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ECMO FOR ACUTE RESPIRATORY FAILURE

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Disclosures

No relevant financial disclosures that would be of potential conflict of interest with this presentation

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Incidence and Outcomes of Acute Lung Injury

Gordon D. Rubenfeld, M.D., Ellen Caldwell, M.S., Eve Peabody, B.A., Jim Weaver, R.R.T., Diane P. Martin, Ph.D., Margaret Neff, M.D., Eric J. Stern, M.D., and Leonard D. Hudson, M.D.

Table 1. Incidence of Acute Lung Injury and ARDS and Mortality from These Conditions.*

Variable	Acute Lung Injury	ARDS
Cases — no.	1,113	828
Crude incidence — no. per 100,000 person-yr	78.9	58.7
Age-adjusted incidence — no. per 100,000 person-yr†	86.2	64.0
Mortality (95% CI) — %	38.5 (34.9–42.2)	41.1 (36.7–45.4)
Estimated annual cases — no.†	190,600	141,500
Estimated annual deaths — no.†	74,500	59,000
Estimated annual hospital days — no.†	3,622,000	2,746,000
Estimated annual days in ICU — no.†	2,154,000	1,642,000

The American-European Consensus Conference on ARDS

Definitions, Mechanisms, Relevant Outcomes, and Clinical Trial Coordination

RECOMMENDED CRITERIA FOR ACUTE LUNG INJURY (ALI) AND ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)

	Timing	Oxygenation	Chest Radiograph	Pulmonary Artery Wedge Pressure
ALI criteria	Acute onset	$Pa_{O_2}/FI_{O_2} \leq 300$ mm Hg (regardless of PEEP level)	Bilateral infiltrates seen on frontal chest radiograph	≤ 18 mm Hg when measured or no clinical evidence of left atrial hypertension
ARDS criteria	Acute onset	$Pa_{O_2}/FI_{O_2} \leq 200$ mm Hg (regardless of PEEP level)	Bilateral infiltrates seen on frontal chest radiograph	≤ 18 mm Hg when measured or no clinical evidence of left atrial hypertension

Am J Respir Crit Care Med Vol 149. pp 818–824, 1994

Berlin definition of ARDS

Acute respiratory distress syndrome (ARDS)			
Timing	Within 1 week of a known clinical insult or new or worsering respiratory symptoms		
Chest imaging[a]	Bilateral opacities – not fully explained by effusions, lobar/lung collage, or noduls		
Origin of edema	Respiratory failure not fully explained by cardiac failure of fluid overload Need objective assessment (eg., echocardiography) to exclude hybrostatic edema if no risk factor present		
	Mild	Moderate	Severe
Oxygenation[b]	200<PaO_2/FiO_2 ≤ 300 with PEEP or CPAP ≥5 cmH_2O[c]	100<PaO_2/FiO_2 ≤ 200 with PEEP or CPAP ≥5 cmH_2O	PaO_2/FiO_2 <100 with PEEP or CPAP ≥5 cmH_2O

Issues regarding reliability and validity of ARDS definition of 1994

Empirical evaluation of meta-analysis of 4188 pts

3 exclusive categories of ARDS based on degree of hypoxemia

Mortality: Mild – 27%, moderate – 32%, severe – 45%

JAMA. 2012;307(23):2526-2533.

Mortality Rates for Patients With Acute Lung Injury/ARDS Have Decreased Over Time*

Massimo Zambon, MD; and Jean-Louis Vincent, MD, PhD, FCCP

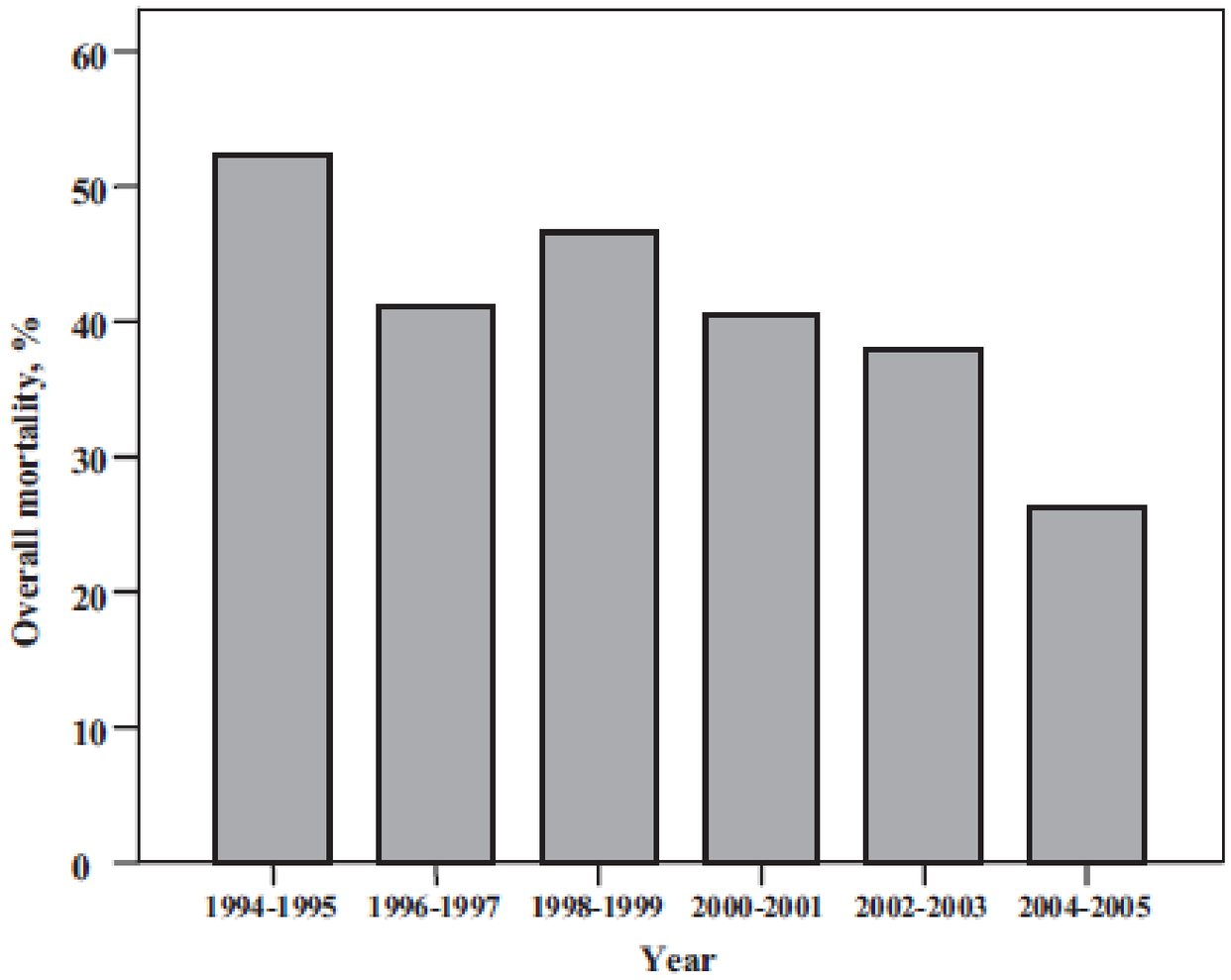

FIGURE 1. Variation in overall pooled mortality rates over time in the 72 ALI/ARDS studies.

The New England
Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

VENTILATION WITH LOWER TIDAL VOLUMES AS COMPARED WITH TRADITIONAL TIDAL VOLUMES FOR ACUTE LUNG INJURY AND THE ACUTE RESPIRATORY DISTRESS SYNDROME

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- Traditional ventilation treatment
  - Tidal volume 12 ml/kg
    - $P_{plateau} < 50$ cm H_2O
- Low tidal volume ventilation
  - Tidal volume 6 ml/kg
    - $P_{plateau} < 30$ cm H_2O

TABLE 4. MAIN OUTCOME VARIABLES.*

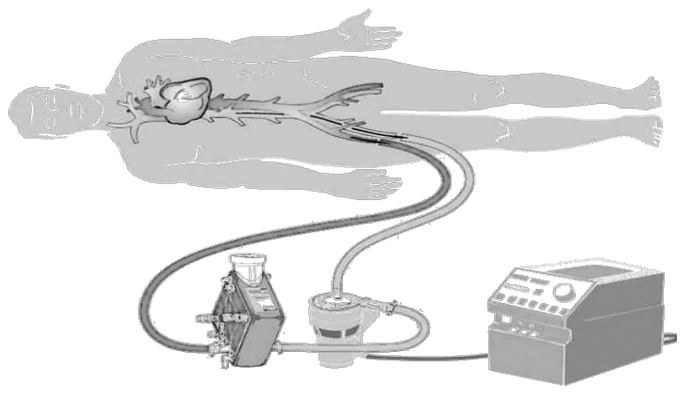
VARIABLE	GROUP RECEIVING LOWER TIDAL VOLUMES	GROUP RECEIVING TRADITIONAL TIDAL VOLUMES	P VALUE
Death before discharge home and breathing without assistance (%)	31.0	39.8	0.007
Breathing without assistance by day 28 (%)	65.7	55.0	<0.001
No. of ventilator-free days, days 1 to 28	12±11	10±11	0.007
Barotrauma,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

ECMO for severe respiratory failure

Blood is drained and returned to the venous system, providing complete or partial support of the lungs, as long as the cardiac output is sufficient

Diseased lungs may heal while the potential injury of aggressive mechanical ventilation is avoided

Reversable respiratory failure cause



Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Mariamma M Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration

- UK based multicenter randomised trial
- Eligible pts 18-65 years old
- Severe respiratory failure (Murray score > 3.0, pH < 7.20), but potentially reversable.
- Exclusion criteria: high pressure (>30cm H2O peak respiratory prassure) or high FiO2 (>0.8) ventilation for more than 7 days, intracranial bleeding, contraindication to continuation of treatment.
- Primary outcome: death or disability at 6 month

