Adding ECLS to the Ventilator to ‘FIX’ the Lungs

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2021 November 20

SSS 2021 | ST. LOUIS SHOCK SYMPOSIUM

Michael S. Plisco MD FCCP

I have no disclosures

First person consent obtained for all patient pictures used

The Team

- Dr. Masood and Wash U. ECLS program
- Local ECLS Network
- ECLS Medical Directors
  - Michael Plisco MD
  - Vinaya Sermadevi MD
  - Chakradhar Venkata M



Thanks VENT for getting us this far…

The ECLS team can take it from here…

Objectives

- Convince you that there is a role for ECLS in ARDS
- Review the ‘traumas’ of ventilator injury
- What is ECLS and why it works
- Data
- Niche

ARDS:

- Syndrome
- Berlin (2012)
  - Timing
  - Imaging
  - Origin
  - Oxygenation

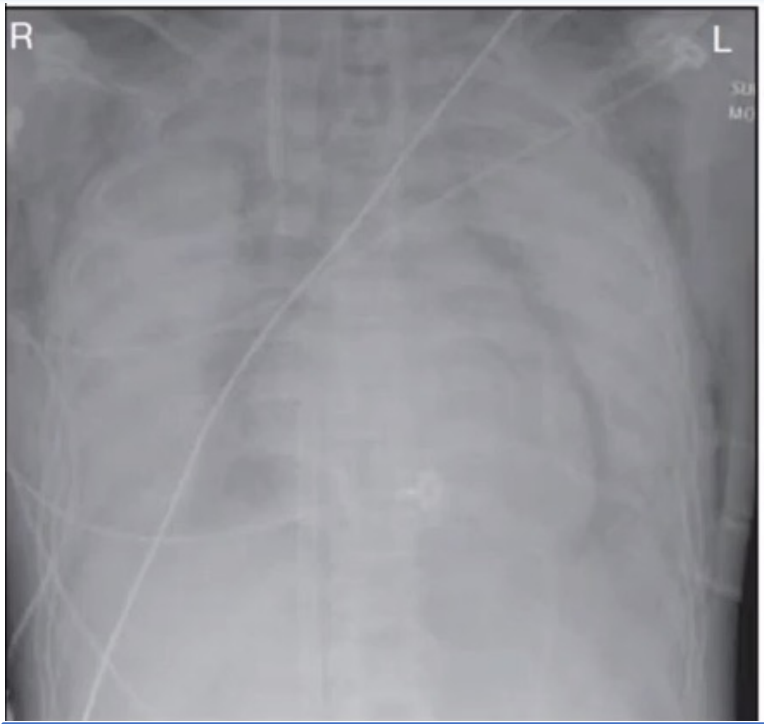

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

	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 $\leq$ 300 mm Hg with PEEP or CPAP $\geq$5 cm H_2O[c]
Moderate	100 mm Hg $<$ PaO_2/FIO_2 $\leq$ 200 mm Hg with PEEP $\geq$5 cm H_2O
Severe	PaO_2/FIO_2 $\leq$ 100 mm Hg with PEEP $\geq$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.

JAMA. 2012;307(23):2526–2533

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ARDS Severity: Lung Injury Score

Severe

Score	0	1	2	3	4
PaO2/FiO2 (FiO2 1.0 x 20min)	>300	225-299	175-224	100-174	<100
CXR consolidation (quadrants)	0	1	2	3	4
PEEP	<5	6-8	9-11	12-14	>15
Compliance [Vt/(Ppl-PEEP)]	>80	60-79	40-59	20-39	<19

LIS = sum of all components / #components

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American Review of Respiratory Disease, 138(3), pp. 720–723

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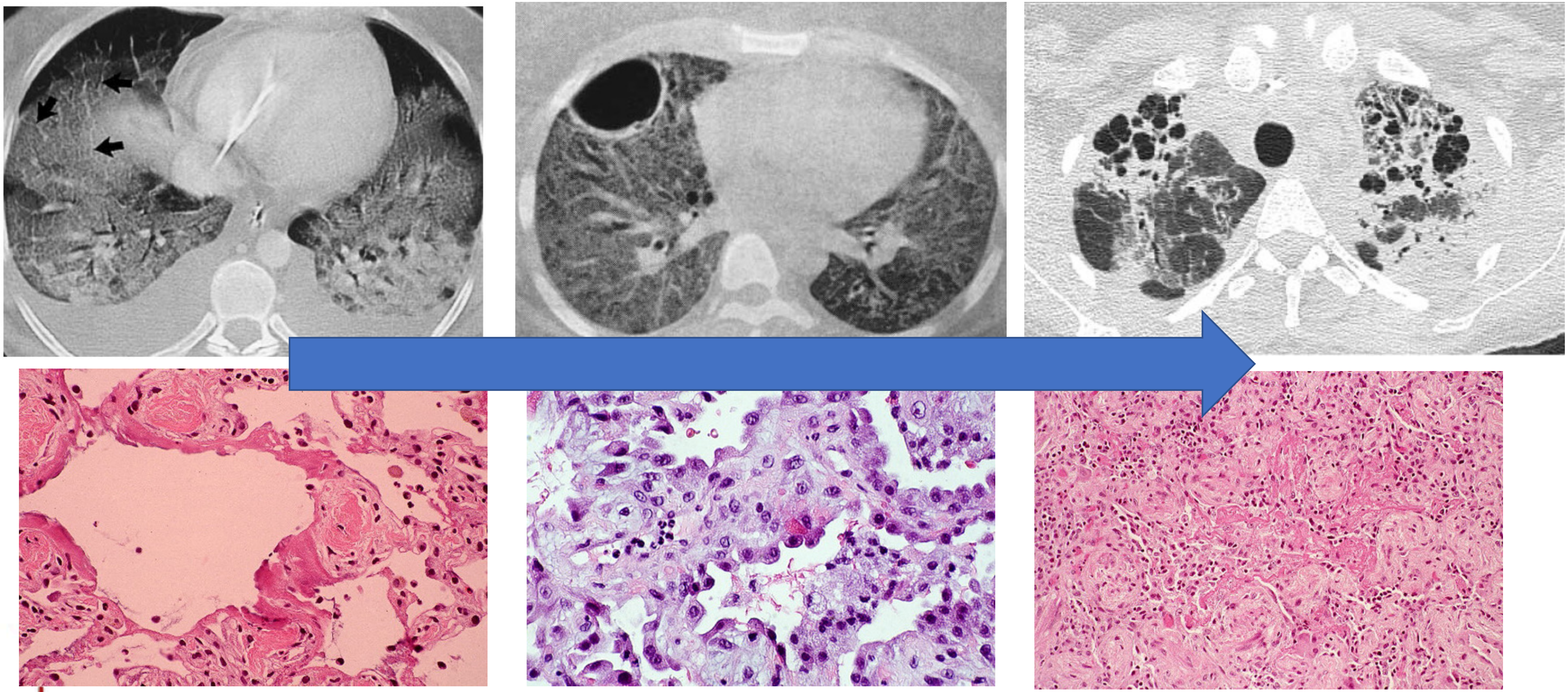
ARDS:

