




Intensive Care Med. 2017 May;43(5):603-11.

Biotrauma

- High TV, alveolar epith
- Regional release of in
- Systemic activation of proteases
- Non-pulmonary organ
- Biomarker: the soluble end-products (sRAGE) - lung epithelial injury

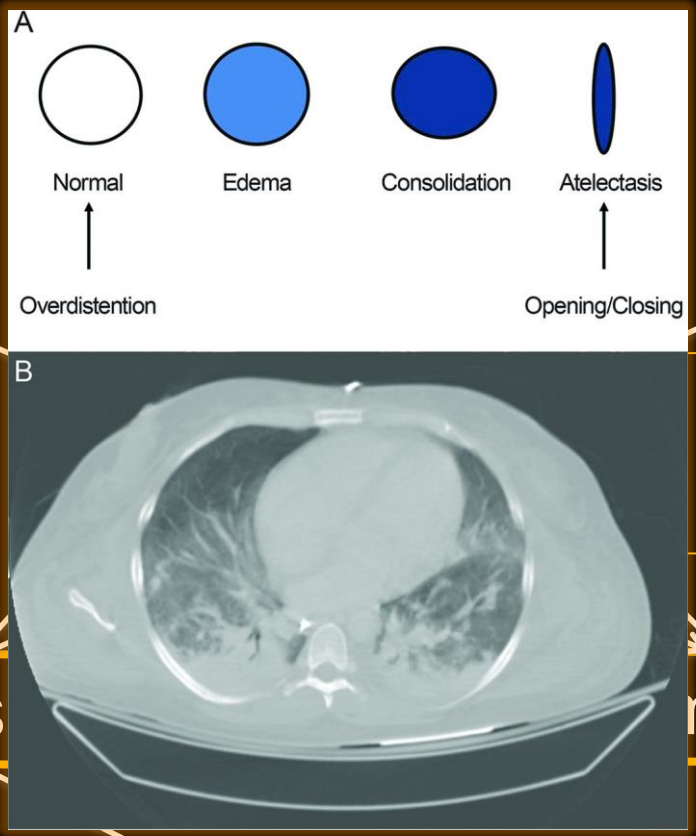


Crit Care Med. 2019 Nov;47(11):1505-12.

Pathophysiology

Lung edema

Atelectasis



Pulmonary vasoconstriction

V/Q mis

npliance ↓

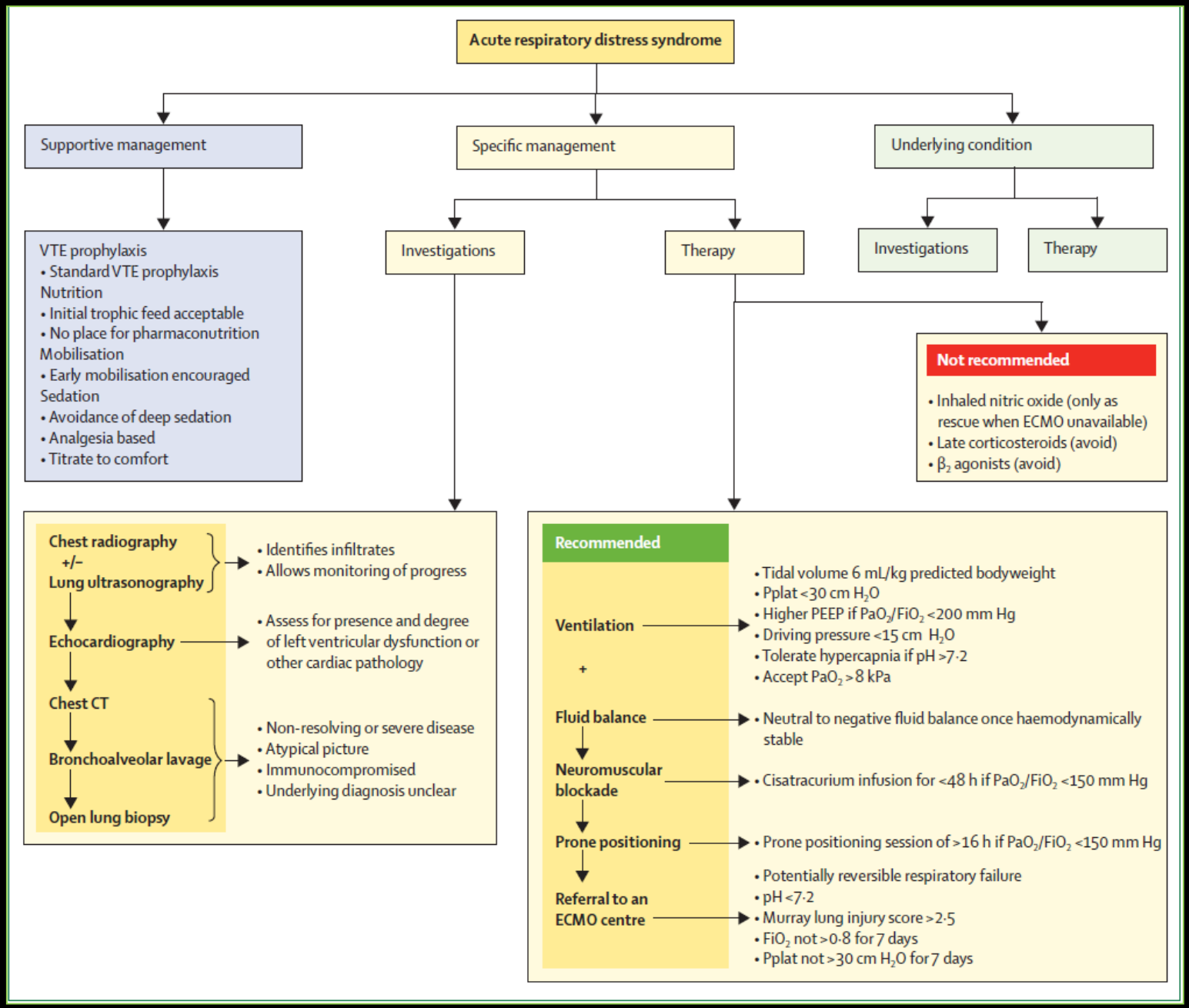
Hypoxemia

Respir Care. 2015 Nov;60(11):1688-704.

Treatment

- Improving Gas exchange
- Fluid management
- Nutrition support
- Avoid secondary injury
- Prevention of complication
- Control of underlying disease
  - Pneumonia, sepsis

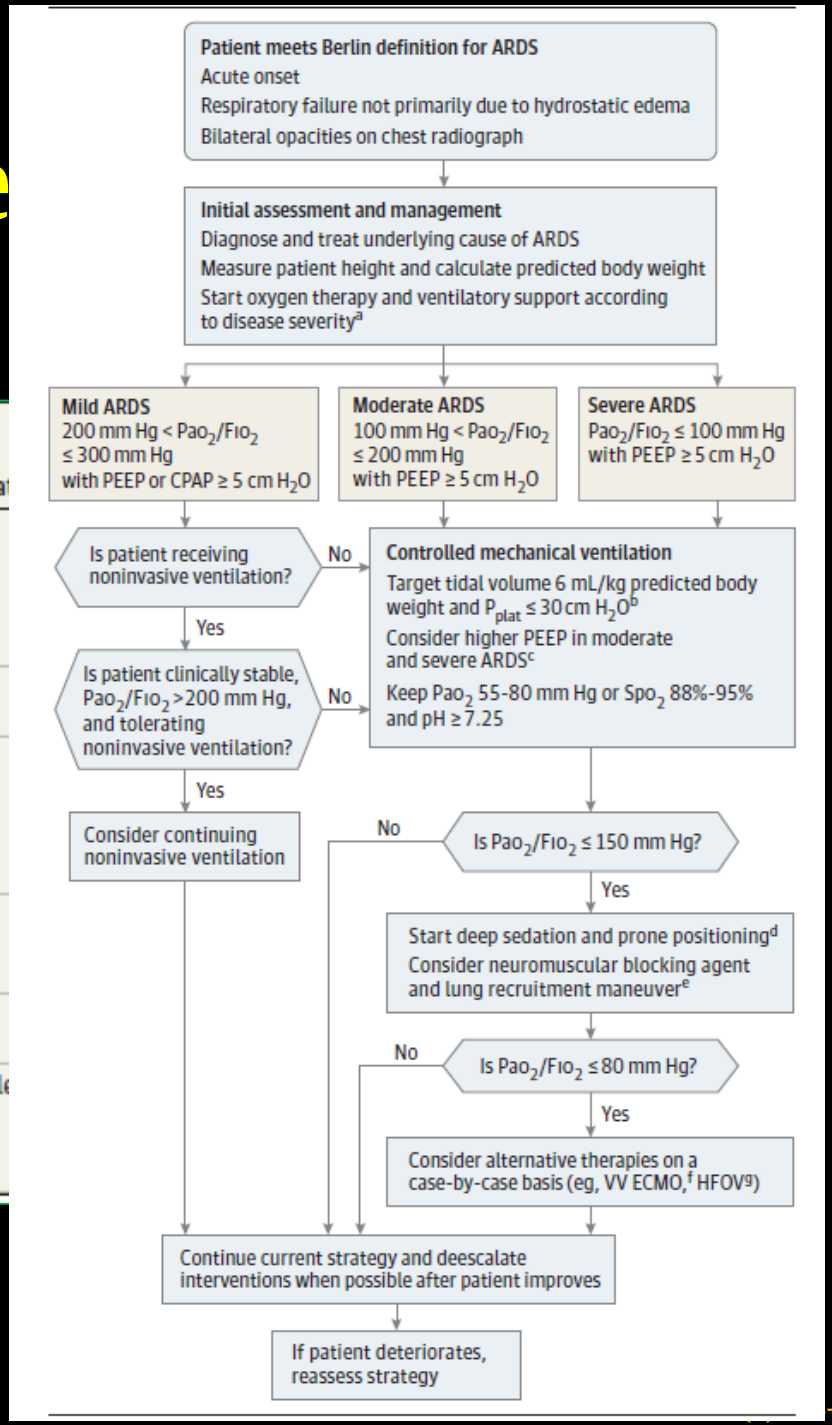
Lancet 2016; 388: 2416–30.