Lancet 2009; 374: 1351–63

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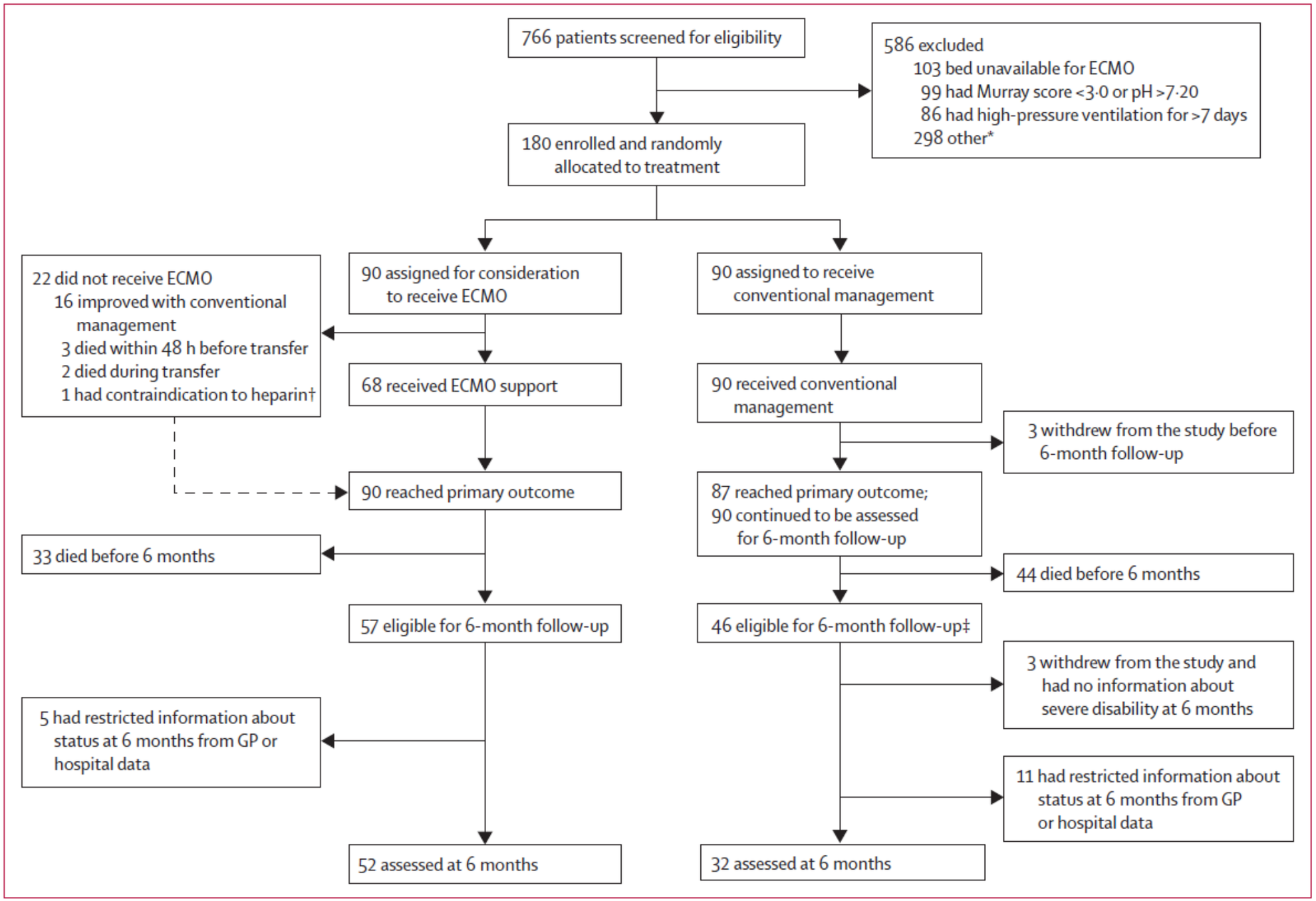

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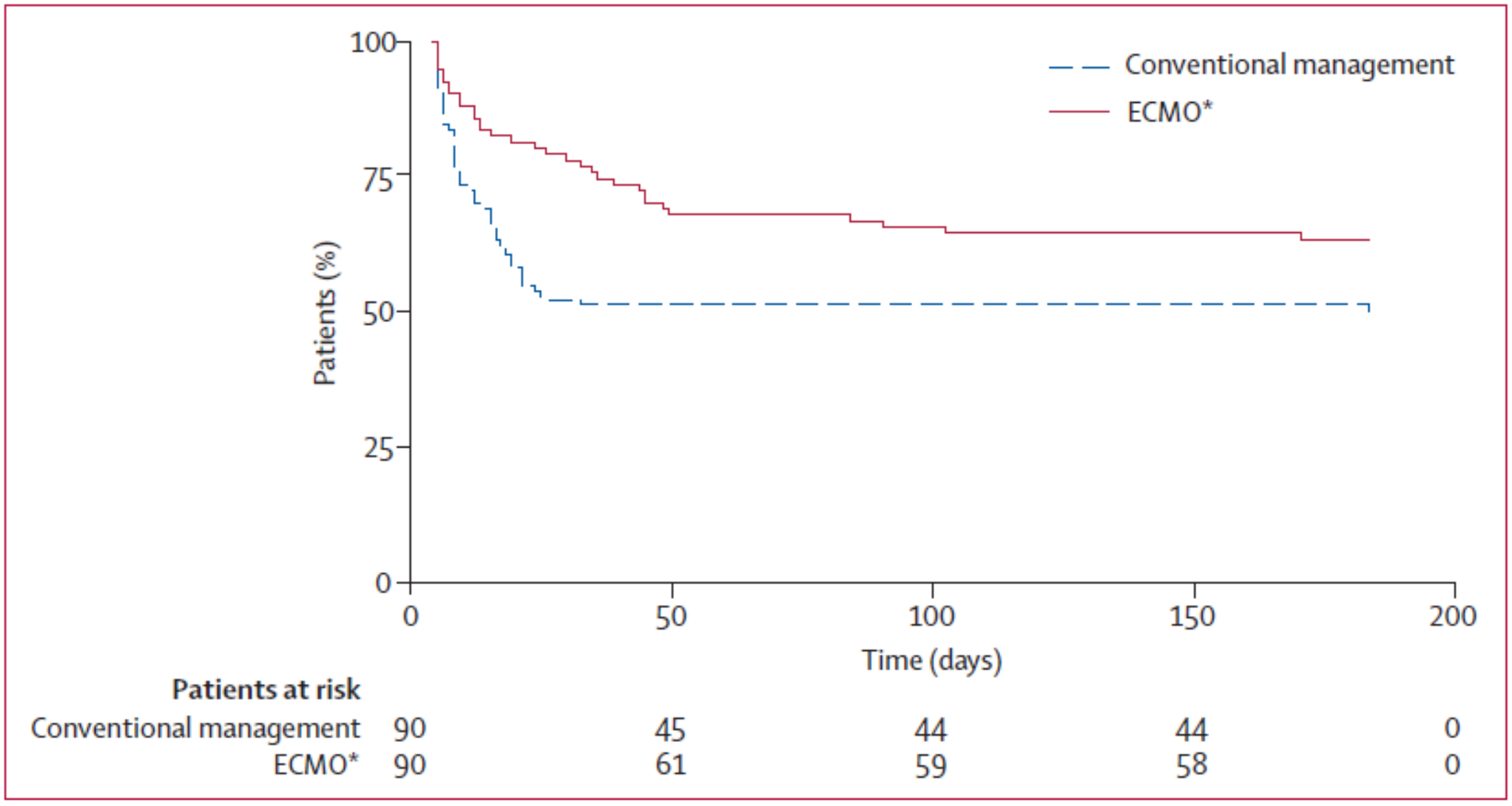
Kaplan-Meier Survival Estimates



Patients at risk					
Conventional management	90	45	44	44	0
ECMO*	90	61	59	58	0

Lancet 2009; 374: 1351–63

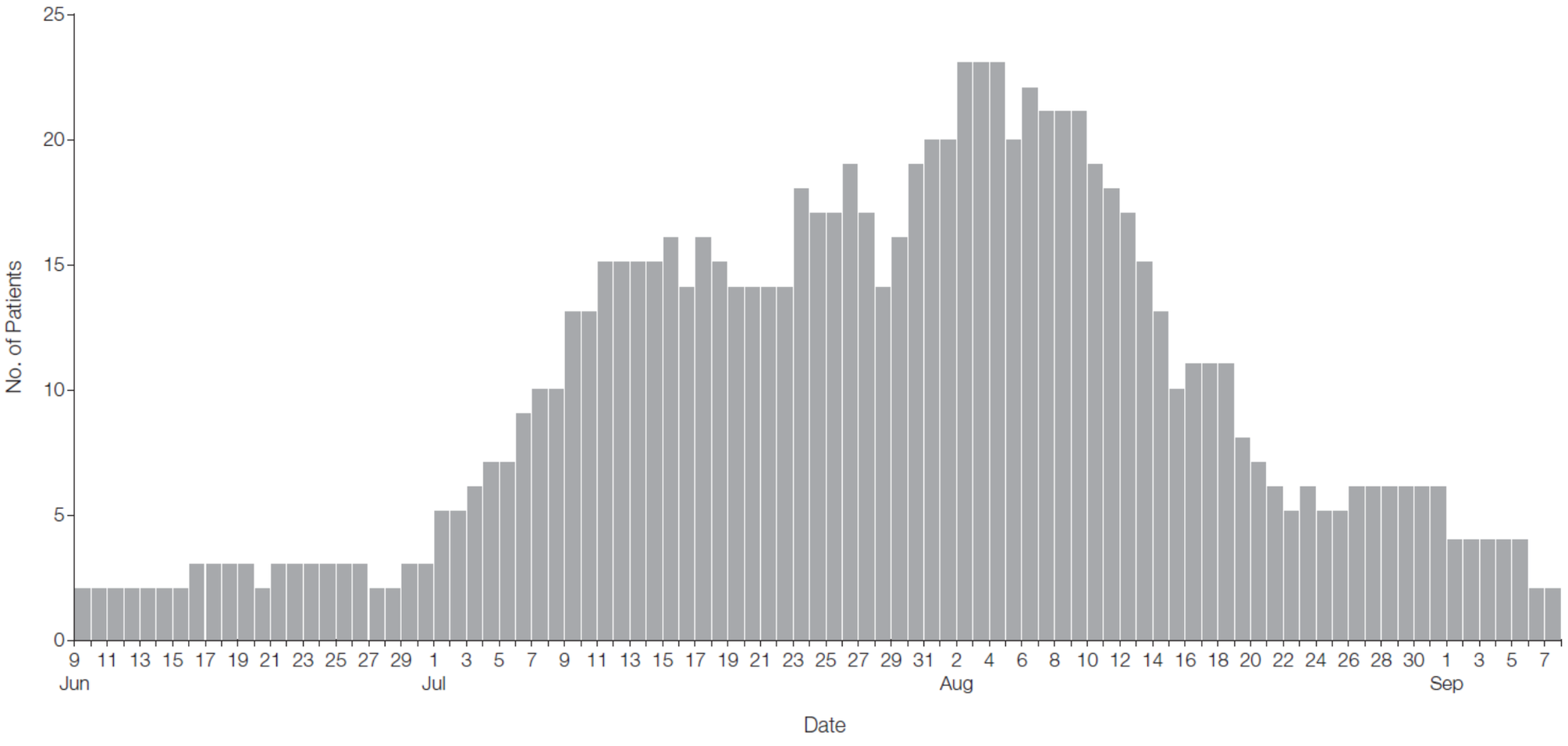
JAMA®

Online article and related content
current as of December 3, 2009.

Extracorporeal Membrane Oxygenation for 2009 Influenza A(H1N1) Acute Respiratory Distress Syndrome

The Australia and New Zealand Extracorporeal Membrane Oxygenation (ANZ ECMO) Influenza Investigators

ECMO treated patients



JAMA. 2009;302(17):1888-1895

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Severity of ARDS before ECMO

Characteristics	2009 Influenza A(H1N1) Confirmed Infection (n = 53)	2009 Influenza A(H1N1) Suspected Infection (n = 15)	All Infections (N = 68)
Ventilation parameters, median (IQR)			
Lowest PaO_2/FIO_2 ratio	55 (48-65)	57 (45-62)	56 (48-63)
Highest FIO_2	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.0)
Highest PEEP, cm H_2O	18 (15-20)	15 (14-18)	18 (15-20)
Highest peak airway pressure, cm H_2O	36 (34-40)	34 (29-36)	36 (33-38)
Lowest pH	7.2 (7.1-7.3)	7.2 (7.1-7.3)	7.2 (7.1-7.3)
Highest $PaCO_2$, mm Hg	69 (54-86)	67 (61-73)	69 (54-83)
Highest tidal volume, mL/kg	5.6 (4.8-6.6)	5.7 (4.4-6.7)	5.6 (4.6-6.7)
Quadrants of radiograph infiltrate, No.	4 (4-4)	4 (4-4)	4 (4-4)
Acute lung injury score[a]	3.8 (3.3-4.0)	3.5 (3.3-3.8)	3.8 (3.5-4.0)
Pneumothorax pre-ECMO, No. (%)	9 (17)	1 (7)	10 (15)
Rescue ARDS therapies used, No. (%)			
Recruitment maneuver	30 (66)	8 (66)	38 (67)
Prone positioning	11 (22)	1 (8)	12 (20)
High-frequency oscillation	3 (6)	0	3 (5)
Nitric oxide	19 (38)	1 (8)	20 (32)
Prostacyclin	12 (23)	2 (15)	14 (22)

Abbreviations: ARDS, acute respiratory distress syndrome; ECMO, extracorporeal membrane oxygenation; FIO_2, fraction of inspired oxygen; IQR, interquartile range; PEEP, positive end-expiratory pressure.