- What do we do…….
- Put them on a ventilator



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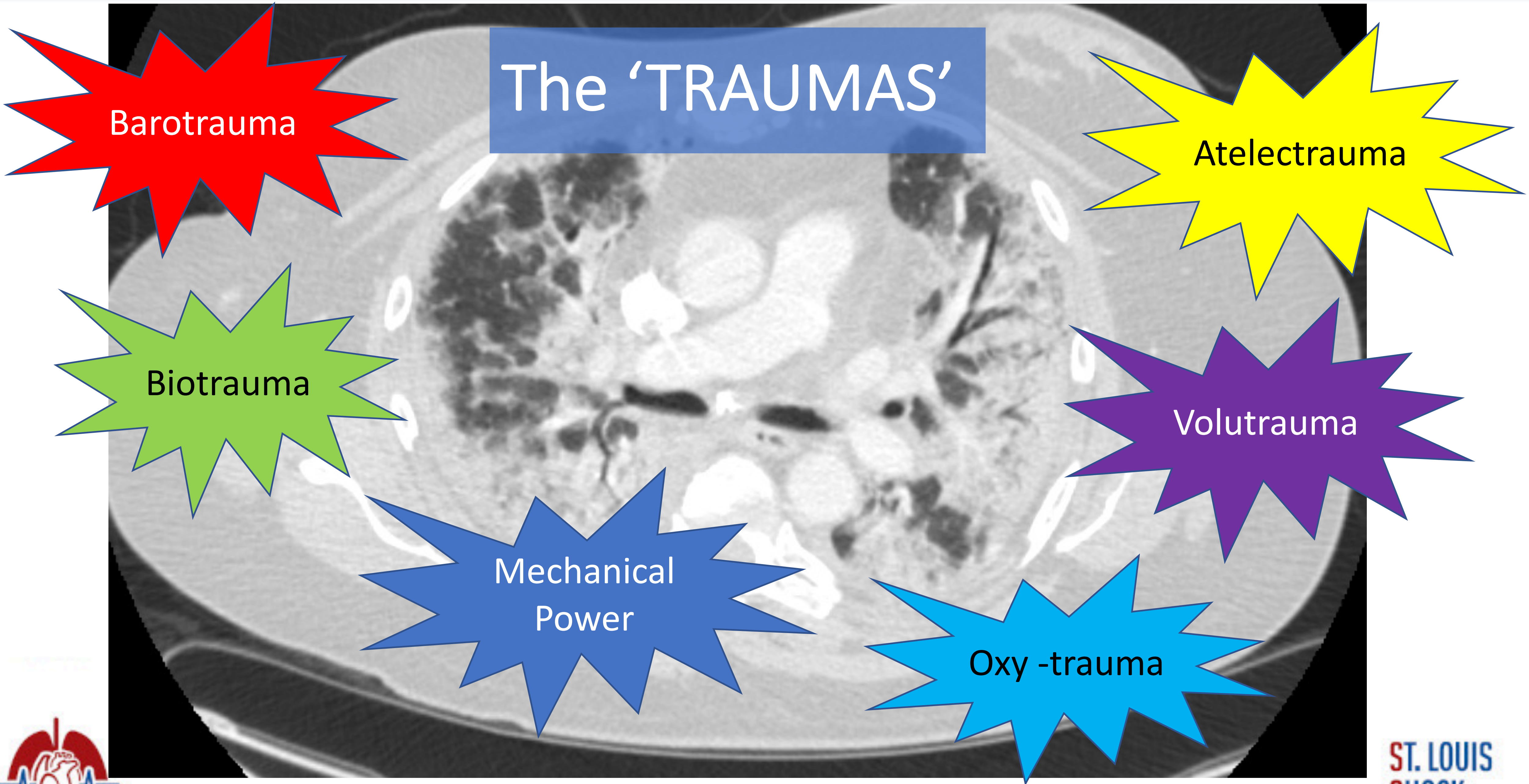
The ‘TRAUMAS’



Crit Care. 2014 Jan 21;18(1):203

Ventilator-related causes of lung injury: the mechanical power

L. Gattinoni[1*], T. Tonetti[1], M. Cressoni[2], P. Cadringher[3], P. Herrmann[1], O. Moerer[1], A. Protti[3], M. Gotti[2], C. Chiurazzi[2], E. Carlesso[2], D. Chiumello[4] and M. Quintel[1]

$$\text{Power}_{rs} = RR \cdot \left\{ \Delta V^2 \cdot \left[\frac{1}{2} \cdot EL_{rs} + RR \cdot \frac{(1 + I:E)}{60 \cdot I:E} \cdot R_{aw} \right] + \Delta V \cdot \text{PEEP} \right\}$$

- Mechanical power
  - Summarizes ventilator related causes of lung injury
- Affected by (variables)
  - Resp rate
  - PEEP
  - Drive Pressure
  - Elastance or diseased lungs (Ppl-PEEP)/Vt
  - Raw: (PPk – Ppl) / flow

Intensive Care Med (2016) 42:1567–1575

ARDS: Management

- Protect the 'baby'

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The New England
Journal of Medicine

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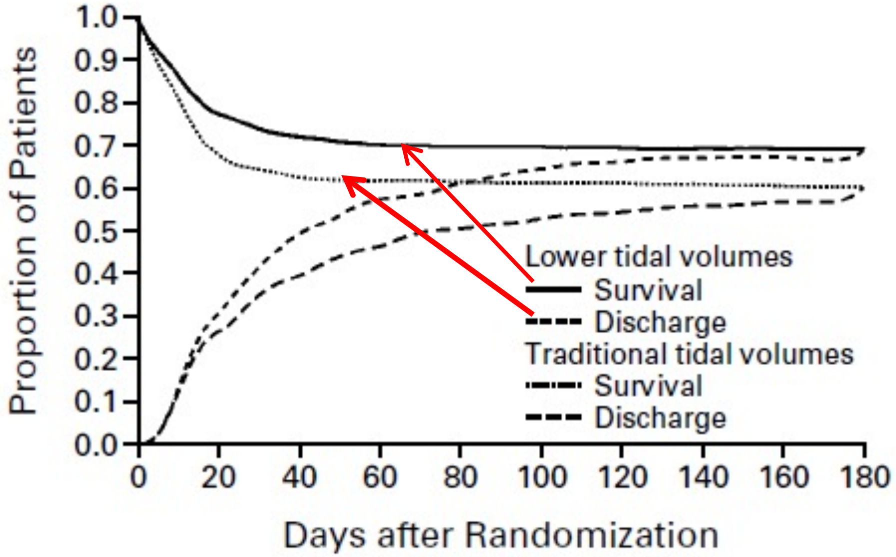
VOLUME 342 | MAY 4, 2000 | NUMBER 18

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

ARDSNet (ARMA)

- RCT, 861 pt
- ARDS, P/F < 300, < 36h MV
- 6cc/kg PBW w/ Ppl < 30 vs Traditional Vt



Decrease Mortality
(31% vs 39.8%)

NNT 11

NEJM 2000. 342(18), pp.1301-1308.