Lancet 2016; 388: 2416–30.

Guide

Intervention	ARDS Severity	Quality of Evidence (GRADE)	Strength of Recommenda
Mechanical ventilation with low tidal volumes and inspiratory pressures[a]	All ARDS	Moderate[61]	Strong
Prone positioning <12 h/d	Severe	Moderate-high[62]	Strong
High-frequency oscillatory ventilation	Moderate or severe	Moderate-high[63]	Strong
Higher PEEP	Moderate or severe	Moderate[64]	Conditional
Recruitment maneuvers	Moderate or severe	Low-moderate[65]	Conditional
Venovenous extracorporeal membrane oxygenation	Severe	Not applicable[66]	Not applicable



-710.

Clinical practice guideline

KQ		
1	비약물_MV	Lower tidal volume
2	비약물_MV	Prevention
3	비약물_MV	PEEP
4	비약물_MV	RM
5	비약물	Prone
6	비약물	ECMO and ECCO2R
7	약물	NMB
8	약물	Steroid
9	약물	iNO

2021 KOREA ARDS

Question ?

- Systemic steroid ?
- Inhaled NO ?

치료	약물	급성호흡곤란증후군 환자에서 전신 스테로이드를 사용하지 않을 것을 권고할 수 있다	급성호흡곤란증후군 (ARDS) 성인환자		systemic steroid		사망률	Con	Korean 2016
치료	약물	급성호흡곤란증후군(ARDS) 성인환자에서 스테로이드 치료를 시행해야 하는가?	급성호흡곤란증후군(ARDS) 성인 환자		Steroid		사망률, 감염의 발생률 및 VFD		Japan 2017
치료	약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 코르티코스테로이드의 사용은 생존율에 영향을 미치는가?	급성호흡곤란증후군 (ARDS) 성인환자		Corticosteroids		중환자실 내 사망		UK 2019
치료	약물	성인 및 소아 급성호흡곤란증후군 환자에서 흡입 일산화질소가스는 통상적인 치료법으로 사용하지 않을 것을 권고한다.	급성호흡곤란증후군 (ARDS) 성인	& 소아환자	inhlaed nitrix oxide		사망률	Con	Korean 2016
치료	약물		급성호흡곤란증후군(ARDS) 성인 환자		Inhaled NO		90일 사망률, 심각한 부작용 발생률		Japan 2017
치료	약물	저산소혈증을 동반한 급성호흡곤란증후군 환자에서, ECMO 를 적용하기 전 흡입 일산화질소가스(inhaled nitric oxide)를 사용할 경우 사망률을 낮출 수 있는가?	저산소혈증을 동반한 ARDS환자		흡입 일산화질소가스		사망률 개선 입증 못함		France 2019
치료	약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 혈관확장제흡입 치료는 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		Inhaled vasodilators		중환자실 내 사망		UK 2019

Issue

- Lower TV or not ?

치료	비약물	급성호흡곤란증후군 환자에서 저일회호흡량 적용을 권고한다.	급성호흡곤란증후군 (ARDS) 성인환자		Lower tidal volume		사망률	Pro	Korean 2016
치료	비약물	급성호흡곤란증후군(ARDS) 성인환자에서 Low tidal volume을 사용해야하는가?	급성호흡곤란증후군(ARDS) 성인 환자		Low tidal volume ventilator	convential tidal volume ventilator	사망률		Japan 2017
치료	비약물	기계 환기를 시행하는 성인 급성호흡곤란증후군 환자에서 저일회호흡량 환기(low tidal volume ventilation)는 사망률을 낮출 수 있는가?	급성호흡곤란증후군 (ARDS) 성인환자		저일회호흡량 환기 (6 mL/kg of PBW)	고식적 기계 환기	사망률		France 2019
치료	비약물	인공호흡기를 적용중인 급성호흡곤란증후군 (ARDS) 성인 환자에서 낮은 1회 환기량을 사용하는것이 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		Lower tidal volume	Higher tidal volume, Conventional tidal volume	중환자실 내 사망		UK 2019
치료	비약물	급성호흡곤란증후군 환자는 낮은 tidal volume과 inspiratory pressure를 사용한 기계호흡을 받아야하는가?	급성호흡곤란증후군 (ARDS) 성인환자		Lower tidal volume **and inspiratory pressure**	traditioinal strategy	사망률		AJRCCM 2017

Lower TV

- ARMA trial by ARDSNet
  - 6mL/kg & Pplat ≤ 30cmH_2O vs 12mL/Kg & Pplat ≤ 50 cmH_2O

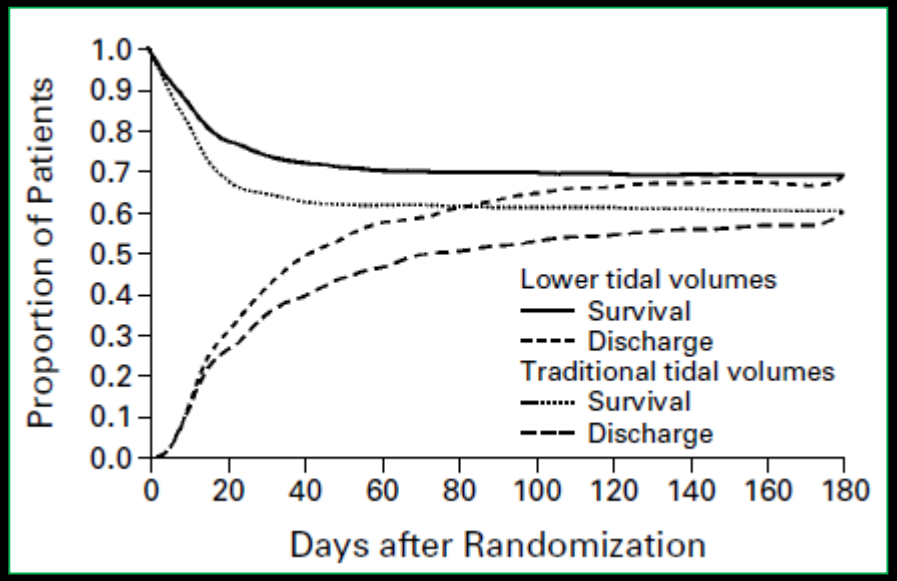


TABLE 4. MAIN OUTCOME VARIABLES.*

VARIABLE	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	P VALUE
Death before discharge home and breathing without assistance (%)	31.0	39.8	0.007
Breathing without assistance by day 28 (%)	65.7	55.0	<0.001
No. of ventilator-free days, days 1 to 28	12±11	10±11	0.007
Barotrauma, days 1 to 28 (%)	10	11	0.43
No. of days without failure of nonpulmonary organs or systems, days 1 to 28	15±11	12±11	0.006

N Engl J Med 2000; 342:1301-8.

Xtravent trial

	All patients			Subgroup: PaO_2/FIO_2 <150		
	$avECCO_2$-R	Control	*p*	$avECCO_2$-R	Control	*p*
Ventilator-free-days-28	10.0 ± 8	9.3 ± 9	0.779	11.3 ± 7.5	5.0 ± 6.3	0.033
Ventilator-free-days-60	33.2 ± 20	29.2 ± 21	0.469	40.9 ± 12.8	28.2 ± 16.4	0.033
Non-pulmonary organ failure free days-60	21.0 ± 14	23.9 ± 15	0.447	24.1 ± 7.5	29.0 ± 17.7	0.428
Lung injury score on day 10	2.2 ± 0.6	2.1 ± 0.5	0.854	2.3 ± 0.8	2.2 ± 0.5	0.601
Length of stay in hospital (days)	46.7 ± 33	35.1 ± 17	0.113	42.0 ± 16.6	40.3 ± 15.7	0.815
Length of stay in ICU (days)	31.3 ± 23	22.9 ± 11	0.144	25.9 ± 13.1	31.0 ± 12.7	0.258
In-hospital mortality	7/40 (17.5 %)	6/39 (15.4 %)	1.000	1/21 (4.8 %)	1/10 (10 %)	0.563

- Conclusion : The use of very low TV with $ECCO_2R$ has reduce VILI compared with a 'normal' lung protective management.

Intensive Care Med. 2013 May;39(5):847-56

A Strategy of UltraProtective lung ventilation With Extracorporeal CO_2 Removal for New-Onset moderate to seVere ARDS

The SUPERNOVA trial

SUPERNOVA

- The benefits of early TV and plateau pressure reduction allowed by the latest generation ECCO$_2$R device in moderate to severe ARDS.
- Decrease
  - From 6 to 5, 4 or 3 ml/kg IBW
  - To decrease Pplat <25 cm H2O
  - To further reduce VILI
  - With sufficient PEEP to prevent lung derecruitment