[a] Data were missing in 4 cases for PaO_2/FIO_2 ratio, in 4 cases for PEEP, in 17 cases for lung compliance, and in 5 cases for quadrants of radiograph infiltrate.

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Patient outcomes

Outcome Measure	2009 Influenza A(H1N1) Confirmed Infection (n = 53)	2009 Influenza A(H1N1) Suspected Infection (n = 15)	All Infections (N = 68)
Length of stay, median (IQR), d			
ICU	26 (16-35)	31 (15-38)	27 (16-37)
Hospital	35 (24-45)	40 (27-54)	39 (23-47)
Duration, median (IQR), d			
Mechanical ventilation	24 (13-31)	28 (13-34)	25 (13-34)
ECMO support	10 (7-14)	11 (10-16)	10 (7-15)
Survival at ICU discharge	38 (72)	10 (67)	48 (71)
Still in ICU	4 (8)	2 (13)	6 (9)
Survival at hospital discharge	22 (42)	10 (67)	32 (47)
Still in hospital[b]	14 (26)	2 (13)	16 (24)
Ambulant at hospital discharge[c]	21 (95)	10 (100)	31 (97)
Sa_{O_2} on room air at hospital discharge, median (IQR), %[c]	97 (95-98)	97 (95-98)	97 (95-98)
Discharge destination			
Died	11 (21)	3 (20)	14 (21)
Home	18 (34)	4 (27)	22 (32)
Other hospital	0	1 (7)	1 (1)
Rehabilitation facility	4 (8)	5 (33)	9 (13)
Cause of death[d]			
Hemorrhage	3 (27)	1 (33)	4 (29)
Intracranial hemorrhage	4 (36)	2 (66)	6 (43)
Infection	1 (9)	0	1 (7)
Intractable respiratory failure	3 (27)	1 (33)	4 (29)

JAMA. 2009;302(17):1888-1895

ECMO indications

I. Patient Condition

A: Indications

1. In hypoxic respiratory failure due to any cause (primary or secondary) ECLS should be considered when the risk of mortality is 50% or greater, and is indicated when the risk of mortality is 80% or greater.

a. 50% mortality risk is associated with a PaO2/FiO2 < 150 on FiO2 > 90% and/or Murray score 2-3.

b. 80% mortality risk is associated with a PaO2/FiO2 < 100 on FiO2> 90% and/or Murray score 3-4 despite optimal care for 6 hours or more.

2. CO2 retention on mechanical ventilation despite high Pplat (>30 cm H2O)

3. Severe air leak syndromes

4. Need for intubation in a patient on lung transplant list

5. Immediate cardiac or respiratory collapse (PE, blocked airway, unresponsive to optimal care)

Acute lung injury score

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

ECMO contraindications

B: Contraindications

There are no absolute contraindications to ECLS, as each patient is considered individually with respect to risks and benefits. There are conditions, however, that are associated with a poor outcome despite ECLS, and can be considered relative contraindications.

1. Mechanical ventilation at high settings (FiO2 > .9, P-plat > 30) for7 days or more

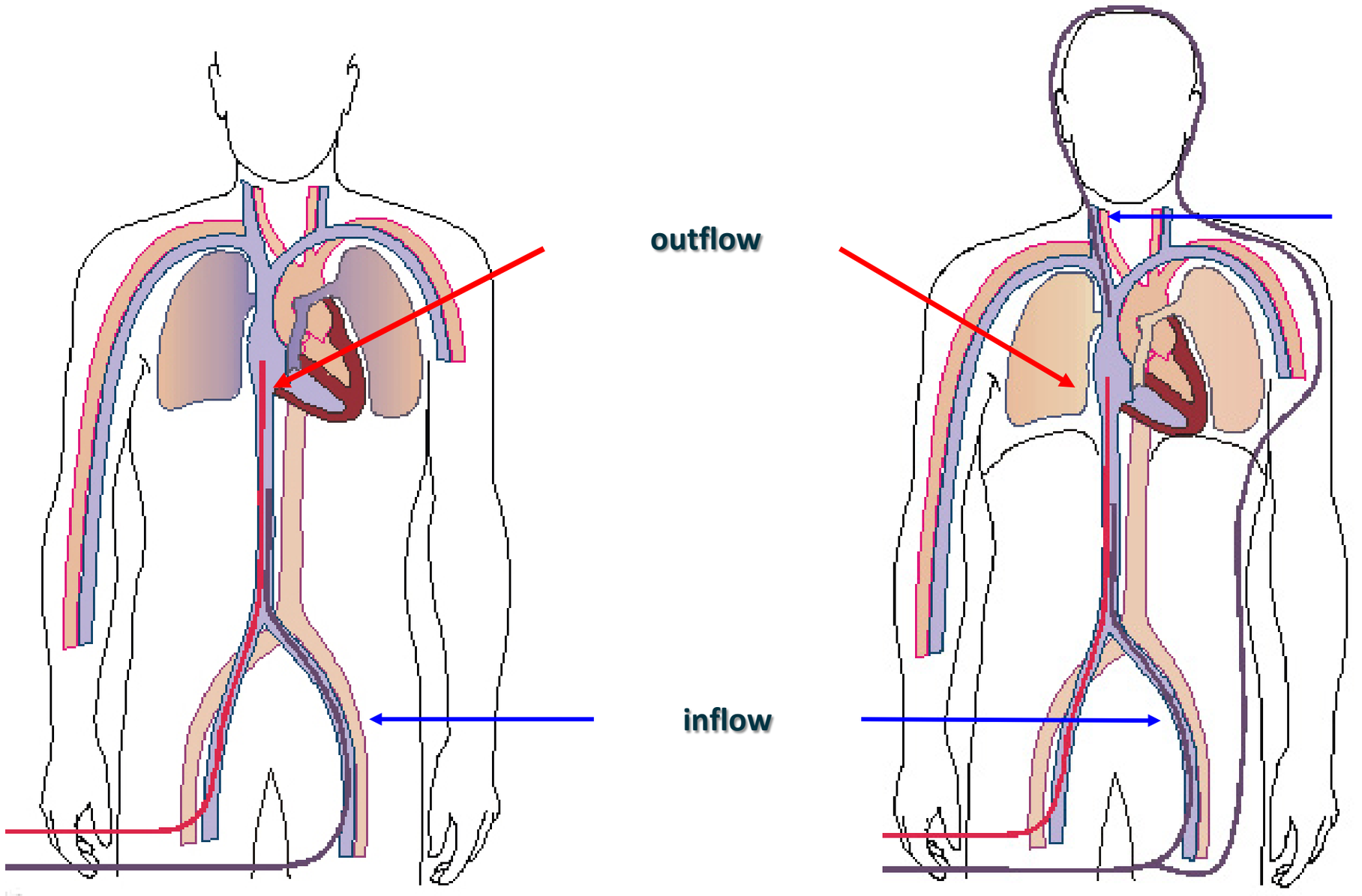
2. Major pharmacologic immunosuppression (absolute neutrophil count <400/mm3)

3. CNS hemorrhage that is recent or expanding

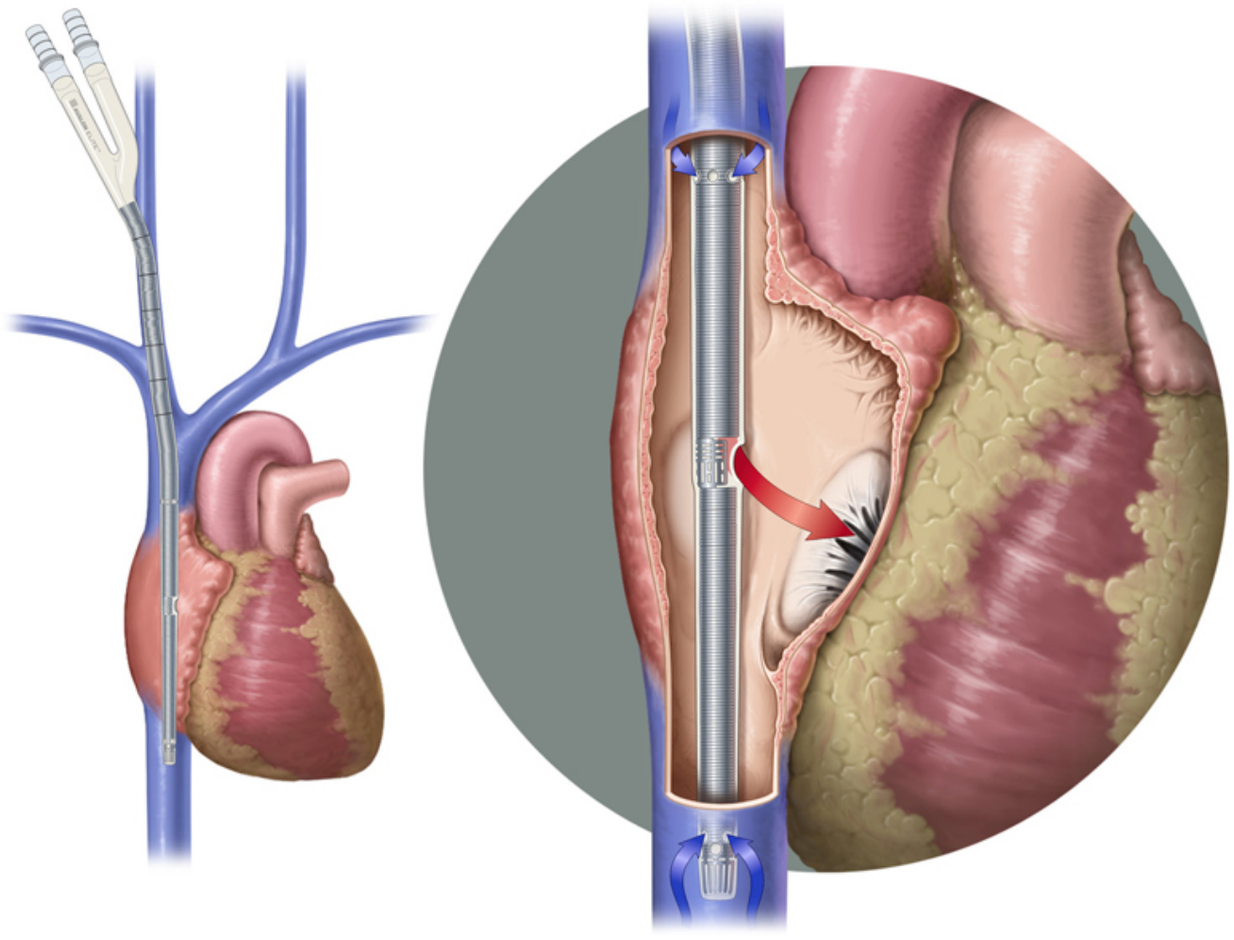
4. Non recoverable co morbidity such as major CNS damage or terminal malignancy