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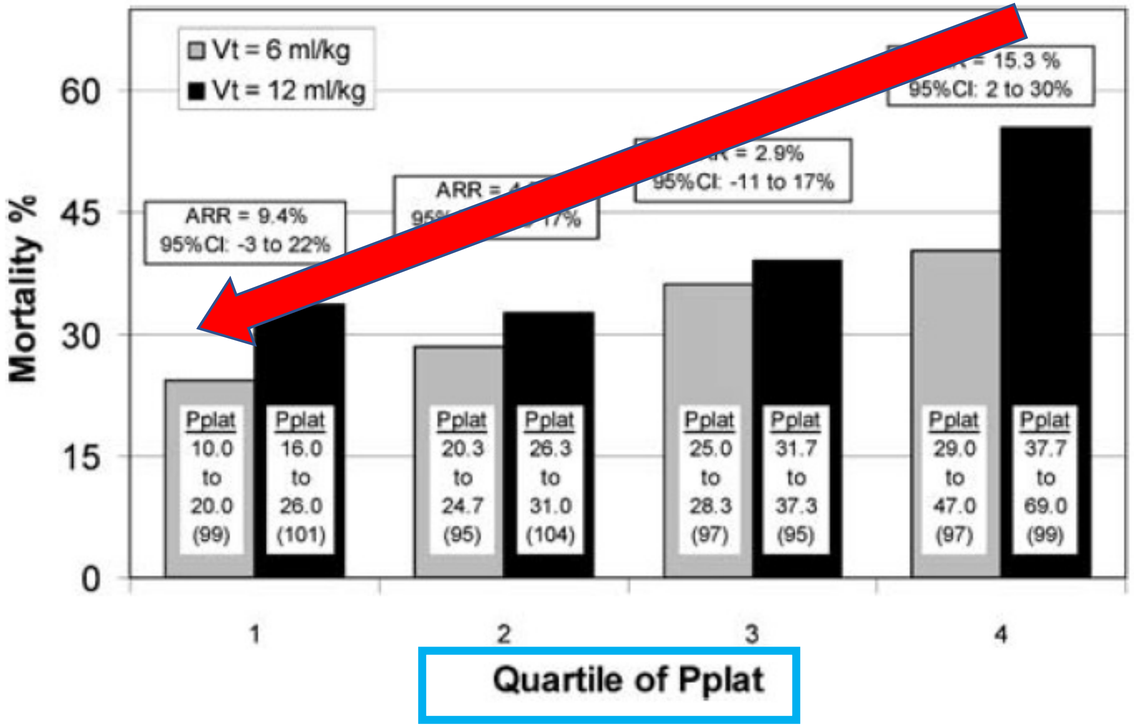
LPV: Is there a safe Ppl?

Tidal Volume Reduction in Patients with Acute Lung Injury When Plateau Pressures Are Not High

David N. Hager, Jerry A. Krishnan, Douglas L. Hayden, and Roy G. Brower for the ARDS Clinical Trials Network

Secondary analysis:
ARDSNET Database



Stratified by quartiles

Mortality lowest
Low Vt
Lowest Ppl

Am J Respir Crit Care Med Vol 172. pp 1241–1245, 2005

Other harms.....

- Sedation +/- NMB
  - PICS
  - Delirium
  - Vent
- RV dysfunction
  - Acidosis
  - Hypercapnia
- Shock
  - Acidosis
  - PEEP
  - Sedation
- Myocardial depression
  - RVF
  - LVF

ARDS:

- Supporting best we can, tolerating all the ‘traumas’……now what?

Look – up in the sky, it’s a bird, it’s a plane…..it’s

ECLS-man!

ECLS: Heart and Lung

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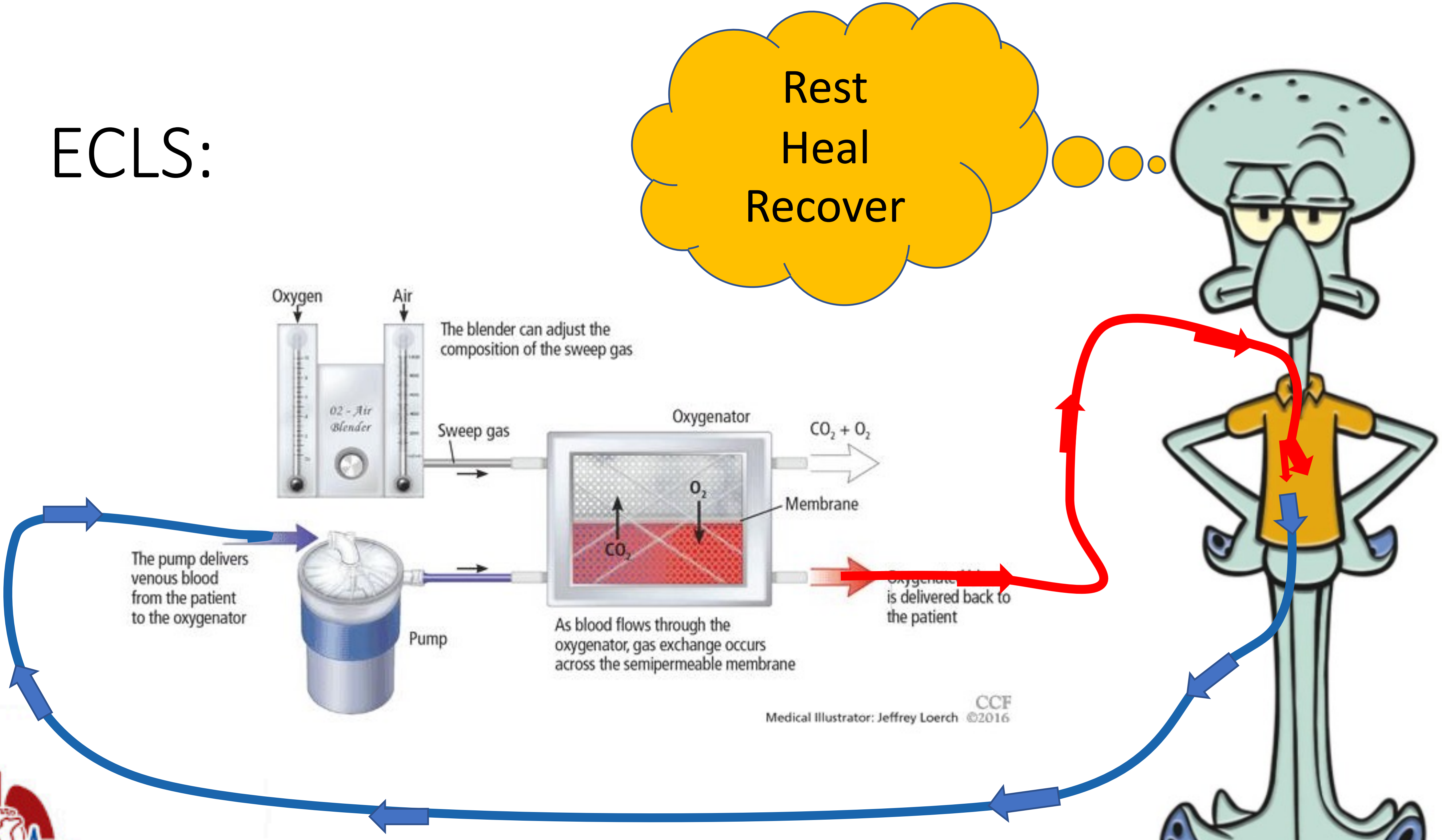
ECLS:



Cleveland Clinic Journal of Medicine May 2016, 83 (5) 373-384

ECLS: How it helps in ARDS

VenoVenous ECLS: DIRECT effects

Lung REST

- Hypoxia – Increases paO_2, SaO_2
- Hypercapnia/Acidosis - Decreased pCO_2, decrease rate
- Lung stress/strain – Decrease Vt, Ppl, RR, DrPr
- Lung injury (VILI) – Decrease 'traumas'

VenoVenous ECLS: INDIRECT effects

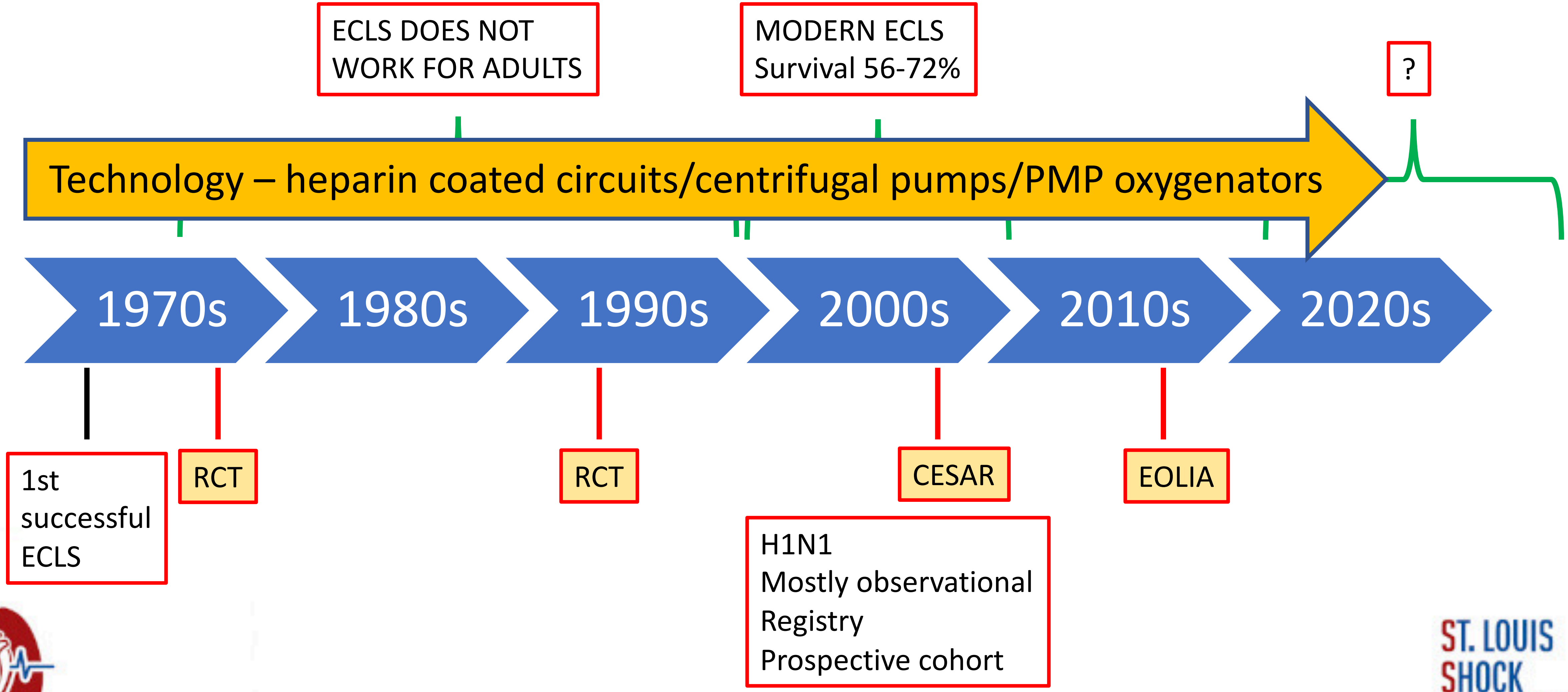
	Pre ECLS	Post ECLS
PVR	Increased	Decreased
Pleural Pressure	Increased	Decreased
Venous return	Decreased	Increased (by decr vent settings)
Perfusion	Decreased	Increased
SVR	Increased	Decreased (less shock)
CO	Decreased	Increased
Perfusion	Decreased	Increased (tissue)
Vasopressors	Increased	Decreased requirements

ECLS: Always a balance

Bleeding
Cannulation
Technical / circuit issues
Transport
Cost

Protective ventilation
Reduction in FiO_2
Reduce sedation
Spontaneous breathing

Evolution of ECLS



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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