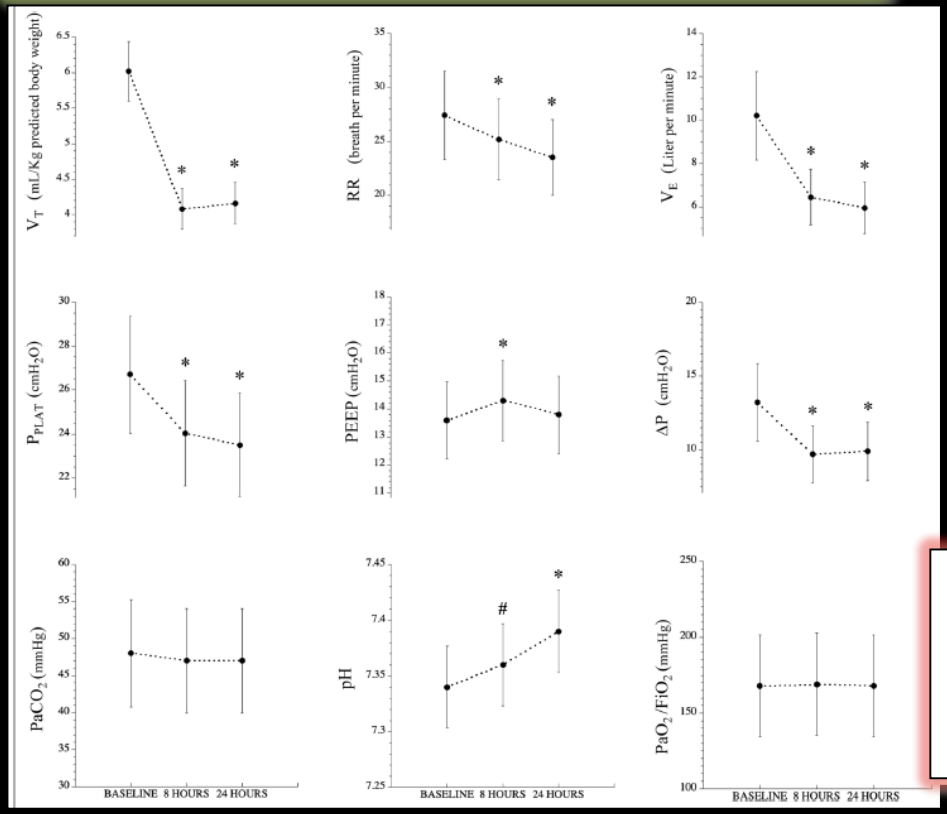
Feasibility and safety of extracorporeal CO_2 removal to enhance protective ventilation in acute respiratory distress syndrome: the SUPERNOVA study

Alain Combes[1], Vito Fanelli[2], Tai Pham[3], V. Marco Ranieri[4*] and On behalf of the European Society of Intensive Care Medicine Trials Group and the "Strategy of Ultra-Protective lung ventilation with Extracorporeal CO2 Removal for New-Onset moderate to severe ARDS" (SUPERNOVA) investigators

Included in the trial and treated with ECCO2R:

- Hemolung = 33
- iLA ACTIVVE = 34
- Cardiohelp® = 28

N= 95



- 2015 – 2017
- N = 95
- Moderate ARDS
  - PaO2/FiO2 100–200 mmHg
  - TV: 3-4 ml/kg
  - Peak pressure: < 25 cmH2O

In conclusion, this study demonstrates that ultra-protective ventilation facilitated by $ECCO_2R$ is feasible, mitigating respiratory acidosis in patients with moderate ARDS. A randomized clinical trial is required to assess overall benefits and harms.

Issue

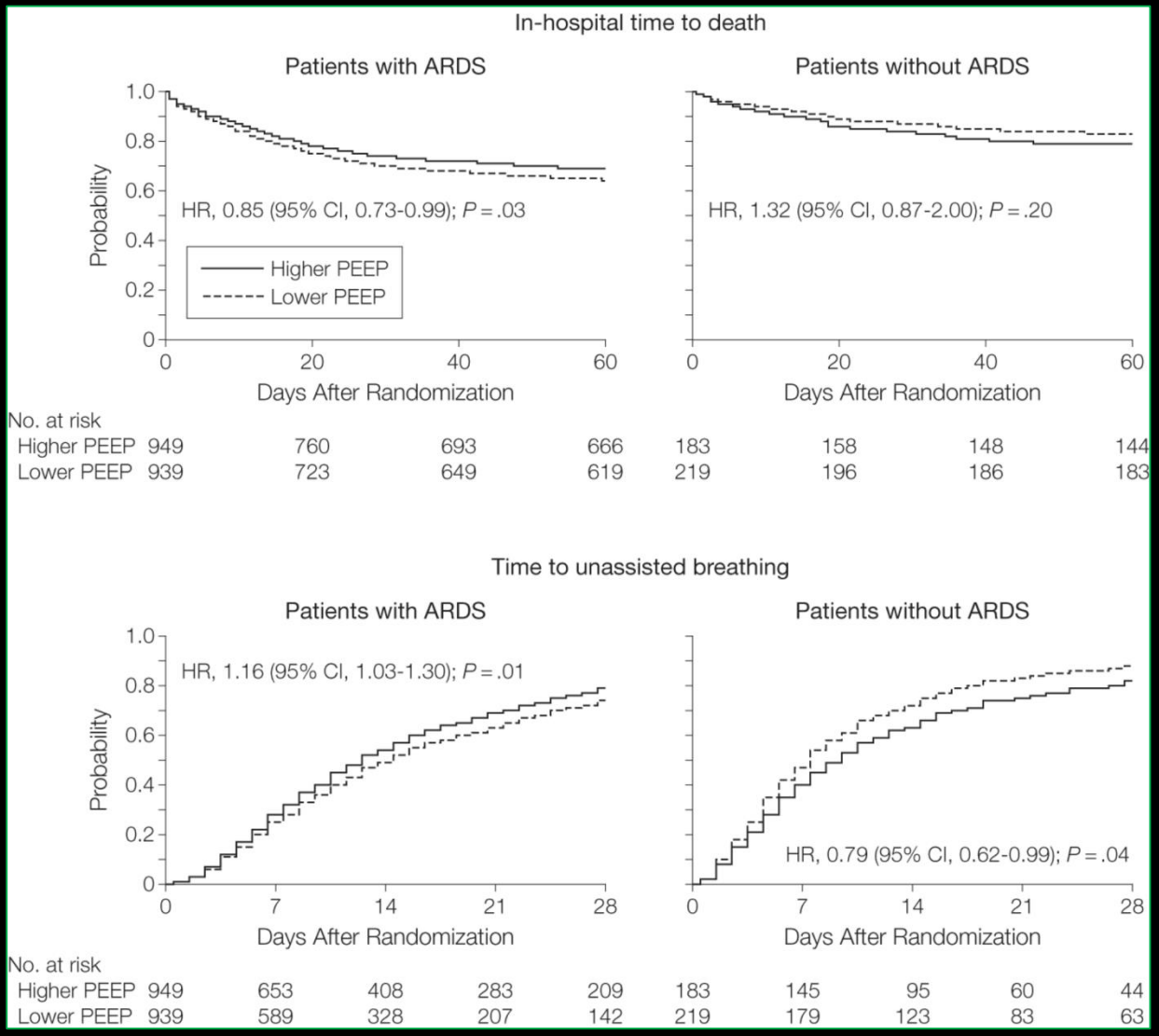
- High PEEP ?

치료	비약물	급성호흡곤란증후군 환자에서 산소화비 (PaO2/FIO2)가 200 mmHg 이하인 경우 사망률을 감소시키기 위해 높은 날숨끝양압을 권고할 수 있다.	급성호흡곤란증후군 (ARDS) 성인환자		높은 날숨끝양압(PEEP)	통상적인 날숨끝양압	사망률	Pro	Korean 2016
치료	비약물	급성호흡곤란증후군(ARDS) 환자는 Lower PEEP과 비교하여 Higher PEEP을 받아야 하는가?	중등증 또는 중증급성호흡곤란증후군 (moderate or severe ARDS) 성인환자		Higher PEEP	Lower PEEP	높은 oxygenation과 사망률 감소로 낮은 PEEP보다 높은 PEEP을 suggest함 (conditional recommendation)		AJRCCM 2017
치료	비약물	급성호흡곤란증후군(ARDS) 성인환자에서 최적의 호기말양압(PEEP) 얼마인가?	급성호흡곤란증후군(ARDS) 성인 환자		Higher PEEP ventilator	Lower PEEP ventilator	사망률		Japan 2017
치료	비약물	Moderate~Severe ARDS 환자에서 High PEEP 은 사망률을 낮출 수 있는가?	Moderate~severe ARDS 성인환자		High PEEP		사망률 감소		France 2019
치료	비약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 높은 호기말양압을 유지하는 것이 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		Higher PEEP	Standard or lower PEEP	중환자실 사망 감소		UK 2019

High PEEP

- Positive effects
  - Recruits collapsed alveoli and keeps recruited units open
  - Decrease shunt, improves PaO2
  - Increases lung compliance
  - Reduces ventilator-associated lung injury
- Negative effects
  - Increases risk of barotrauma (overdistension)
  - Hemodynamic compromise

High PEEP



JAMA. 2010;303(9):865-73.

Optimal PEEP

ARDSnet FiO2/PEEP Titration

Goal O2 Sat 88 - 95% (PaO2 55 - 80mmHg)

Wait 5 - 10 min Before Step Up or Down
(Titrate FiO2/PEEP at Same Time)