5. Age: no specific age contraindication but consider increasing risk with increasing age

V-V ECMO

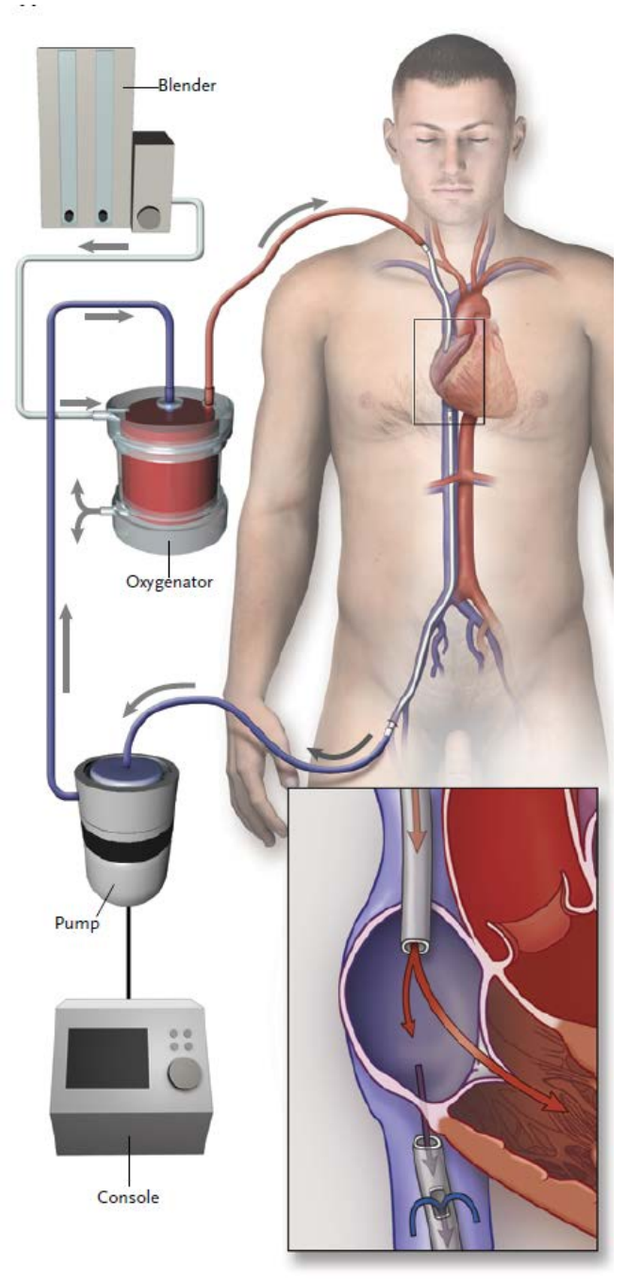


V-V ECMO



V-V ECMO

- Femoral – drainage, jugular – return
- Cannula size:
    - Drainage 21-29 Fr, 50-55 cm
    - Return 17 – 21 Fr, 18-23 cm
- Recirculation
- Blood flow 5-6 l/min (60% CO)

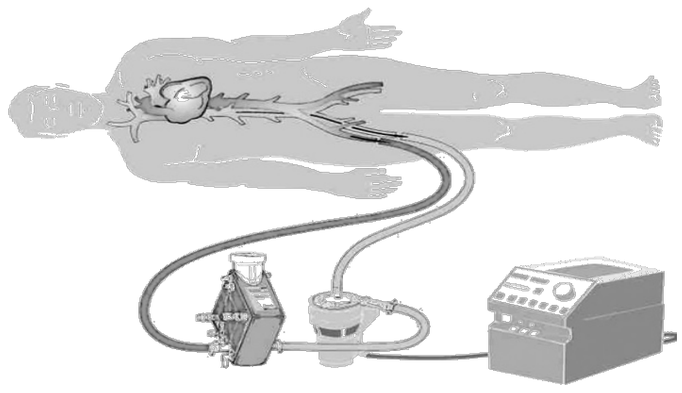


ECMO for severe respiratory failure

Not a treatment

Replaces pulmonary function – provides gas exchange to sustain life of a patient when native lung function cannot

Gives time to treat the patient and allow the lung to recover



Background

No RCTs comparing mechanical lung ventilation strategies during ECMO

Mechanical ventilation on ECMO is guided by trials of conventional treatment of ARDS

The New England
Journal of Medicine

VOLUME 342 MAY 4, 2000 NUMBER 18

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  - Tidal volume 6 ml/kg
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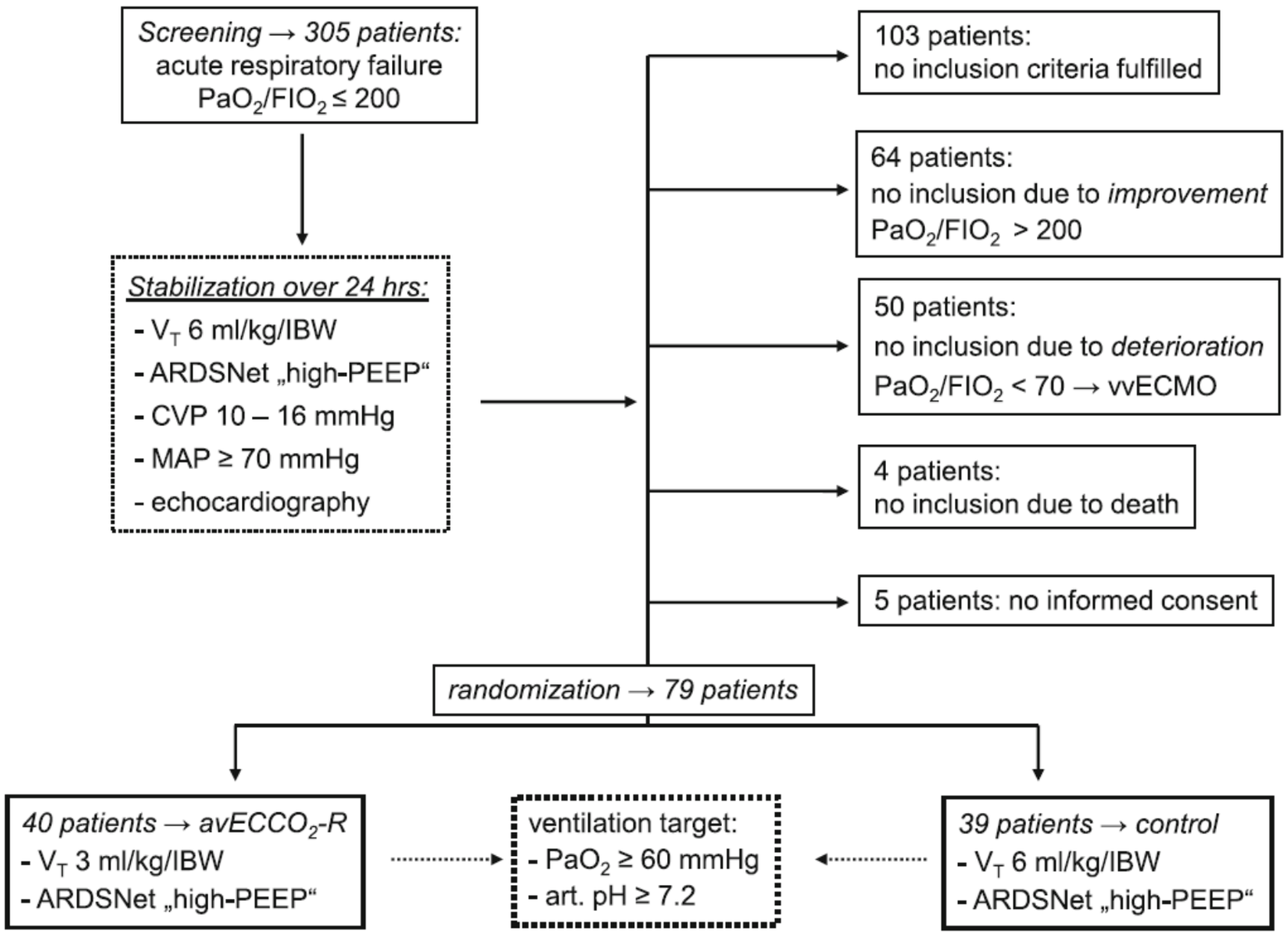
Lower tidal volume strategy ($\approx$ 3 ml/kg) combined with extracorporeal CO_2 removal versus 'conventional' protective ventilation (6 ml/kg) in severe ARDS



Intensive Care Med 2013; 39: 847 - 858

Lower tidal volume strategy ($\approx$3 ml/kg) combined with extracorporeal CO_2 removal versus 'conventional' protective ventilation (6 ml/kg) in severe ARDS

- Ventilation with 3 ml/kg PBV combined with ECCO2-R was safe and feasable
- The use of ECCO2-R was associated with significant reduction in sedation
- The serum levels of pro-inflammatory mediators were significantly reduced
- Ventilation with 3 ml/kg PBV combined with ECCO2-R was not associated with reduction of MV (post hoc – pts with pO2/FiO2 < 150 had significantly shorter ventilation period)

Intensive Care Med 2013; 39: 847 - 858

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JULY 22, 2004 VOL. 351 NO. 4

Higher versus Lower Positive End-Expiratory Pressures in Patients with the Acute Respiratory Distress Syndrome

The National Heart, Lung, and Blood Institute ARDS Clinical Trials Network*

Table 1. Summary of Ventilator Procedures in the Lower- and Higher-PEEP Groups.*

Procedure	Value
Ventilator mode	Volume assist/control
Tidal-volume goal	6 ml/kg of predicted body weight
Plateau-pressure goal	≤30 cm of water
Ventilator rate and pH goal	6–35, adjusted to achieve arterial pH ≥7.30 if possible
Inspiration:expiration time	1:1–1:3
Oxygenation goal	
PaO_2	55–80 mm Hg
SpO_2	88–95%
Allowable combinations of PEEP and FiO_2†	

Lower-PEEP group														
FiO_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 group (before protocol changed to use higher levels of PEEP)														
FiO_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	1.0	
PEEP	5	8	10	12	14	14	16	16	18	20	22	22	22–24	
Higher-PEEP group (after protocol changed to use higher levels of PEEP)														
FiO_2	0.3	0.3	0.4	0.4	0.5	0.5	0.5–0.8	0.8	0.9	1.0				
PEEP	12	14	14	16	16	18	20	22	22	22–24				

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Table 4. Main Outcome Variables.*

Outcome	Lower-PEEP Group	Higher-PEEP Group	P Value
Death before discharge home (%)†			
Unadjusted	24.9	27.5	0.48
Adjusted for differences in baseline covariates	27.5	25.1	0.47
Breathing without assistance by day 28 (%)	72.8	72.3	0.89
No. of ventilator-free days from day 1 to day 28‡	14.5±10.4	13.8±10.6	0.50
No. of days not spent in intensive care unit from day 1 to day 28	12.2±10.4	12.3±10.3	0.83
Barotrauma (%)§	10	11	0.51
No. of days without failure of circulatory, coagulation, hepatic, and renal organs from day 1 to day 28	16±11	16±11	0.82