CESAR 2009

3rd RCT, 180pts

- **Severe but reversible respiratory failure**
  - Murray LIS > 3 (despite opt Tx) and/or
  - Uncompensated hypercapnia with pH < 7.2
- Randomized
  - 'Usual care' vs Transfer to ECLS Center

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Peek et al, LANCET 2009

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CESAR: Conclusions

Survival to 6mo without disability (RR 0.69, p=0.03)

- ECLS group – 63%
- Conventional management - 47%

Time from randomization to death, favored ECLS

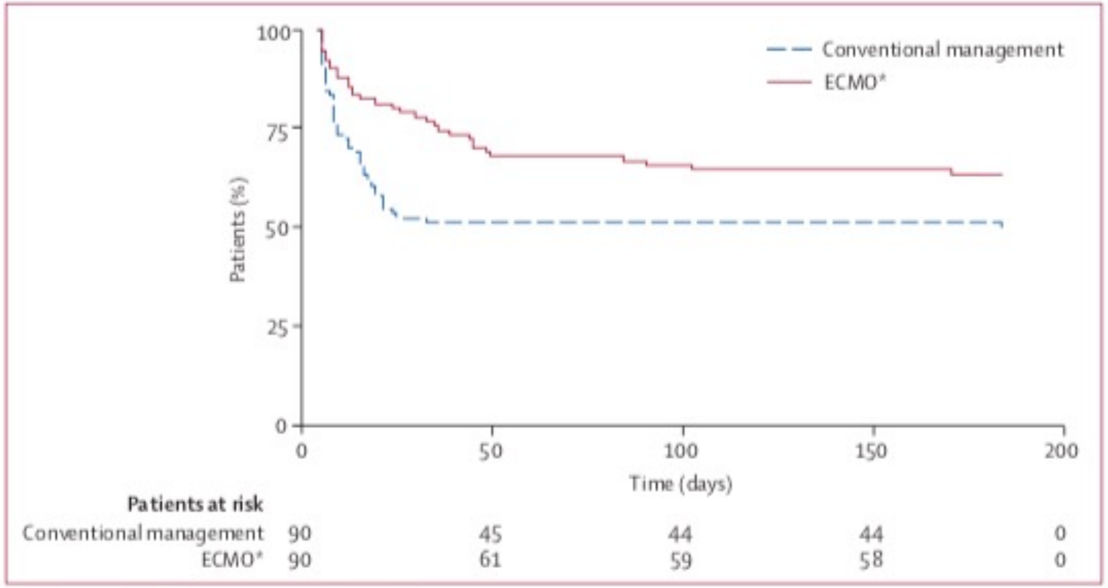

Figure 2: Kaplan-Meier survival estimates

Peek et al, LANCET 2009

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CESAR: Criticisms

- NOT Mechanical Ventilation vs ECLS
- Control
  - Conventional ventilation not standardized
    - (70% LPV, 42% prone)
- ECLS group (transfer to ECLS Center)
  - 75% received ECLS
  - Protocolized ARDS Tx
    - (93% LPV, 4% proned)
  - Advanced therapies

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Peek et al, LANCET 2009

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CESAR: Lessons

- Be ARDS Center of Excellence
- If you cannot, transfer to a place that is
- Have ECLS available as part of ARDS treatment

- Created…

What we've been doing for the past 5 years at Mercy...

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The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 MAY 24, 2018 VOL. 378 NO. 21

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome

A. Combes, D. Hajage, G. Capellier, A. Demoule, S. Lavoué, C. Guervilly, D. Da Silva, L. Zafrani, P. Tirot, B. Veber, E. Maury, B. Levy, Y. Cohen, C. Richard, P. Kalfon, L. Bouadma, H. Mehdaoui, G. Beduneau, G. Lebreton, L. Brochard, N.D. Ferguson, E. Fan, A.S. Slutsky, D. Brodie, and A. Mercat, for the EOLIA Trial Group, REVA, and ECMONet*

EOLIA 2018

ECLS to Rescue Lung Injury in severe ARDS

- RCT (4th), Prospective MC, 249pt*
- Immediate VV ECLS vs Conventional LPV
- Very severe ARDS
- Endpoints
  - PRIMARY: 60d Mortality
  - Secondary:
    - Key –Tx failure at 60d (death in ECLS or crossover/death in CONTROL)
    - Other – Alive and free 60d of ICU/organ failure
  - Safety

NEJM. 378.21 (2018): 1965-1975.

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EOLIA: Inclusions

- Very Severe ARDS
  - P/F < 50mmHg for > 3h
  - P/F < 80mmHg for > 6h
  - pH < 7.25 with pCO2 > 60mmHg for > 6h
    - Bc of Ppl < 32

- Rescue ECLS for controls
  - Refractory hypoxemia (SaO2 < 80% for > 6h)
    - Despite Prone + RM + iNO/Flolan AND
    - If physician felt reversible MOD and ECLS might change outcome

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NEJM. 378.21 (2018): 1965-1975.

EOLIA: Trial procedures

ECLS

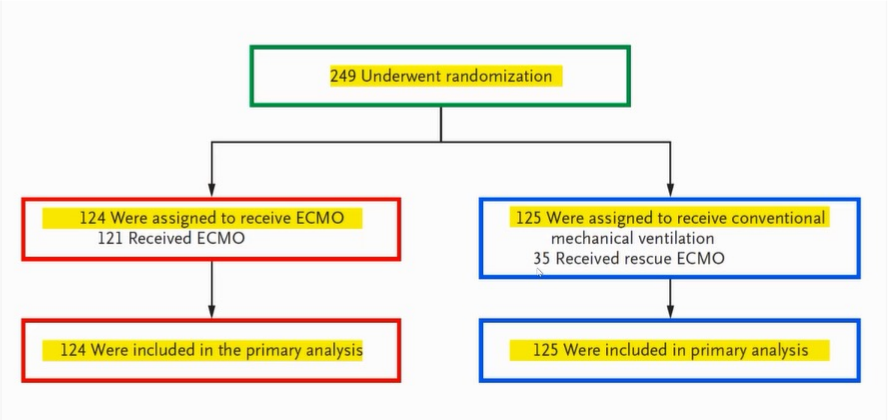
- Venovenous
- MV
  - Volume AC
  - PEEP>10
  - Vt for Ppl < 25
  - FiO_2 0.3-0.6
  - APRV
- Low anticoagulation
  - (0.2-0.3 AntiXa)

Control

- MV
  - Vt 6cc/kg
  - PEEP to get Ppl 28-30cmH_2O
  - EXPRESS/High Recruitment
- Rec Prone/NMB
- Tx refractory hypoxemia
  - RM
  - iNO/Flolan

NEJM. 378.21 (2018): 1965-1975.