FiO2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

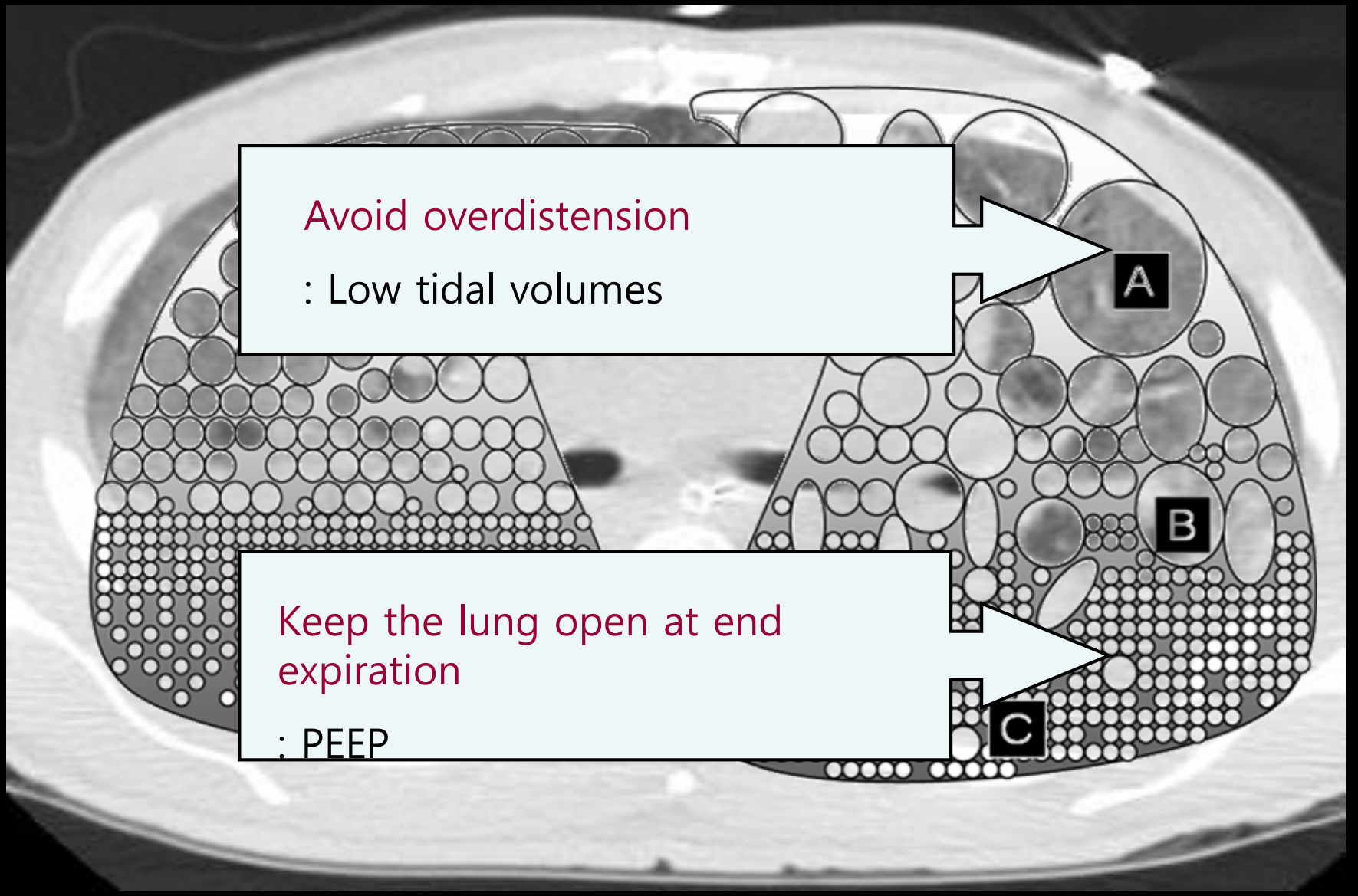
FiO2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

REBELEM

Decrease of alveolar recruitment , increase of cyclic atelectasis : worsening of ARDS

JAMA. 2019;321(9):846-57.

Ventilator


Avoid overdistension
: Low tidal volumes
A
B
Keep the lung open at end expiration
: PEEP
C

Issue

- RM ?

	치료	비약물	급성호흡곤란증후군 환자에서 폐포동원술 사용을 권고할 수 있다.	급성호흡곤란증후군 (ARDS) 성인환자		폐포동원술		사망률	Korean 2016
4	치료	비약물	급성호흡곤란증후군(ARDS) 환자는 Recruitment maneuvers(RMs)를 받아야 하는가?	급성호흡곤란증후군 (ARDS) 성인환자		RMs	control group	사망률 감소, 산소화 oxygenation, rescue therapy의 감소로 성인 ARDS환자에서 RMs를 suggest함 (conditional recommendation)	AJRCCM 2017
	치료	비약물	급성호흡곤란증후군 환자에서 폐포동원술(aleveolar recruitment)은 일상적으로 사용되어야 있는가?	급성호흡곤란증후군 (ARDS) 성인환자		폐포동원술		혈역학적 악화 사망률감소는 불분명	France 2019

Recruitment maneuver

- Set the ventilator to CPAP mode and increase the pressure to 30–40 cm H_2O for 30–40 s while monitoring the patient for signs of adverse effects
- Decrease the intrapulmonary shunt and improve oxygenation and compliance
- There was no differences in mortality rate, not recommended in severe ARDS

R3.3 – Recruitment maneuvers should probably not be used routinely in ARDS patients.
GRADE 2 –, STRONG AGREEMENT

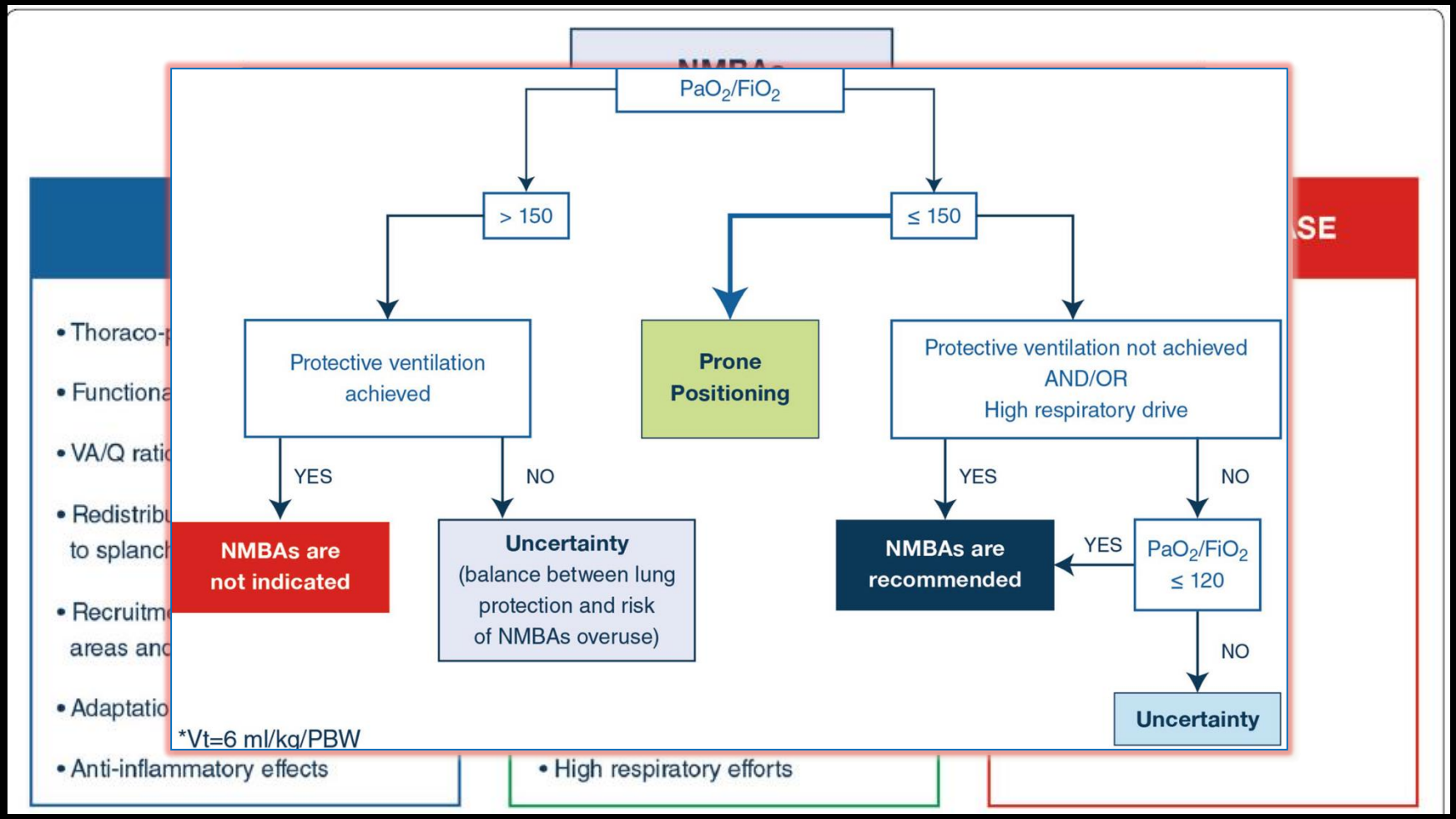
Ann. Intensive Care (2019) 9:69

Issue

- Neuromuscular blocker ?

치료	약물	급성호흡곤란증후군 환자에서 기계환기 시작 후 48시간 동안 신경근육차단제의 사용을 권고할 수 있다.	급성호흡곤란증후군 (ARDS) 성인환자		Neuromuscular blocker		사망률 Pro	Korean 2016
치료	약물	급성호흡곤란증후군(ARDS) 성인환자에서 신경근육차단제를 사용해야 하는가?	급성호흡곤란증후군(ARDS) 성인 환자		Neuromuscular blocker		중환자실 사망률, 28일 사망률, 압력손상 및 근질환 발생률	Japan 2017
치료	약물	PaO2/FiO2 비율<150mmHg in ARDS, NMB 의 조기 사용은 사망률을 낮출 수 있는가?	급성호흡곤란증후군 (ARDS) 성인환자		Neuromuscular blocker		사망률 감소	France 2019
치료	약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 신경근차단제를 사용하는것이 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		Neuromuscular blocker		중환자실 내 사망	UK 2019