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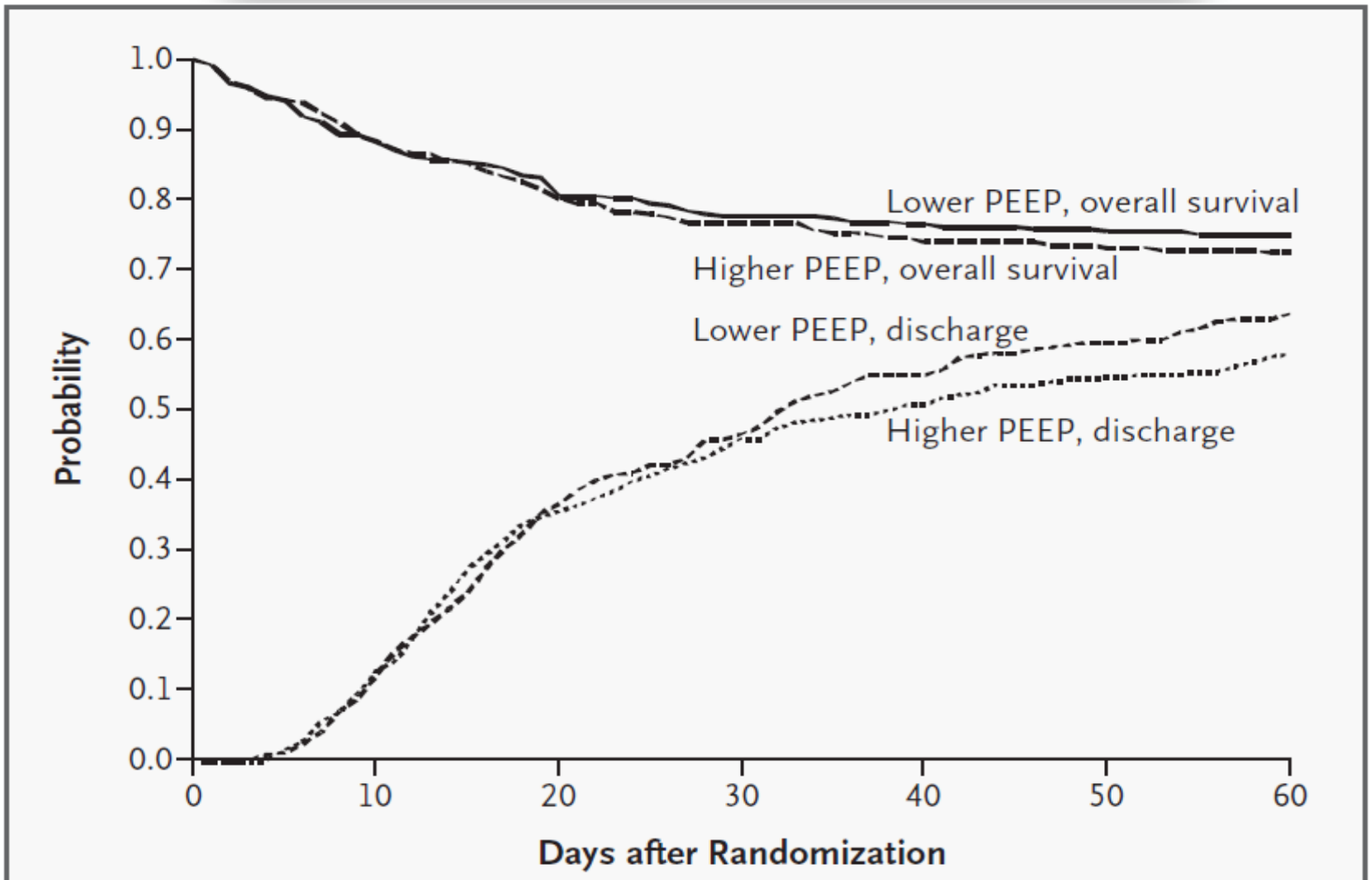
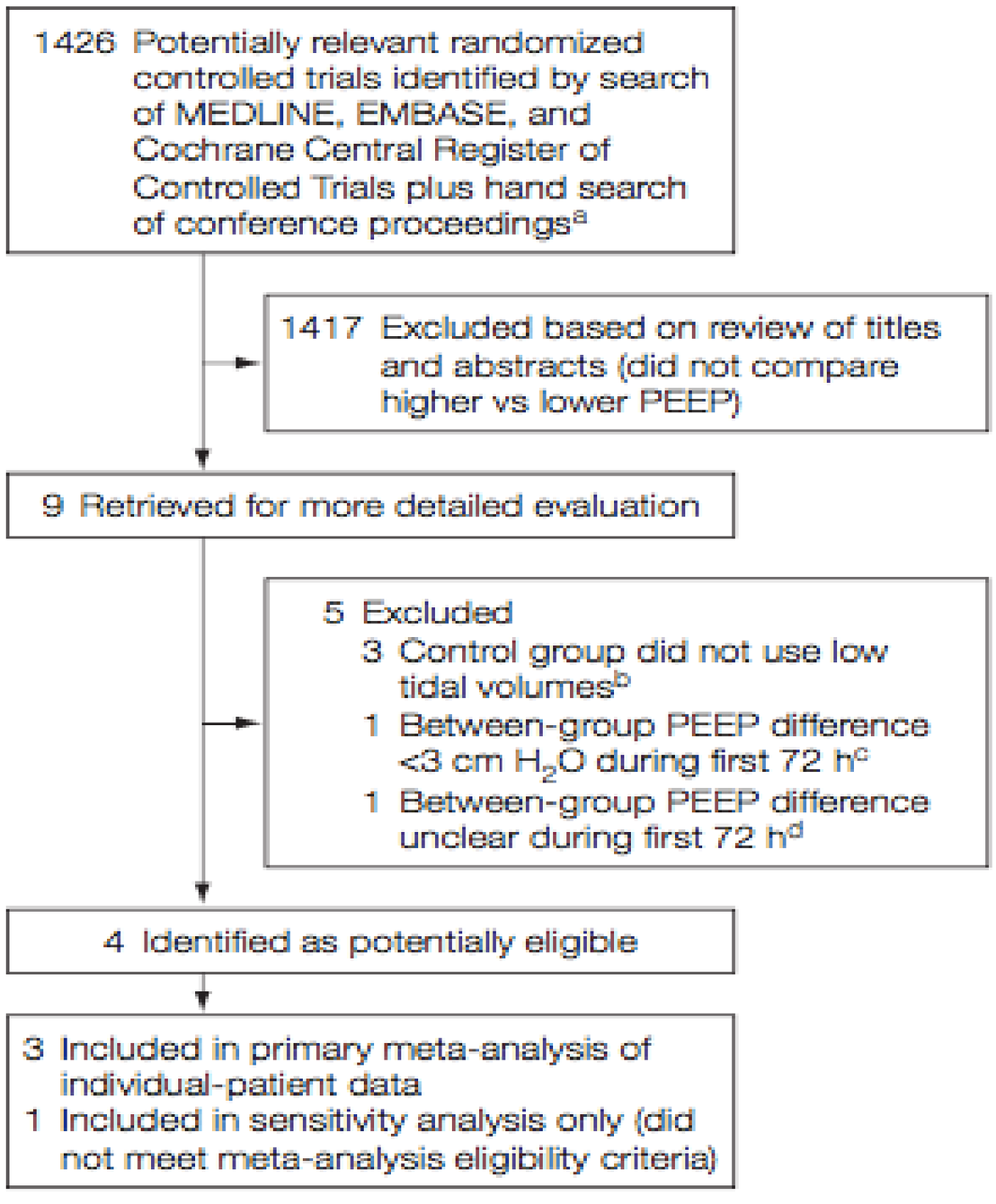


Figure 1. Probabilities of Survival and of Discharge Home While Breathing without Assistance, from the Day of Randomization (Day 0) to Day 60 among Patients with Acute Lung Injury and ARDS, According to Whether Patients Received Lower or Higher Levels of PEEP.

Higher vs Lower Positive End-Expiratory Pressure in Patients With Acute Lung Injury and Acute Respiratory Distress Syndrome

Systematic Review and Meta-analysis



JAMA. 2010;303(9):865-873

Higher vs Lower Positive End-Expiratory Pressure in Patients With Acute Lung Injury and Acute Respiratory Distress Syndrome

Systematic Review and Meta-analysis

Table 4. Clinical Outcomes in All Patients and Stratified by Presence of ARDS at Baseline

	All Patients				With ARDS				Without ARDS			
	No. (%)				No. (%)				No. (%)			
Outcomes	Higher PEEP (n = 1136)	Lower PEEP (n = 1163)	Adjusted RR (95% CI)[a]	*P* Value	Higher PEEP (n = 951)	Lower PEEP (n = 941)	Adjusted RR (95% CI)[a]	*P* Value	Higher PEEP (n = 184)	Lower PEEP (n = 220)	Adjusted RR (95% CI)[a]	*P* Value
Death in hospital	374 (32.9)	409 (35.2)	0.94 (0.86 to 1.04)	.25	324 (34.1)	368 (39.1)	0.90 (0.81 to 1.00)	.049	50 (27.2)	44 (19.4)	1.37 (0.98 to 1.92)	.07
Death in ICU[b]	324 (28.5)	381 (32.8)	0.87 (0.78 to 0.97)	.01	288 (30.3)	344 (36.6)	0.85 (0.76 to 0.95)	.001	36 (19.6)	37 (16.8)	1.07 (0.74 to 1.55)	.71
Pneumothorax between day 1 and day 28[c]	87 (7.7)	75 (6.5)	1.19 (0.89 to 1.60)	.24	80 (8.4)	64 (6.8)	1.25 (0.94 to 1.68)	.13	7 (3.8)	11 (5.0)	0.72 (0.37 to 1.39)	.33
Death after pneumothorax[c]	43 (3.8)	40 (3.5)	1.11 (0.73 to 1.69)	.63	41 (4.3)	35 (3.7)	1.20 (0.79 to 1.81)	.39	2 (1.1)	5 (2.3)	0.44 (0.08 to 2.35)[g]	.34

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Prone Positioning in Severe Acute Respiratory Distress Syndrome

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

Outcome	Supine Group (N=229)	Prone Group (N=237)	Hazard Ratio or Odds Ratio with the Prone Position (95% CI)	P Value
Mortality — no. (% [95% CI])				
At day 28				
Not adjusted	75 (32.8 [26.4–38.6])	38 (16.0 [11.3–20.7])	0.39 (0.25–0.63)	<0.001
Adjusted for SOFA score†			0.42 (0.26–0.66)	<0.001
At day 90				
Not adjusted	94 (41.0 [34.6–47.4])	56 (23.6 [18.2–29.0])	0.44 (0.29–0.67)	<0.001
Adjusted for SOFA score†			0.48 (0.32–0.72)	<0.001
Successful extubation at day 90 — no./total no. (% [95% CI])	145/223 (65.0 [58.7–71.3])	186/231 (80.5 [75.4–85.6])	0.45 (0.29–0.70)	<0.001
Time to successful extubation, assessed at day 90 — days				
Survivors	19±21	17±16		0.87
Nonsurvivors	16±11	18±14		
Length of ICU stay, assessed at day 90 — days				
Survivors	26±27	24±22		0.05
Nonsurvivors	18±15	21±20		
Ventilation-free days				
At day 28	10±10	14±9		<0.001
At day 90	43±38	57±34		<0.001
Pneumothorax — no. (% [95% CI])	13 (5.7 [3.9–7.5])	15 (6.3 [4.9–7.7])	0.89 (0.39–2.02)	0.85
Noninvasive ventilation — no./total no. (% [95% CI])				
At day 28	10/212 (4.7 [1.9–7.5])	4/228 (1.8 [0.1–3.5])	0.36 (0.07–3.50)	0.11
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