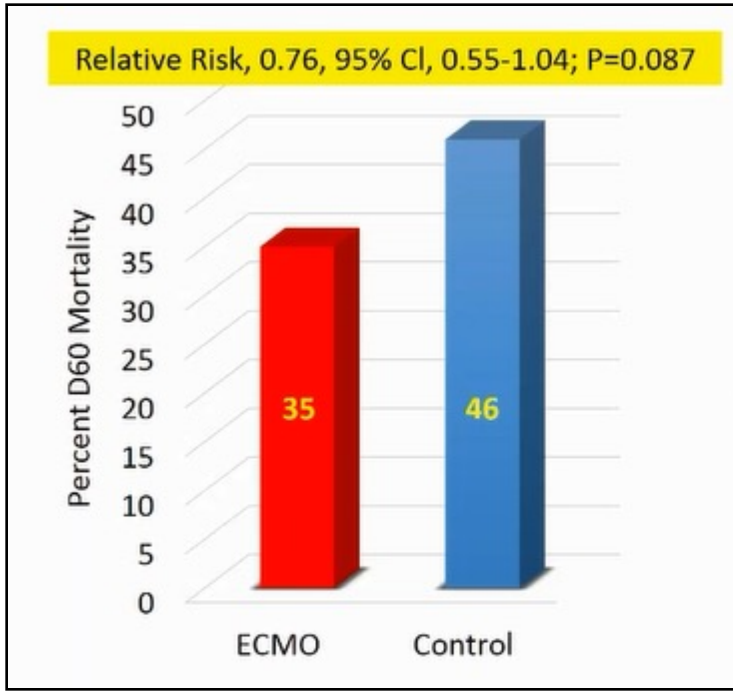
EOLIA: Results



- Intent to treat
  - Crossover: 28% (35/125) controls
  - Not Treated: 3 in ECLS (2 died prior)
- Baseline characteristics: No difference
  - P/F 73
  - Prone: 56% ECLS, 62% Control (final 66% vs 90%)
  - NMB: ~100% both
  - Median time to randomization: 34h
- Stopped early
  - Investigators predicted 20% difference in survival unlikely

NEJM. 378.21 (2018): 1965-1975.

EOLIA: Primary Endpoint (60d mortality)



ECLS led to **11% reduction in 60d death** – NOT statistically significant

NEJM. 378.21 (2018): 1965-1975.

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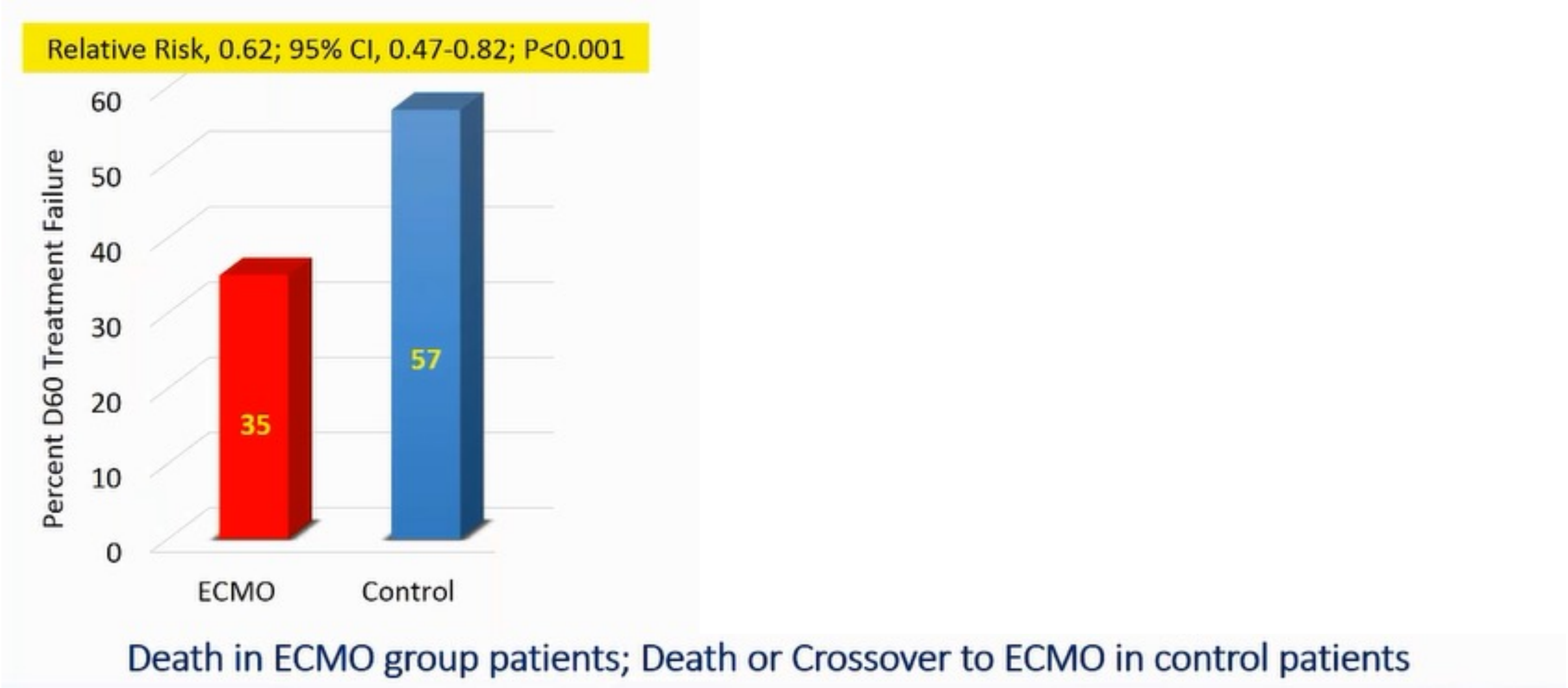
EOLIA: KEY Secondary endpoint (Tx failure)



Treatment failure identified as
ECLS group → DEATH
CONTROL group → DEATH OR crossover to ECLS

Significantly LESS treatment failure in ECLS group

NEJM. 378.21 (2018): 1965-1975.