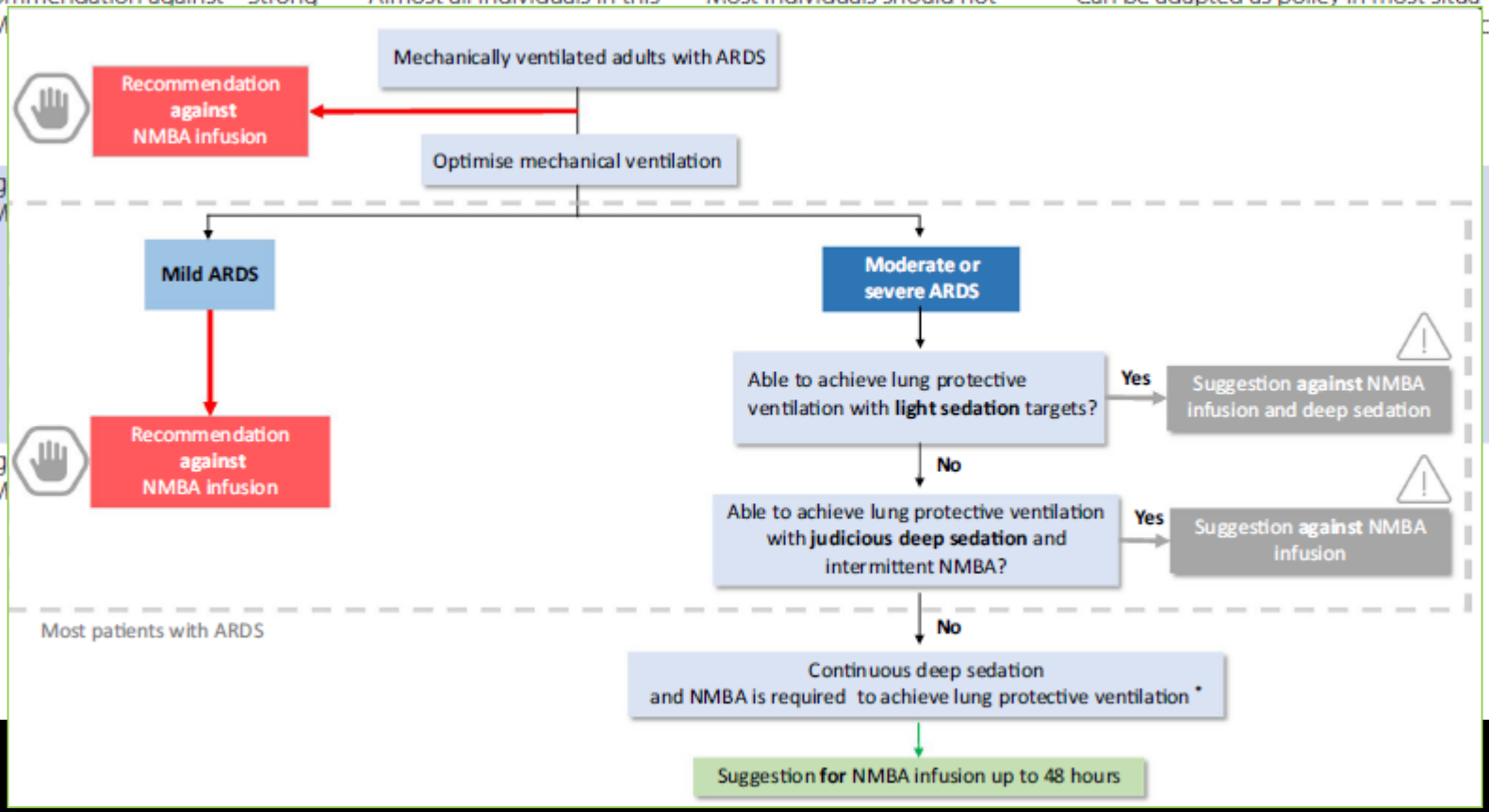
NMB



Intensive Care Med. 2020;46(12):2357-72.

Practical guideline

Category	Strength	Implications to patients	Implications to clinicians	Implications to policymakers
Recommendation against NM	Strong	Almost all individuals in this	Most individuals should not	Can be adapted as policy in most situa- ce



Intensive Care Med (2020) 46. 1977–86.

Issue

- Prone position ?

치료	비약물	중등도 이상의 급성호흡곤란증후군 환자에서 금기가 아닌 경우 복와위 적용을 권고한다.	급성호흡곤란증후군 (ARDS) 성인환자		복와위	앙아위	사망률 Pro	Korean 2016
치료	비약물	급성호흡곤란증후군(ARDS) 환자는 prone positioning을 받아야하는가?	중등증 이상 급성호흡곤란증후군 (severe ARDS) 성인환자		하루 12시간 이상의 prone positioning	supine positioning group	sever ARDS 환자에서 사망률 감소로 recommend함.	AJRCCM 2017
치료	비약물	급성호흡곤란증후군(ARDS) 성인환자에서 prone position을 적용해야되는가?	급성호흡곤란증후군(ARDS) 성인 환자		Prone position		사망률	Japan 2017
치료	비약물	PaO2/FiO2 비율 < 150mmHg 인 급성호흡곤란증후군환자에서 복와위(prone position)가 앙아위(supine position)와 비교해서 사망률을 낮출 수 있는가?	급성호흡곤란증후군 (ARDS) 성인환자		복와위(prone position)	앙아위	사망률 감소	France 2019
치료	비약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 복와위를 사용하는것이 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		Prone positioning		중환자실 내 사망	UK 2019

Prone position

- Redistributes blood flow and ventilation
- Promotes secretion clearance
- Shifts the weight of the mediastinal contents anteriorly
- Improvement of P/F ratio
- Duration: > 16 hours

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 6, 2013 VOL. 368 NO. 23

Prone Positioning in Severe Acute Respiratory Distress Syndrome

Ferdinando Raimondi, MD
Giovanni Bordone, MD
Gaetano Iapichino, MD
Jordi Mancebo, MD

moderate (n=192) and severe (n=150) hypoxemia.

Interventions Patients were randomized to undergo supine (n=174) or prone (20 hours per day; n=168) positioning during ventilation.

Main Outcome Measures The primary outcome was 28-day all-cause mortality.

CONCLUSIONS

In patients with severe ARDS, early application of prolonged prone-positioning sessions significantly decreased 28-day and 90-day mortality. (Funded by the Programme Hospitalier de Recherche Clinique National 2006 and 2010 of the French Ministry of Health; PROSEVA ClinicalTrials.gov number, NCT00527813.)

JAMA. 2009;302(18):1977-1984 www.jama.com

patients with ARDS, for whom high fraction of inspired oxygen (FIO_2) or high plateau pressure makes mechanical ventilation potentially injurious.[2] Moreover, prone positioning has been advocated as a rescue maneuver for severe hypoxemia, owing to its positive effects on oxygenation,[3-5] which have been repeatedly documented since its first description in 1976.[6] However, no randomized clinical trial has yet demonstrated a significant reduction in mortality rate associated with prone positioning.[7-9] In a previous randomized trial[7] we had observed, in a hypothesis-generating post hoc analysis,[10] that in the subgroup of patients with the most severe hypoxemia and with ARDS, survival was better in the prone than in the supine position. In that study, prone po-

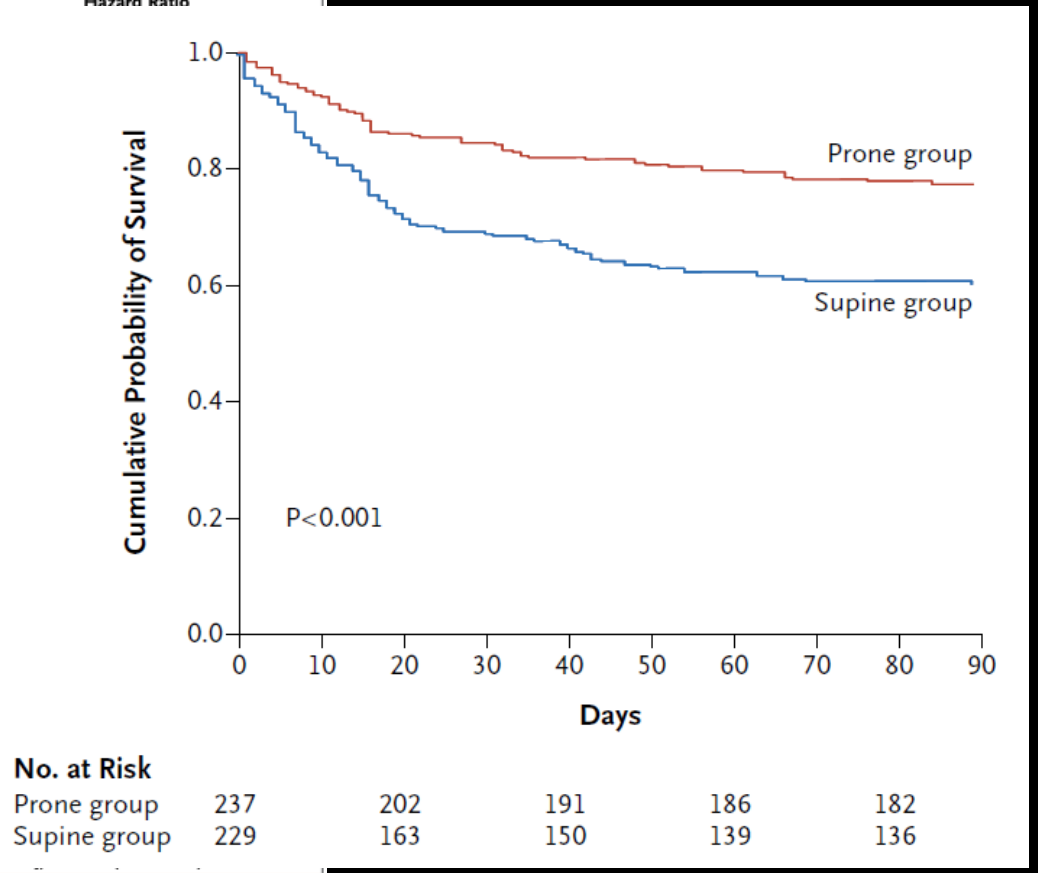
For editorial comment see p 2030.

Author Affiliations and Members of the Prone-Supine II Study Group are listed at the end of this article.
Corresponding Author: Luciano Gattinoni, MD, FRCP, Dipartimento di Anestesia e Rianimazione, Fondazione IRCCS–"Ospedale Maggiore Policlinico, Mangiagalli, Regina Elena" di Milano; Via F. Sforza 35, 20122 Milan, Italy (gattinon@policlinico.mi.it).