The NEW ENGLAND JOURNAL of MEDICINE

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

Prone Positioning in Severe Acute Respiratory Distress Syndrome

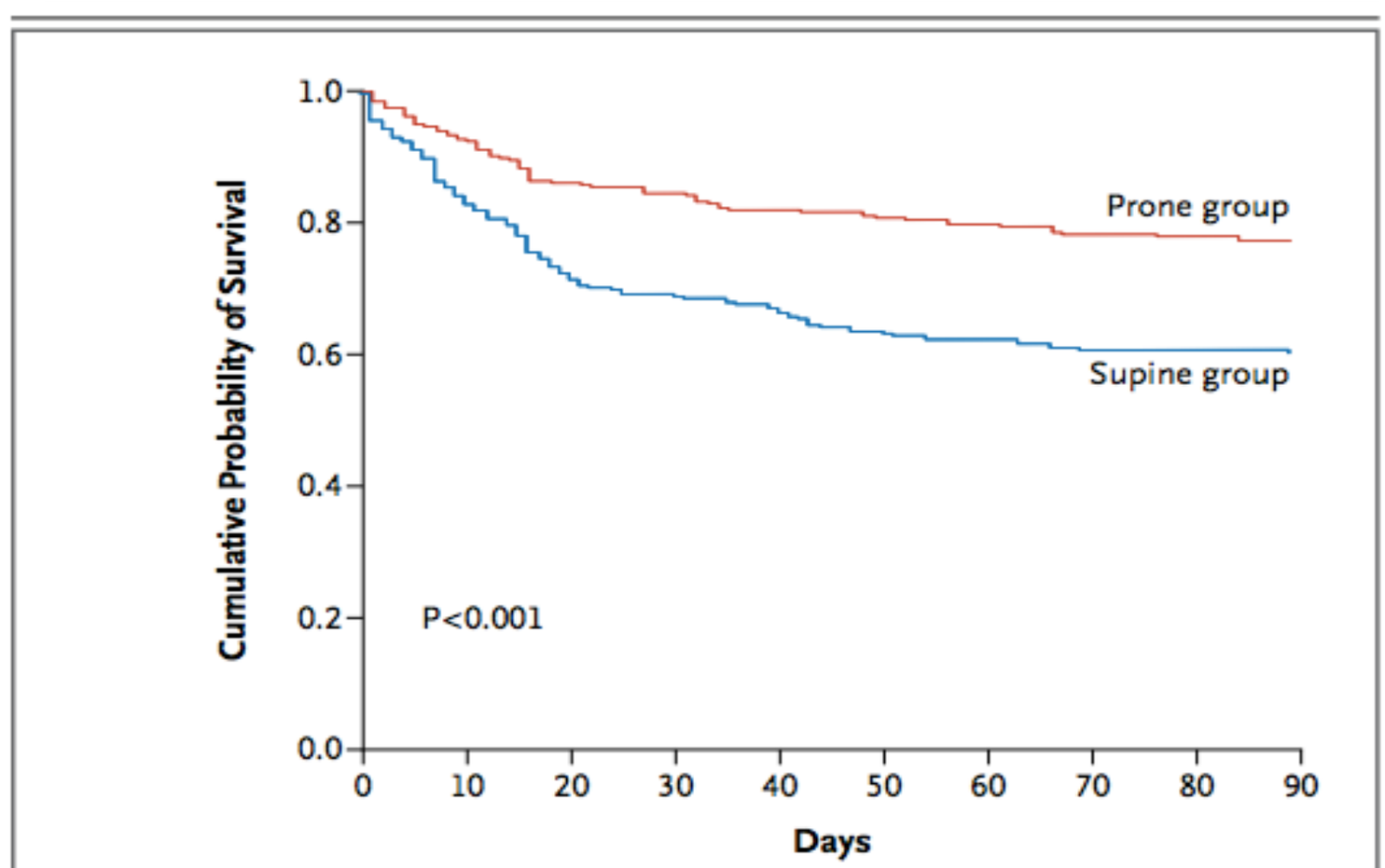

Figure 2. Kaplan–Meier Plot of the Probability of Survival from Randomization to Day 90.

Prone position during ECMO is safe and improves oxygenation

Valesca Kipping[*1], Steffen Weber-Carstens*[*1], Christian Lojewski[1], Paul Feldmann[1], Antje Rydlewski[1], Willehad Boemke[1], Claudia Spies[1], Marc Kastrup[1], Udo X. Kaisers[2], Klaus-D. Wernecke[3], Maria Deja[1]*

TABLE III - CLINICAL PARAMETERS DURING AND AFTER PRONE POSITIONINGS

	1st procedure			2nd procedure			Multivariate nonparametric analysis of longitudinal data in a two-factorial design (MANOVA)		
Parameter median (IQR)	**pre-PrP**	**in-PrP**	**post-PrP**	**pre-PrP**	**in-PrP**	**post-PrP**	$F_{Position}$	$F_{Procedure}$	**Interactions**
PaO_2/FiO_2, mmHg	69 (53-155)	100 (76-114)	94 (76-112)	81 (62-128)	105 (83-219)	128 (69-237)	p = 0.002	p = 0.06	p = 0.62
PEEP, cmH_2O	16.5 (16-22.3)	16.5 (16-22.3)	17.5 (16.3-22.3)	18 (16.3-21.3)	17.5 (16-19.8)	17 (16-19.8)	p = 0.62	p = 0.41	p = 0.03
PIP, cmH_2O	35.5 (29.8-38.5)	35 (29.8-42)	34 (31.3-38.5)	37.5 (32.5-39.8)	36 (32.25-38)	35.5 (30.5-37.8)	p = 0.11	p = 0.63	p = 0.051
BF ECMO, l/min	3.4 (2.4-4.1)	3.4 (3-4.1)	3.4 (3-4.1)	3.7 (3-4.1)	3.8 (3.2-4.4)	3.6 (3.2-4.3)	p = 0.57	p = 0.14	p = 0.34
$PaCO_2$, mmHg	46 (43-51)	46 (41-51)	47 (40-48)	40 (36-47)	42 (37-45)	41 (39-46)	p = 0.84	p<0.001	p = 0.45

Int J Artif Organs 2013; 36 (11): 821-832

Prone position during ECMO is safe and improves oxygenation

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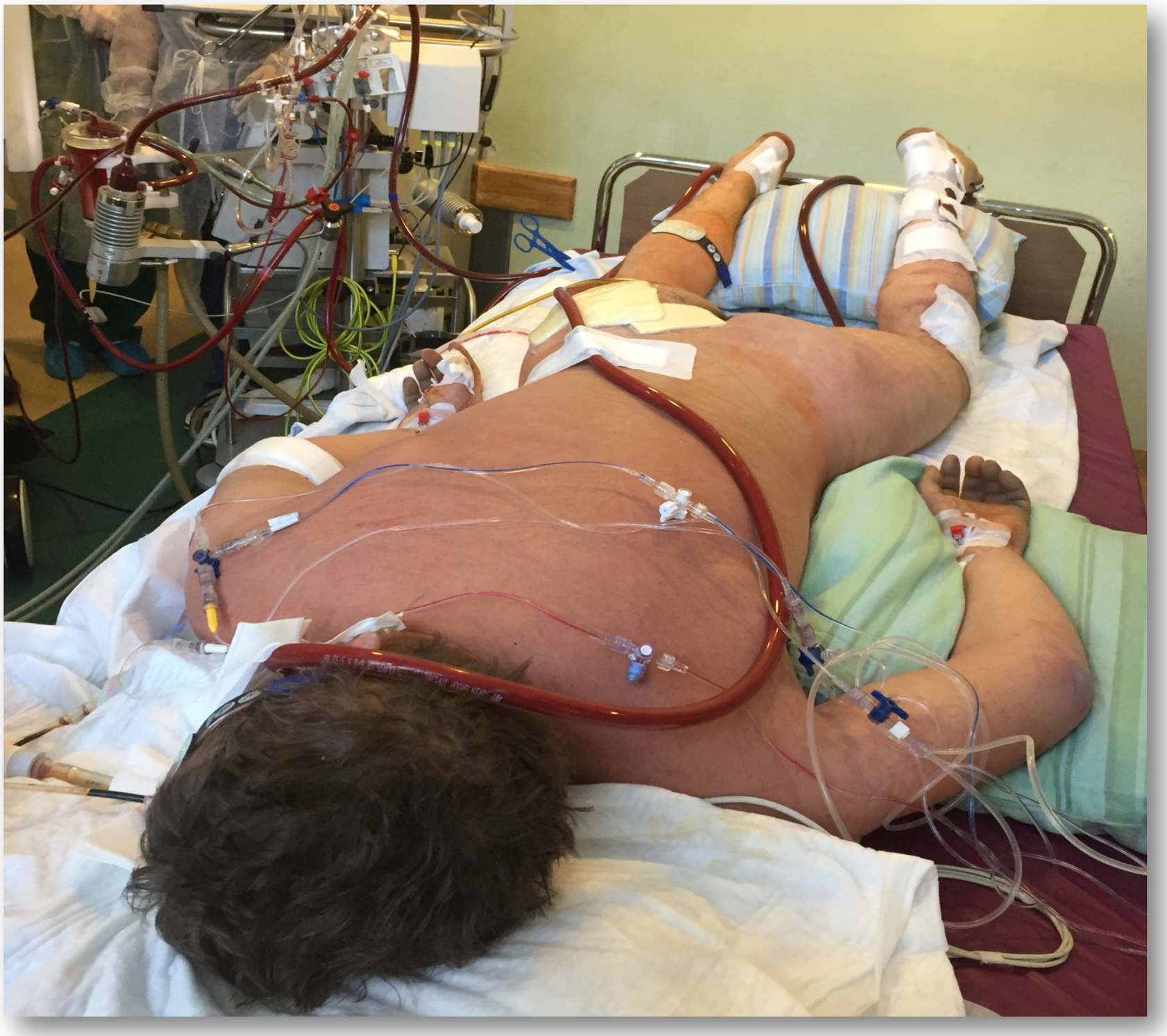
Prone positioning in ECMO is feasible and safe (12 ECMO pts, 74 procedures of proning)

- No dislocations of intravascular catheters/cannulae, endotracheal tubes or chest tubes.
- Two procedures had to be interrupted

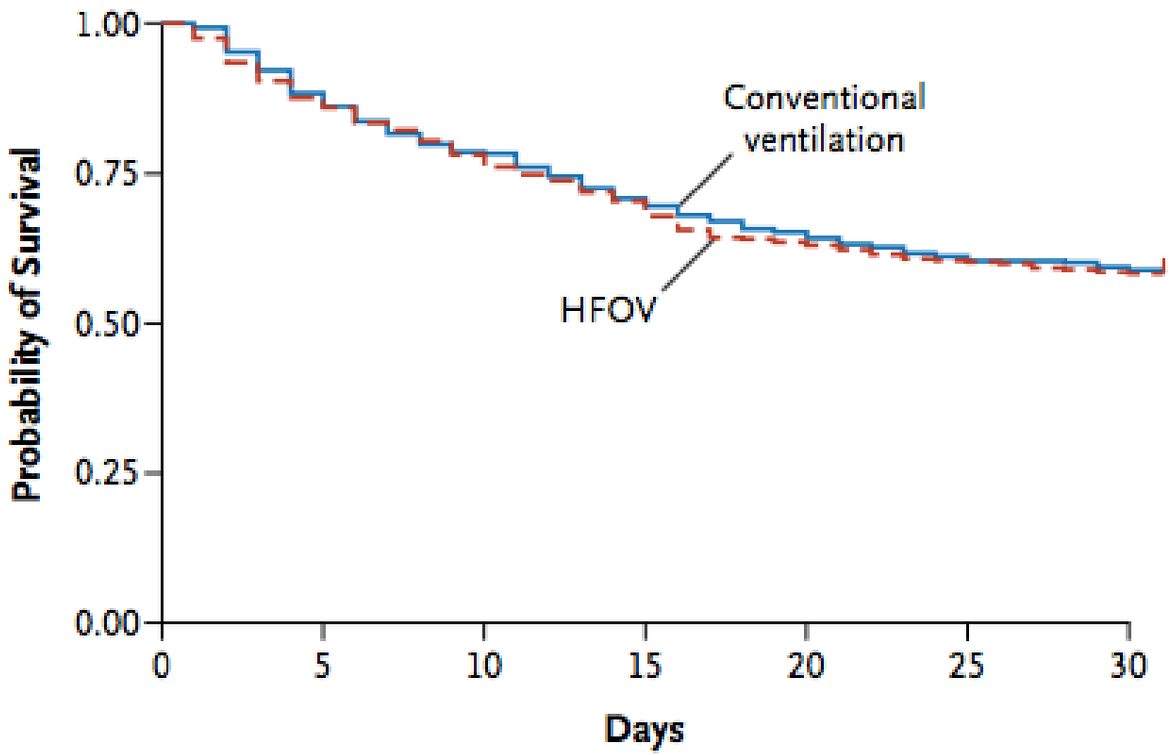
Int J Artif Organs 2013; 36 (11): 821-832