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EOLIA: Secondary Endpoints

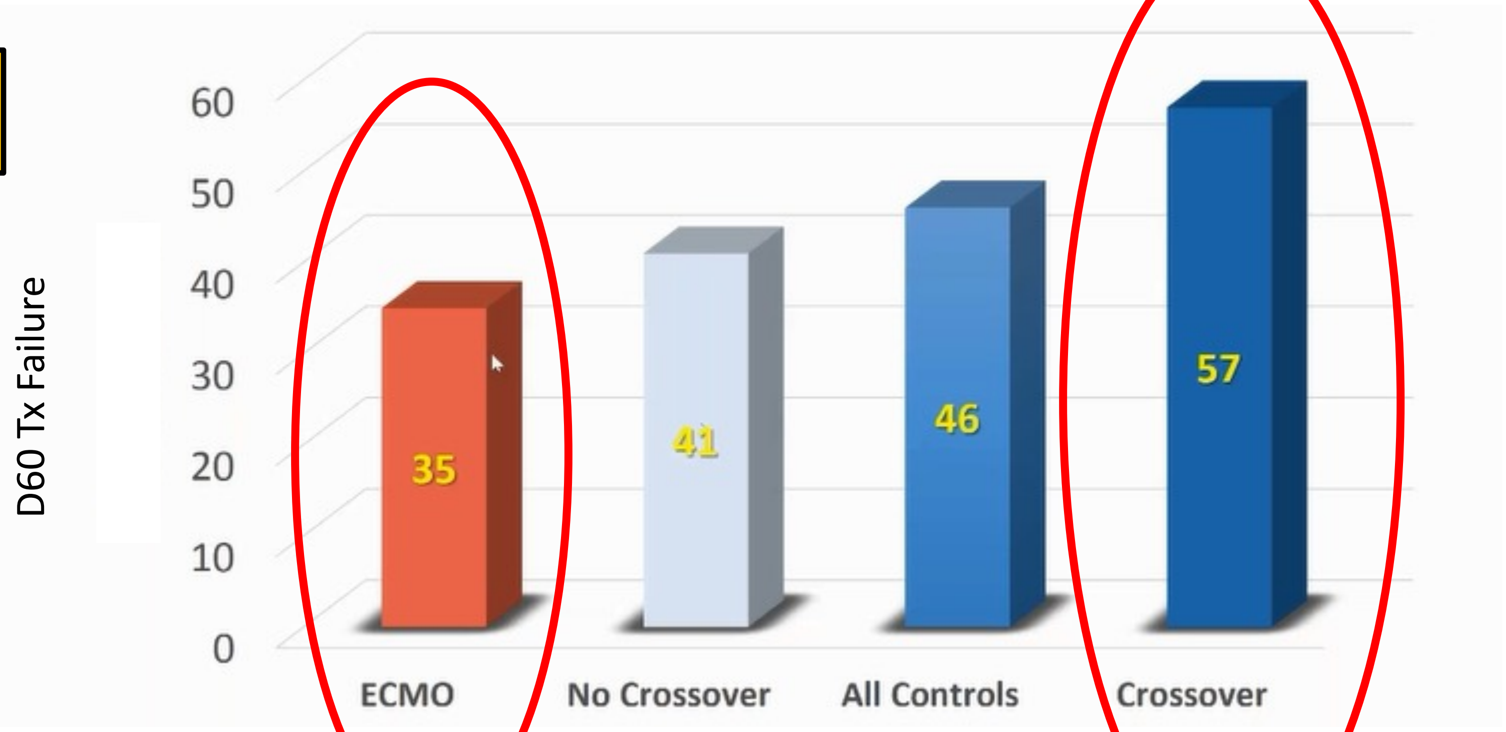
Endpoint at D60	ECMO Group (N = 124)	Control Group (N = 125)	Median Difference (95% CI)
Days alive and free of vasopressor use	49 [0–56]	40 [0–53]	**9 (0 to 51)**
Days alive and free of cardiac failure (SOFA)	48 [0–56]	41 [0–53]	**7 (0 to 51)**
Days alive and free of dialysis	50 [0–60]	32 [0–57]	**18 (0 to 51)**
Days alive and free of renal failure (SOFA)	46 [0–60]	21 [0–56]	**25 (6 to 53)**
Days alive and free of prone position	59 [0–59]	46 [0–57]	**13 (5 to 59)**
Days alive and free of NO/prostacyclin	59 [0–60]	39 [0–58]	**20 (4 to 59)**

All **<u>significantly better in ECLS</u>** group

NEJM. 378.21 (2018): 1965-1975.

EOLIA: ECLS Death vs Crossover Death

35% vs 57%



43% survived that physician felt would have died

NEJM. 378.21 (2018): 1965-1975.

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EOLIA: Adverse events

Table 3. Adverse Events as Defined by the Trial Protocol in the Intention-to-Treat Population.

Event	ECMO Group (N=124)	Control Group (N=125)	Absolute Risk Difference (95% CI)*
	number (percent)		*percentage points*
Pneumothorax	18 (15)	16 (13)	2 (−7 to 10)
Thrombocytopenia†			
Any	50 (40)	40 (32)	8 (−4 to 20)
Severe	33 (27)	20 (16)	11 (0 to 21)
Hypothermia‡	28 (23)	27 (22)	1 (−9 to 11)
Bleeding			
Leading to transfusion	57 (46)	35 (28)	18 (6 to 30)
Massive§	3 (2)	1 (1)	2 (−2 to 6)
Cardiac rhythm disturbances	38 (31)	46 (37)	−6 (−18 to 6)
Cardiac arrest	24 (19)	22 (18)	2 (−8 to 12)
Stroke¶	3 (2)	8 (6)	−4 (−10 to 1)
Ischemic stroke	0	6 (5)	−5 (−10 to −2)
Hemorrhagic stroke	3 (2)	5 (4)	−2 (−7 to 3)
Massive stroke	2 (2)	1 (1)	1 (−3 to 5)
Ventilator-associated pneumonia treated with antibiotic agents	48 (39)	46 (37)	2 (−10 to 14)
Gas emboli	0	0	0 (−3 to 3)

ECLS
Lower strokes
Less Hemorrhagic strokes

NEJM. 378.21 (2018): 1965-1975.

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EOLIA: Things to consider

- 11% reduction in mortality
  - Clinically important, even if not statistically significant
- Early ECLS may be better than later ECLS
  - D60 mortality 35% vs 57%
- ECLS improves physiologic endpoints lung resuscitation
- Immediate
  - 34h median time to randomization
  - Prone at time of randomization (56%)
- ECLS Cessation
  - ECLS terminated when felt recovery not possible
  - EOLIA: average run 16 +/- 14d
    - We all know long recovery time possible

ECLS…now what.