PROSEVA

Table 3. Primary and Secondary Outcomes According to Study Group.*

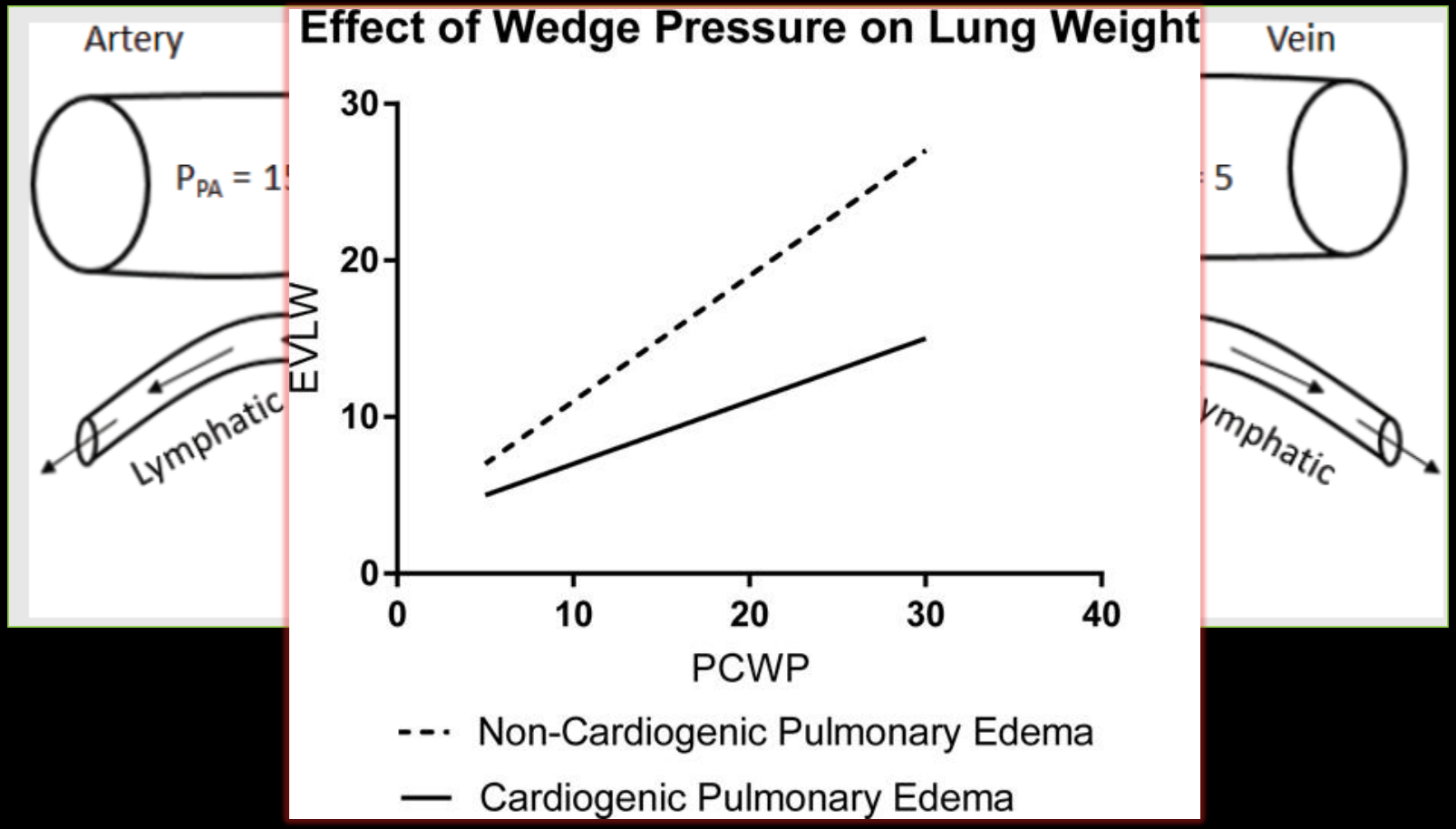
Outcome	Supine Group (N=229)	Prone Gr (N=23	Hazard Ratio	
Mortality — no. (% [95% CI])				
At day 28				
Not adjusted	75 (32.8 [26.4–38.6])	38 (16.0 [11.		
Adjusted for SOFA score†				
At day 90				
Not adjusted	94 (41.0 [34.6–47.4])	56 (23.6 [18.		
Adjusted for SOFA score†				
Successful extubation at day 90 — no./total no. (% [95% CI])	145/223 (65.0 [58.7–71.3])	186/23 (80.5 [75.4-		
Time to successful extubation, assessed at day 90 — days				
Survivors	19±21	17±1(		
Nonsurvivors	16±11	18±1-		
Length of ICU stay, assessed at day 90 — days				
Survivors	26±27	24±2:		
Nonsurvivors	18±15	21±2(		
Ventilation-free days				
At day 28	10±10	14±9		
At day 90	43±38	57±3-		
Pneumothorax — no. (% [95% CI])	13 (5.7 [3.9–7.5])	15 (6.3 [4.9		
Noninvasive ventilation — no./total no. (% [95% CI])				
At day 28	10/212 (4.7 [1.9–7.5])	4/228 (1.8		
At day 90	3/206 (1.5 [0.2–3.2])	4/225 (1.8 [0.1–3.5])	1.22 (0.23–6.97)	1.00
Tracheotomy — no./total no. (% [95% CI])				
At day 28	12/229 (5.2 [2.3–8.1])	9/237 (3.8 [1.4–6.0])	0.71 (0.27–1.86)	0.37
At day 90	18/223 (8.1 [4.5–11.7])	15/235 (6.4 [3.3–9.5])	0.78 (0.36–1.67)	0.59



N Engl J Med 2013; 368:2159-68.


CHONNAM UNIVERSITY HOSPITAL
전남대학교병원

Fluid balance



Can J Respir Ther 2019;55:1–8.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

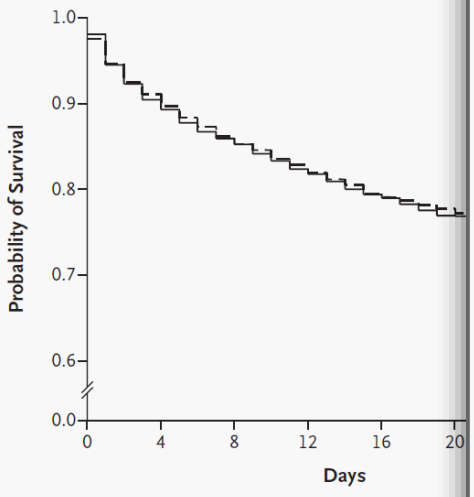


Figure 1. Kaplan–Meier Estimates of the Probability of S
P=0.96 for the comparison between patients assigned to
those assigned to receive saline.

Patients	Albumin Group	Saline Group	Relative Risk (95% CI)
	no. of deaths/total no.		
Overall	726/3473	729/3460	0.99 (0.91–1.09)
Trauma			
Yes	81/596	59/590	1.36 (0.99–1.86)
No	641/2831	666/2830	0.96 (0.88–1.06)
Severe sepsis			
Yes	185/603	217/615	0.87 (0.74–1.02)
No	518/2734	492/2720	1.05 (0.94–1.17)
ARDS			
Yes	24/61	28/66	0.93 (0.61–1.41)
No	697/3365	697/3354	1.00 (0.91–1.09)

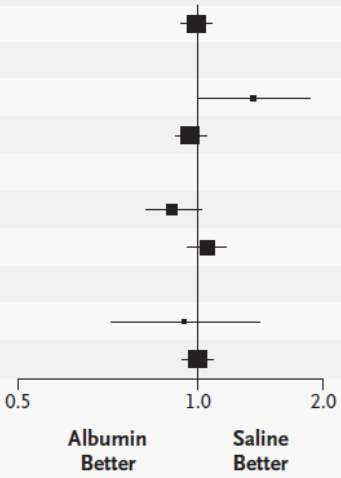


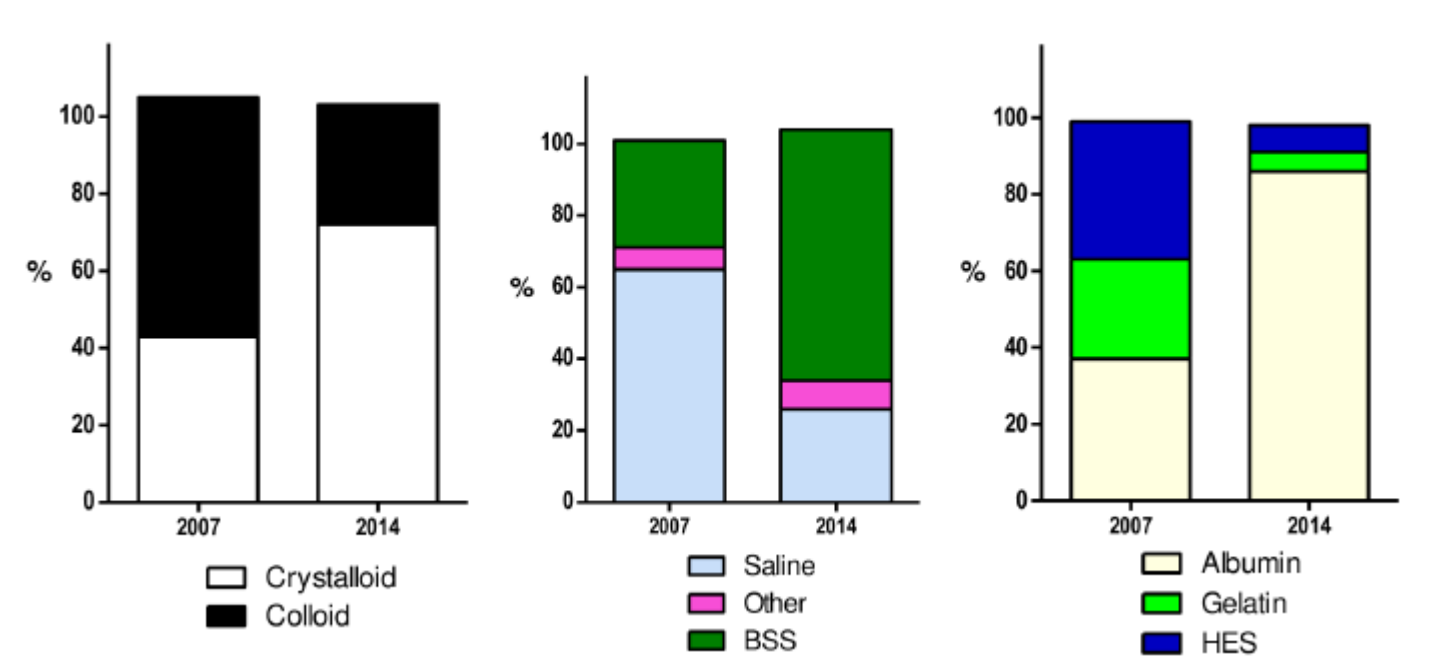
Figure 2. Relative Risk of Death from Any Cause among All the Patients and among the Patients in the Six Predefined Subgroups.