ORIGINAL ARTICLE

High-Frequency Oscillation for Acute Respiratory Distress Syndrome

Duncan Young, D.M., Sarah E. Lamb, D.Phil., Sanjoy Shah, M.D., Iain MacKenzie, M.D., William Tunnicliffe, M.Sc., Ranjit Lall, Ph.D., Kathy Rowan, D.Phil., and Brian H. Cuthbertson, M.D., for the OSCAR Study Group*



No. at Risk							
Conventional ventilation	397	351	312	281	259	243	236
HFOV	398	349	311	280	253	241	233

Figure 3. Kaplan–Meier Survival Estimates during the First 30 Study Days.

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 FEBRUARY 28, 2013 VOL. 368 NO. 9

High-Frequency Oscillation in Early Acute Respiratory Distress Syndrome

Niall D. Ferguson, M.D., Deborah J. Cook, M.D., Gordon H. Guyatt, M.D., Sangeeta Mehta, M.D., Lori Hand, R.R.T., Peggy Austin, C.C.R.A., Qi Zhou, Ph.D., Andrea Matte, R.R.T., Stephen D. Walter, Ph.D., Francois Lamontagne, M.D., John T. Granton, M.D., Yaseen M. Arabi, M.D., Alejandro C. Arroliga, M.D., Thomas E. Stewart, M.D., Arthur S. Slutsky, M.D., and Maureen O. Meade, M.D., for the OSCILLATE Trial Investigators and the Canadian Critical Care Trials Group*

Table 4. Outcomes.

Outcome	HFOV Group (N = 275)	Control Group (N = 273)	Relative Risk (95% CI)	P Value
Death in hospital — no. (%)	129 (47)	96 (35)	1.33 (1.09–1.64)	0.005
Death in intensive care unit — no. (%)	123 (45)	84 (31)	1.45 (1.17–1.81)	0.001
Death before day 28 — no. (%)	111 (40)	78 (29)	1.41 (1.12–1.79)	0.004
New barotrauma — no./total no. (%)*	46/256 (18)	34/259 (13)	1.37 (0.91–2.06)	0.13
New tracheostomy — no./total no. (%)†	59/273 (22)	66/267 (25)	0.87 (0.64–1.19)	0.39
Refractory hypoxemia — no. (%)	19 (7)	38 (14)	0.50 (0.29–0.84)	0.007
Death after refractory hypoxemia — no./total no. (%)	15/19 (79)	25/38 (66)	1.20 (0.87–1.66)	0.31
Refractory acidosis — no. (%)	9 (3)	8 (3)	1.12 (0.44–2.85)	0.82
Refractory barotrauma — no. (%)	2 (<1)	2 (<1)	0.99 (0.14–7.00)	0.99
Use of mechanical ventilation, among survivors — days				0.59
Median	11	10		
Interquartile range	7–19	6–18		
Stay in intensive care, among survivors — days				0.93
Median	15	14		
Interquartile range	9–25	9–26		
Length of hospitalization, among survivors — days				0.74
Median	30	25		
Interquartile range	16–45	15–41		

CRITICAL CARE

Mechanical ventilation during extracorporeal membrane oxygenation

Matthieu Schmidt[1*], Vincent Pellegrino[2], Alain Combes[3], Carlos Scheinkestel[2], D Jamie Cooper[1,2] and Carol Hodgson[1,2]

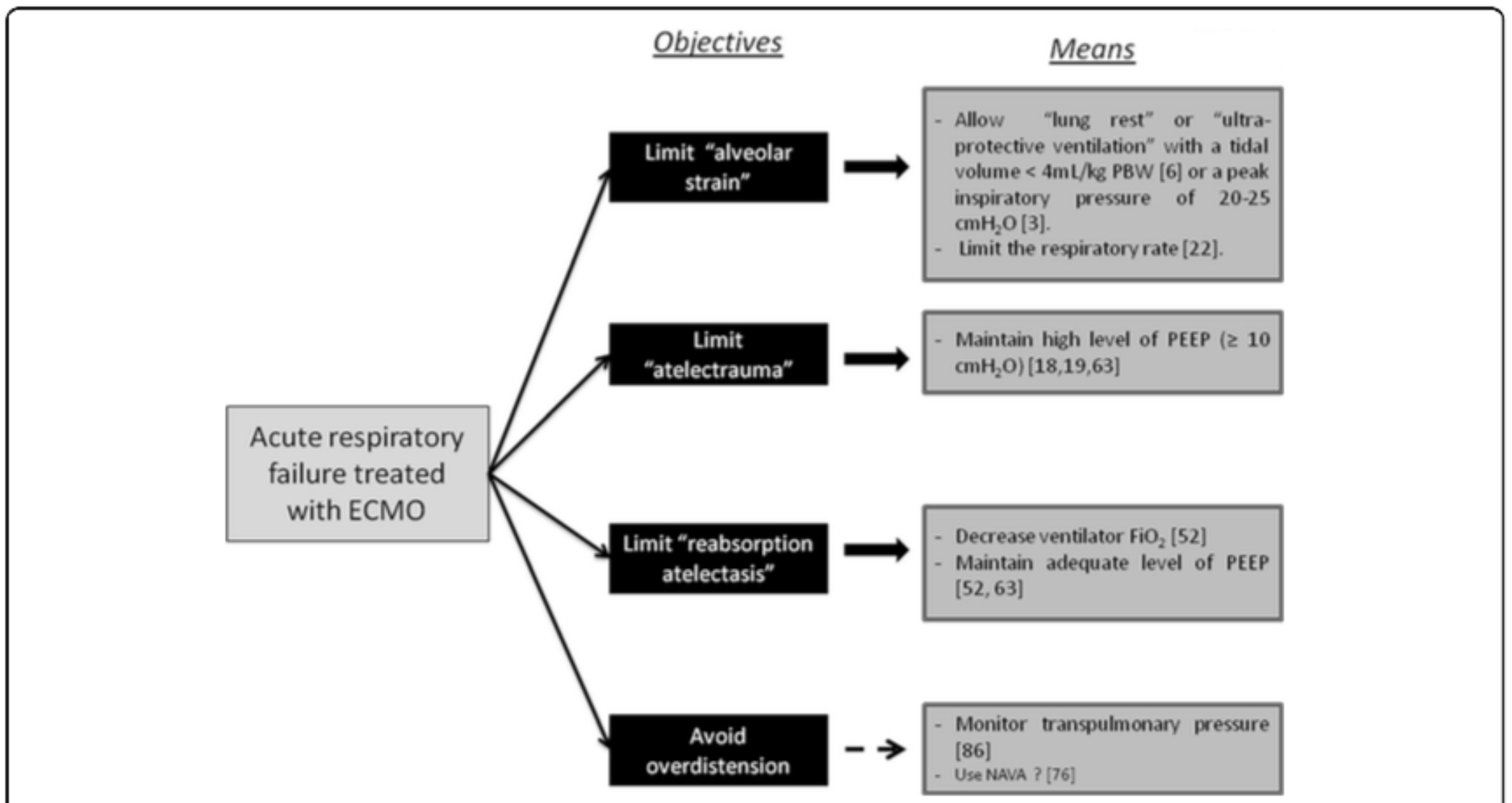


Figure 1 Specifications of mechanical ventilation with extracorporeal membrane oxygenation for patients with severe acute respiratory failure. ECMO, extracorporeal membrane oxygenation; FiO_2, fraction of inspired oxygen; NAVA, neurally adjusted ventilator assist; PBW, predicted body weight; PEEP, positive end-expiratory pressure.

Mechanical Ventilation during Extracorporeal Membrane Oxygenation

An International Survey

Jonathan D. Marhong*, Teagan Telesnicki*, Laveena Munshi, Lorenzo Del Sorbo, Michael Detsky, and Eddy Fan

Interdepartmental Division of Critical Care Medicine, and Department of Medicine, University of Toronto, University Health Network and Mount Sinai Hospital, Toronto, Ontario, Canada

- ECMO survey – ELSO reporting centers
- 27% had explicit mechanical ventilation protocol for VV ECMO patients
- “lung rest” – 77%, “lung recruitment” – 18%
- Controlled ventilation mode – 62%, spontaneous breathing modes – 27%

AnnalsATS Volume 11 Number 6 | July 2014

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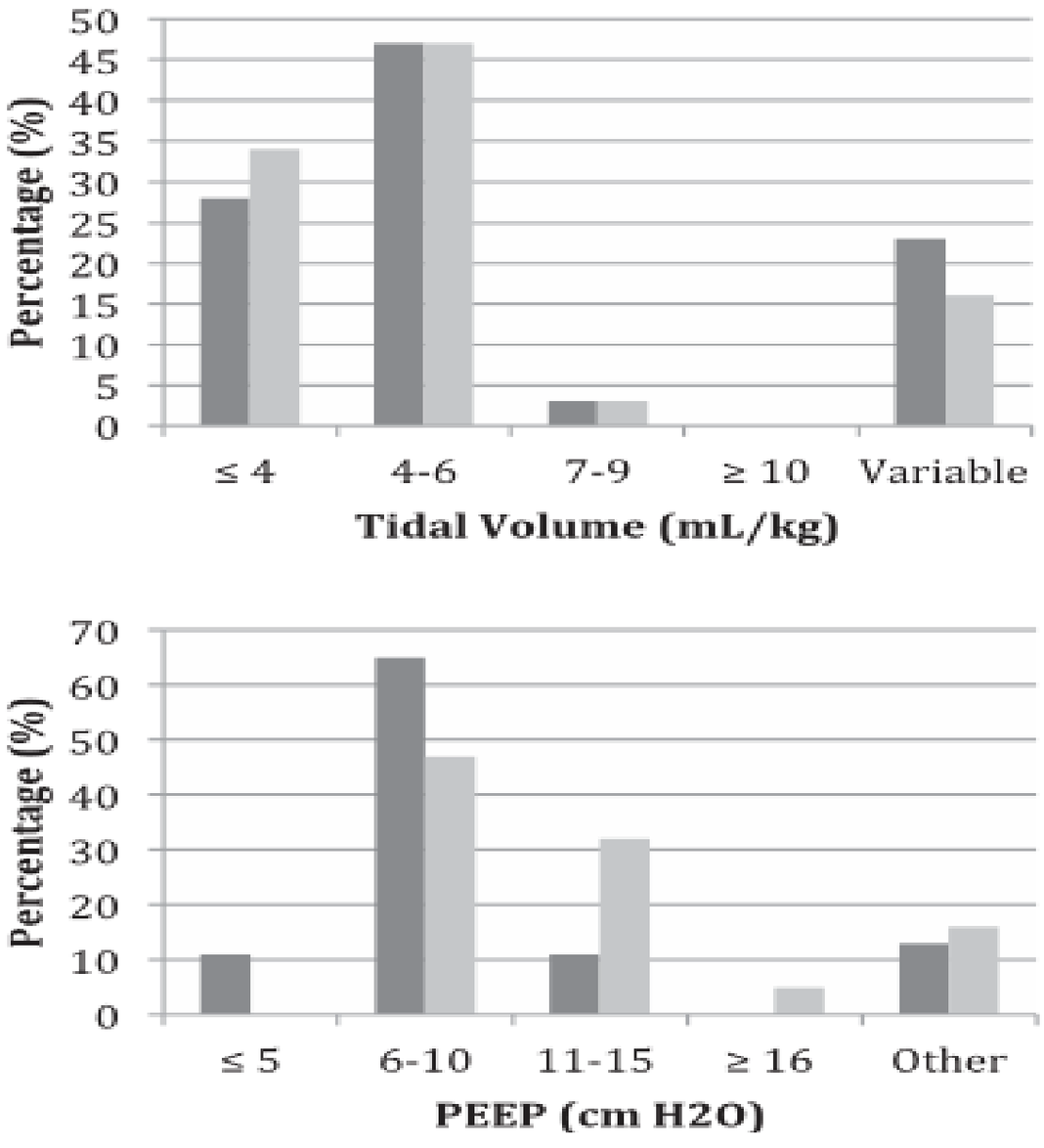

Ventilatation strategies on ECMO

a) First 24 hours: moderate to heavy sedation.