The size of each symbol indicates the relative number of events in the given group. The horizontal bars represent the confidence intervals (CI). ARDS denotes the acute respiratory distress syndrome.

- Albumin versus normal saline
- 6997 patients
- Primary outcome: 28-day death

N Engl J Med. 2004; 350:2247-56.

Patterns of fluid resuscitation



PLoS One. 2017 May 12;12(5)

Crystalloids vs. colloids

Starches compared to crystalloid for fluid resuscitation in critically ill patients

Participants: critically ill people requiring fluid resuscitation
Setting: in hospital, in Algeria, Argentina, Belgium, Brazil, Canada, China, France, Germany, India, the Netherlands, Phillipines, South Africa, Switzerland, Tunisia, the UK, USA and Vietnam
Intervention: starches to include hydroxyethyl starch, hetastarch, and pentastarch
Comparison: crystalloids to include normal saline, hypertonic saline, Ringer's lactate and Ringer's acetate

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with crystalloids	Risk with starches				
	238 per 1000	241 per 1000 (214 to 272)				could not be certain whether it accounted for attrition
All-cause mortality (within 30 days)	Study population		RR 0.99 (0.90 to 1.09)	10,135 (11 studies)	⊕⊕⊕◯ Moderate[b]	We excluded data from 1 study because we could not be certain whether it accounted for attrition
	191 per 1000	189 per 1000 (172 to 208)				
Transfusion of blood products	Study population		RR 1.19 (1.02 to 1.39)	1917 (8 studies)	⊕⊕⊕◯ Moderate[a]	1 study included different types of colloids (HES, gelatins, or albumin). We did not include this in analysis

AUTHORS' CONCLUSIONS: Using starches, dextrans, albumin or FFP (moderate-certainty evidence), or gelatins (low-certainty evidence), versus crystalloids probably makes little or no difference to mortality. Starches probably slightly increase the need for blood transfusion and RRT (moderate-certainty evidence), and albumin or FFP may make little or no difference to the need for renal replacement therapy (low-certainty evidence). Evidence for blood transfusions for dextrans, and albumin or FFP, is uncertain. Similarly, evidence for adverse events is uncertain. Certainty of evidence may improve with inclusion of three ongoing studies and seven studies awaiting classification, in future updates.

Cochrane Database Syst Rev. 2018 Aug 3;8:CD000567.

Fluid management

- tes
- ng
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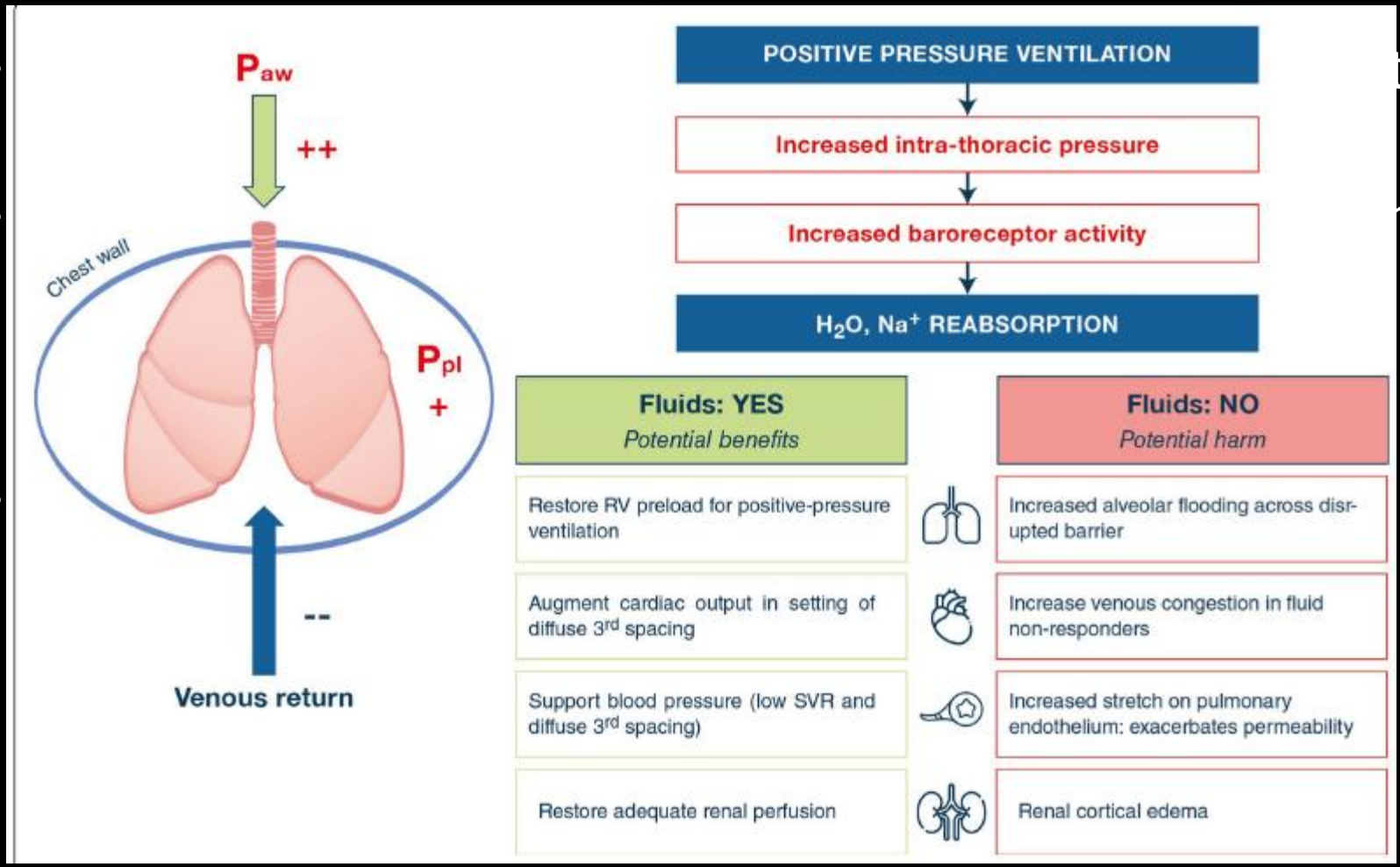


Intensive Care Med (2020) 46:2252–64.

Adjuvant therapy

치료	약물	급성호흡곤란증후군(ARDS) 성인환자에서 매일의 체액균형을 어떻게 유지해야 하는가?	급성호흡곤란증후군(ARDS) 성인환자		fluid restriction		사망률, VFD, 및 신대체요법의 필요성
치료	약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 적절한 수액요법은 무엇인가?	급성호흡곤란증후군 (ARDS) 성인환자		Conservative fluid strategy	Liberal fluid strategy	중환자실 내 사망
치료_약물	Non-fluid	급성호흡곤란증후군(ARDS) 성인환자에서 Neutrophil elastase inhibitors를 사용해야 하는가?	급성호흡곤란증후군(ARDS) 성인환자		Neutrophil elastase inhibitors		90일 이전 사망률, 심각한 부작용 발생률 및 VFD
치료_약물		급성호흡곤란증후군(ARDS) 성인환자에서 다음 약제들을 치료에 이용해야 하는가?	급성호흡곤란증후군(ARDS) 성인환자				
치료_약물		Inhaled/intravenous B2 stimulant	급성호흡곤란증후군(ARDS) 성인환자		Inhaled/IV B2 stimulant		90일 사망률, 심각한 부작용 발생률
치료_약물		Granulocyte macrophage colony-stimulating factor(GM-CSF)	급성호흡곤란증후군(ARDS) 성인환자		GM-CSF		90일 사망률, 심각한 부작용 발생률
치료_약물		Prostaglandin E1(PGE1)	급성호흡곤란증후군(ARDS) 성인환자		PGE1		90일 사망률, 심각한 부작용 발생률
치료_약물		Statin	급성호흡곤란증후군(ARDS) 성인환자		Statin		90일 사망률, 심각한 부작용 발생률
치료_약물		Surfactant	급성호흡곤란증후군(ARDS) 성인환자		Surfactant		90일 사망률, 심각한 부작용 발생률
치료_약물		Activated protein C(APC)	급성호흡곤란증후군(ARDS) 성인환자		APC		90일 사망률, 심각한 부작용 발생률
치료_약물		N-acethylcystein(NAC)	급성호흡곤란증후군(ARDS) 성인환자		NAC		90일 사망률, 심각한 부작용 발생률
치료_약물		Ketoconazole or lisofylline	급성호흡곤란증후군(ARDS) 성인환자		ketoconazole		90일 사망률, 심각한 부작용 발생률

Issue

치료	비약물	중증 급성호흡곤란증후군 환자에서 기존의 방법으로 저산소혈증의 개선이 어려운 경우에 구조요법으로 체외막산소공급을 권고할 수 있다.	급성호흡곤란증후군 (ARDS) 성인환자		ECMO		사망률 ???	
치료	비약물	급성호흡곤란증후군(ARDS) 환자는 ECMO를 받아야 하는가?	중증급성호흡곤란증후군 (severe ARDS) 성인환자		ECMO		사망률?	
치료	비약물	PaO2/FiO2 비율<80mmHg 인Severe ARDS환자에서, 적절한 management 에도 기계환기가 위험해지는 경우, 체외막산소공급(extraocorporeal membrane oxygenation, ECMO) 적용이 사망률을 낮출 수 있는가?	심각한 급성호흡곤란증후군 (ARDS) 성인환자		ECMO(VV)		사망률 감소	
치료	비약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 체외막산화기 치료는 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		ECMO		중환자실 내 사망	
치료	비약물	고탄산증을 동반한 급성호흡곤란증후군 환자에서 EC-CO2R의 사용이 사망률을 감소시킬수 있는가?	고탄산증을 동반한 ARDS 환자		저유량체외 CO2제거 (EC-CO2R)		사망률감소를 입증하지 못함	
치료	비약물	급성호흡곤란증후군 (ARDS) 성인 환자에서 체외이산화탄소제거 치료는 사망률 개선에 유용한가?	급성호흡곤란증후군 (ARDS) 성인환자		ECCO2R		중환자실 내 사망	

Despite improvements in management of ARDS on the critical care unit, this complex disease continues to be a major life-threatening event.

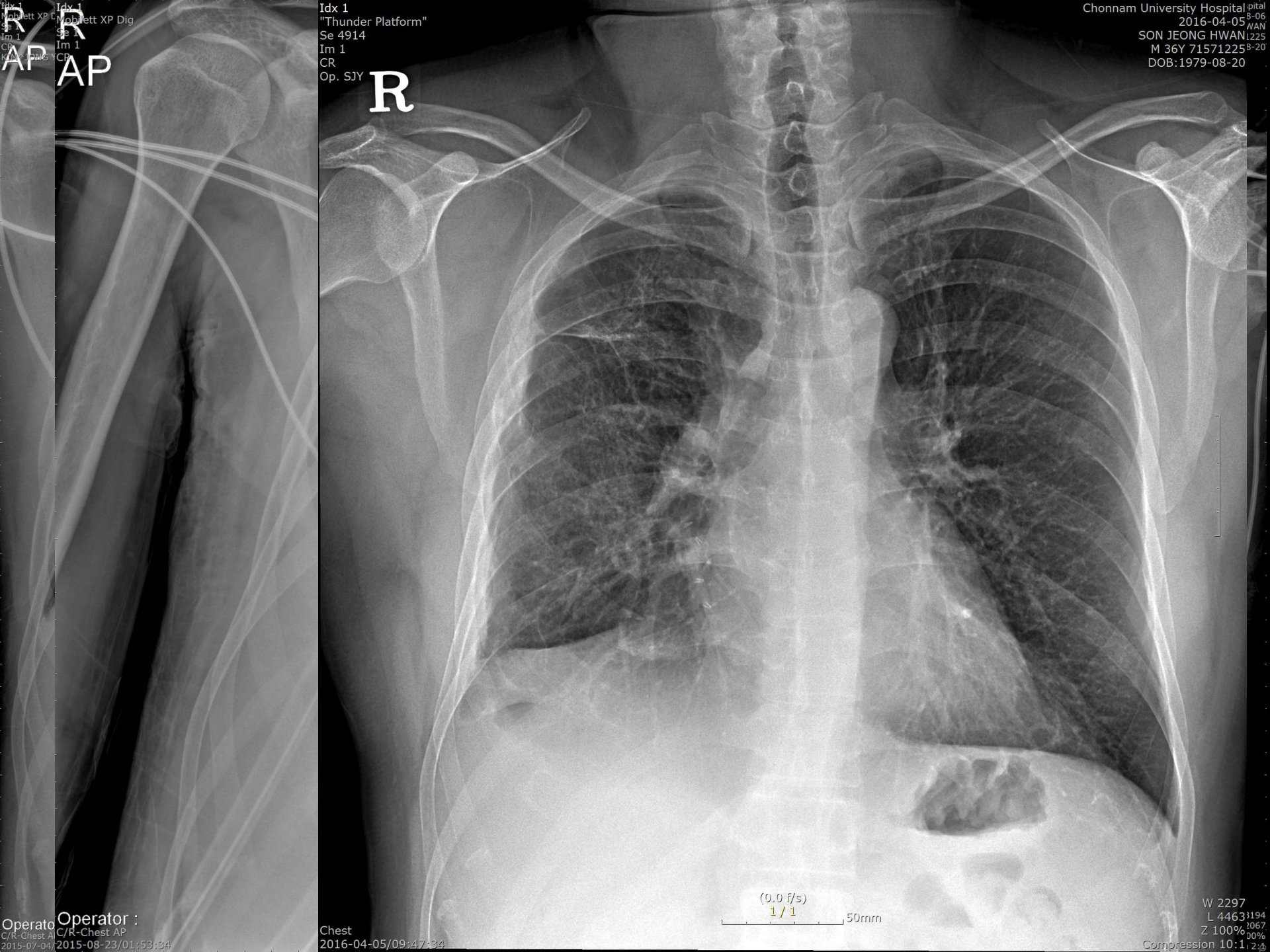
J Inflamm (Lond). 2019; 16: 1.

Superimposed VILI and viral disease incite inflammation and edema, intense cytokine release, right ventricular overload, and systemic organ dysfunction.

JAMA. 2020;323(22):2329-30.

Prevention and management of ARDS in the setting of surgeon.

Intensive Care Med. 2021;47(2):208221.


Idx 1
"Thunder Platform"
Se 4914
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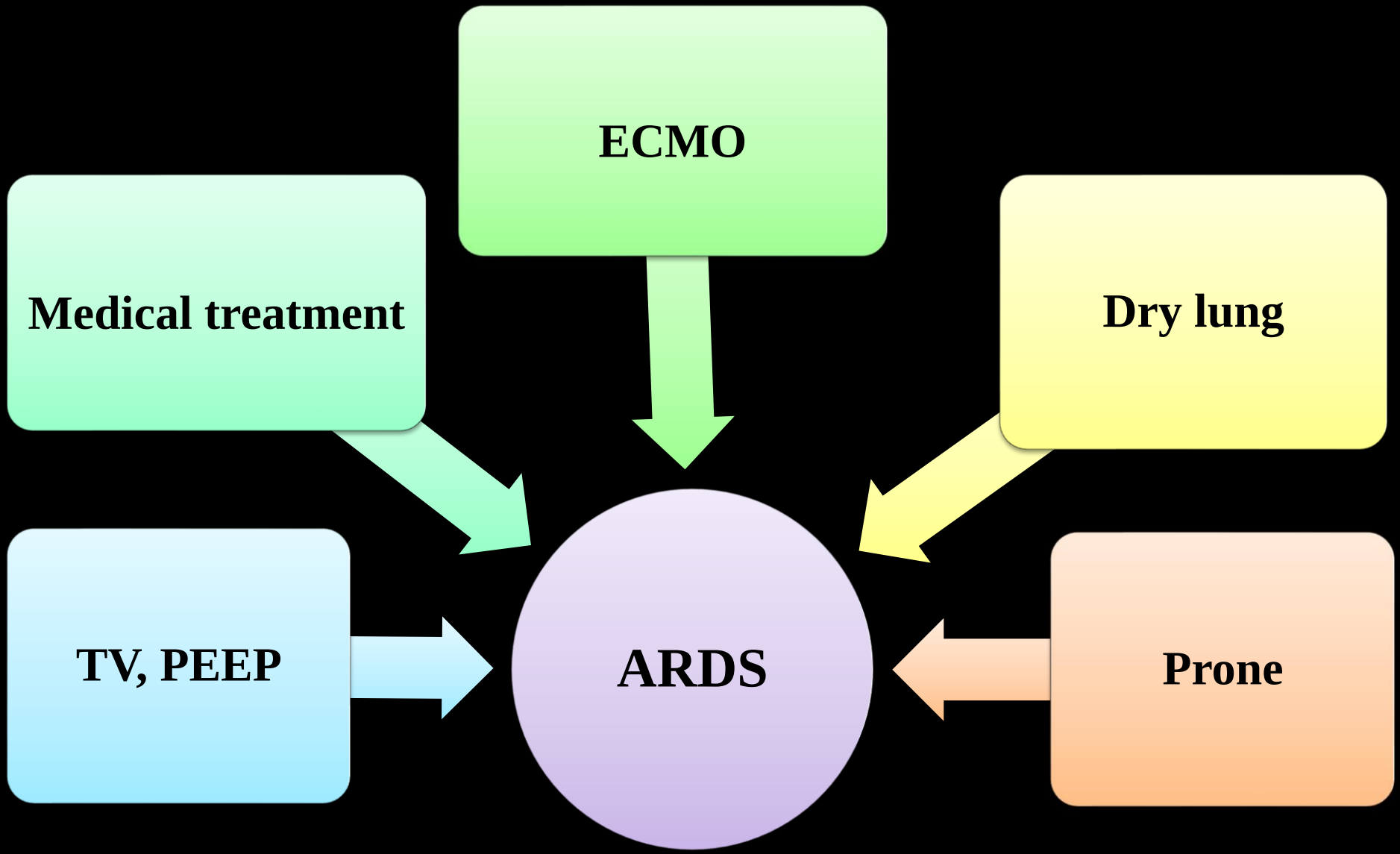
CR
Op. SJY
R
Chonnam University Hospital
2016-04-05
SON JEONG HWAN
M 36Y 71571225
DOB:1979-08-20
(0.0 f/s)
1 / 1
50mm
Chest
2016-04-05/09:47:34
W 2297
L 4463
Z 100%
Compression 10:1
Operator :
C/R-Chest AP
2015-08-23/01:53:34


ECMO
Medical treatment
Dry lung
TV, PEEP
ARDS
Prone

Thank you for your time and your attention !