Pressure controlled ventilation at 25/15, I:E 2:1, rate 5, FiO2 50% ,FiN2 50% If initial PaCO2>50, increase sweep slowly to bring PaCO2 down slowly, 10-20 mmHg/hour

b) After 24-48 hours: (Stable hemodynamics off pressors, fluid balance underway, sepsis Rx underway) moderate to minimal sedation.

Pressure controlled vent at 20/10. I:E 2:1, rate 5 plus spontaneous breaths, FiO2 .2-.4, FiN2 60-80%. (rest settings)

c) After 48 hours Minimal to no sedation.

PCV as above or CPAP20 plus spontaneous breathing. Trach or extubate within 3-5 days

Ventilatation strategies on ECMO

Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

Giles J Peek, Miranda Mugford, Ravindranath Tiruvoipati, Andrew Wilson, Elizabeth Allen, Mariamma M Thalanany, Clare L Hibbert, Ann Truesdale, Felicity Clemens, Nicola Cooper, Richard K Firmin, Diana Elbourne, for the CESAR trial collaboration

Pressure control ventilation

- Peek inspiratory pressure 20-25 cmH2O
- PEEP between 10 – 15 cmH2O
- Respiratory rate – 10 cycles/min
- FiO2 – 30%

ECLS Registry Report

International Summary

January, 2016

Extracorporeal Life Support Organization
2800 Plymouth Road
Building 300, Room 303
Ann Arbor, MI 48109

Overall Outcomes

	Total Patients	*Survived ECLS*		*Survived to DC or Transfer*	
Neonatal					
Respiratory	28,723	24,155	84%	21,274	74%
Cardiac	6,269	3,885	62%	2,599	41%
ECPR	1,254	806	64%	514	41%
Pediatric					
Respiratory	7,210	4,787	66%	4,155	58%
Cardiac	8,021	5,341	67%	4,067	51%
ECPR	2,788	1,532	55%	1,144	41%
Adult					
Respiratory	9,102	5,989	66%	5,254	58%
Cardiac	7,850	4,394	56%	3,233	41%
ECPR	2,379	948	40%	707	30%
Total	73,596	51,837	70%	42,947	58%

Predicting Survival after Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure

The Respiratory Extracorporeal Membrane Oxygenation Survival Prediction (RESP) Score

Matthieu Schmidt[1,2], Michael Bailey[1,3], Jayne Sheldrake[3], Carol Hodgson[1,3], Cecile Aubron[1], Peter T. Rycus[4], Carlos Scheinkestel[3], D. Jamie Cooper[1,3], Daniel Brodie[4,5], Vincent Pellegrino[1,3], Alain Combes[2], and David Pilcher[1,3]

- Retrospective review of 2355 ELSO registry adult pts with severe acute respiratory failure (2000-2012)
- Validated on 140 multicenter French pts used to create Preserve score
- Help clinicians to target patients most likely to get benefit from ECMO

American Journal of Respiratory and Critical Care Medicine Volume 189 Number 11 | June 1 2014

Predicting Survival after Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure

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Table 3: The RESP Score at ECMO Initiation

Parameter	Score
Age, yr	
18 to 49	0
50 to 59	−2
⩾60	−3
Immunocompromised status*	−2
Mechanical ventilation prior to initiation of ECMO	
<48 h	3
48 h to 7 d	1
>7 d	0
Acute respiratory diagnosis group (select only one)	
Viral pneumonia	3
Bacterial pneumonia	3
Asthma	11
Trauma and burn	3
Aspiration pneumonitis	5
Other acute respiratory diagnoses	1
Nonrespiratory and chronic respiratory diagnoses	0
Central nervous system dysfunction†	−7
Acute associated (nonpulmonary) infection‡	−3
Neuromuscular blockade agents before ECMO	1
Nitric oxide use before ECMO	−1
Bicarbonate infusion before ECMO	−2
Cardiac arrest before ECMO	−2
Pa_{CO_2}, mm Hg	
<75	0
⩾75	−1
Peak inspiratory pressure, cm H_2O	
<42	0
⩾42	−1
Total score	−22 to 15

Predicting Survival after Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Failure

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Table 3: The RESP Score at ECMO Initiation

Parameter	Score
Age, yr	
18 to 49	0
50 to 59	2
Cardiac arrest before ECMO	−2
Pa_{CO_2}, mm Hg	
<75	0
⩾75	−1
Peak inspiratory pressure, cm H_2O	
<42	0
⩾42	−1
Total score	−22 to 15

Hospital Survival by Risk Class

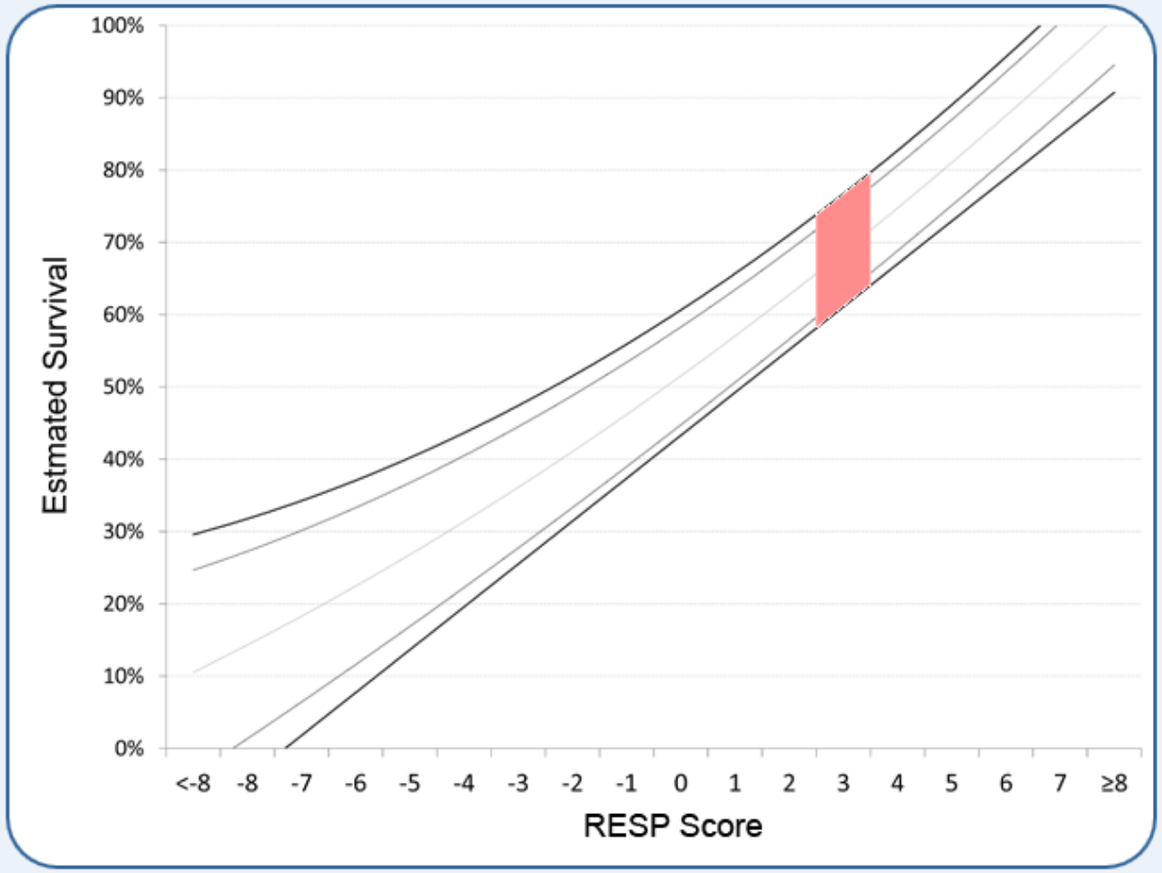
Total RESP Score	Risk Class	Survival
⩾6	I	92%
3 to 5	II	76%
−1 to 2	III	57%
−5 to −2	IV	33%
⩽−6	V	18%

Extracorporeal Life Support Organization

The **RESP** Score

The RESP Score has been developed by **ELSO** and **The Department of Intensive Care at The Alfred Hospital, Melbourne**. It is designed to assist prediction of survival for adult patients undergoing Extra-Corporeal Membrane Oxygenation for respiratory failure. It should not be considered for patients who are not on ECMO or as substitute for clinical assessment.

For more information see:
Schmidt M, Bailey M, Sheldrake J, et al. Predicting Survival after ECMO for Severe Acute Respiratory Failure: the Respiratory ECMO Survival Prediction (RESP)-Score. Am J Respir Crit Care Med. 2014.



TheAlfred

The patient's RESP Score is

3

Age (years:)

18-49 ○
50-59 ◉
≥60 ○

Immunocompromised NO

Mechanical ventilation prior to initiation of ECMO

<48 hours ◉
48 hours - 7 days ○
>7 days ○

Acute Respiratory diagnosis group

Viral pneumonia ◉
Bacterial pneumonia ○
Asthma ○
Trauma/burn ○
Aspiration pneumonitis ○
Other acute respiratory diagnosis ○
Non-respiratory and chronic respiratory diagnoses ○

Central nervous system dysfunction NO

Acute associated (non-pulmonary) infection NO

Neuro-muscular blockade before ECMO NO

Nitric oxide use before ECMO YES

Bicarbonate infusion before ECMO NO

Cardiac arrest before ECMO NO

$PaCO_2$ ≥75 mmHg / 10kpa NO

Peak inspiratory pressure ≥42cmH_2O NO

http://www.respscore.com

Vilniaus universiteto ligoninės
SANTARIŠKIŲ KLINIKOS

Summary

- **Mortality for ARDS remains high despite improvement in patient care.**
- **No major impact on outcomes**
- **Need for effective therapeutic intervention**
- **ECMO for acute severe respiratory failure has positive impact on outcome**
- **Outcomes of severe respiratory failure patients treated with ECMO can be predicted.**

Thank You For Your Attention!