→EOLIA aftermath

- Editorials
- He said, she said
- Editorials
- Pro/Con debates
- Metanalsyses
- …..then

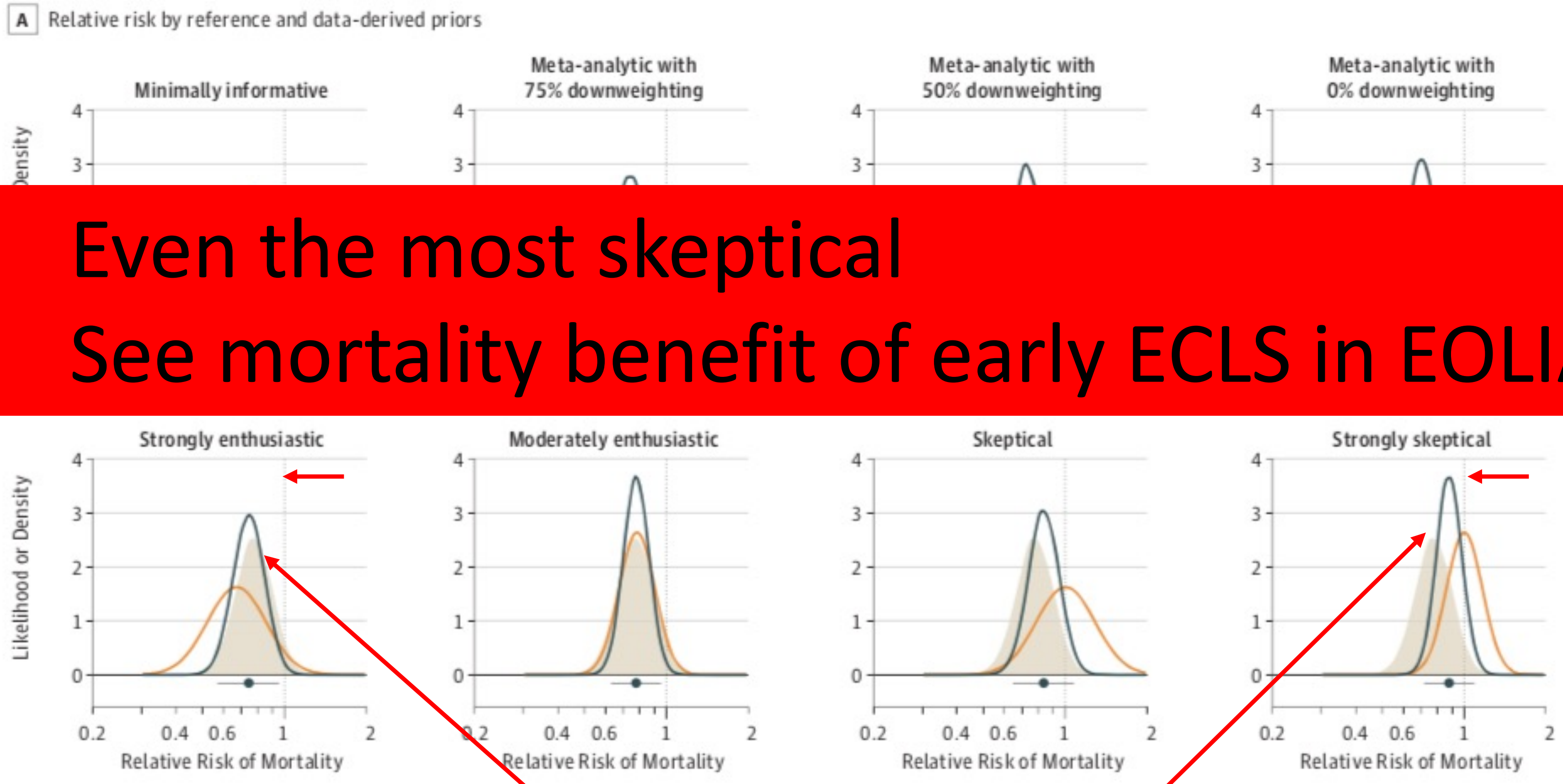
JAMA | Special Communication | CARING FOR THE CRITICALLY ILL PATIENT

Extracorporeal Membrane Oxygenation for Severe Acute Respiratory Distress Syndrome and Posterior Probability of Mortality Benefit in a Post Hoc Bayesian Analysis of a Randomized Clinical Trial

Ewan C. Goligher, MD, PhD; George Tomlinson, PhD; David Hajage, MD, PhD; Duminda N. Wijeysundera, MD, PhD; Eddy Fan, MD, PhD; Peter Jüni, MD; Daniel Brodie, MD; Arthur S. Slutsky, MD; Alain Combes, MD, PhD

- Post hoc Bayesian analysis of EOLIA
- Through the Bayesian analysis

Figure 2. Posterior Probability Distributions for RR and ARR Based on EOLIA Trial Results for the Benefit of Early ECMO on Mortality in Patients With Very Severe ARDS, by Reference and Data-Derived Priors



Even the most skeptical
See mortality benefit of early ECLS in EOLIA

Strongly Enthusiastic

R < 1 99%

Posterior Probability that true RR < 1

Strongly Skeptical

R < 1 88%

RR 1 that ECLS has any mortality benefit

JAMA, *320*(21), pp.2251-2259.

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JAMA | Special Communication | CARING FOR THE CRITICALLY ILL PATIENT

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- Whether ‘Enthusiastic or Skeptic’
- The posterior probability of mortality benefit with early ECLS was 88-99%
- Would the most ‘ECNO of the ECNO-est’ say to their patient,

> “I’m sorry, not going to offer ECLS,
> there is only 88% chance of mortality benefit”?

JAMA, *320*(21), pp.2251-2259.

ECLS Meta-Analysis and Systematic Reviews

Author	Year	No. Trials	No. patients	Outcome	Conclusion
Munshi	2019	5 trials 3 obs, 2 RCT	773	Primary: 60d mortality RCT 30d mortality - All	ECLS decrease mortality 34% vs 47% (RR 0.73[95% CI 0.58-0.92]) ECLS decrease mortality (RR 0.69[95% CI 0.5-0.95])
Arethra	2019	10 trials	1497	Hospital Mortality 2RCT -2 quasi RCT	ECLS decrease mortality OR=0.51, 95% CI=0.37–0.70)
Wang	2020	18 trials	2399	1y mortality 60d mortality	ECLS decreased mortality (OR 0.48, 95% CI, 0.27-0.83 ECLS decreased mortality (95% CI, 0.37-0.86
Combes	2020	2 trials Individual pt	429	90d Mortality	ECLS decreased mortality ECLS 36% vs Control 48% [RR 0.75 (95% CI 0.6-0.94)]

The Lancet Respiratory Medicine 2019, *7*(2), pp.163-172.
Intensive care medicine 2020, pp.1-10.
Heart, Lung and Circulation 2021, *30*(5), pp.631-641.
BioMed research international, 2019.

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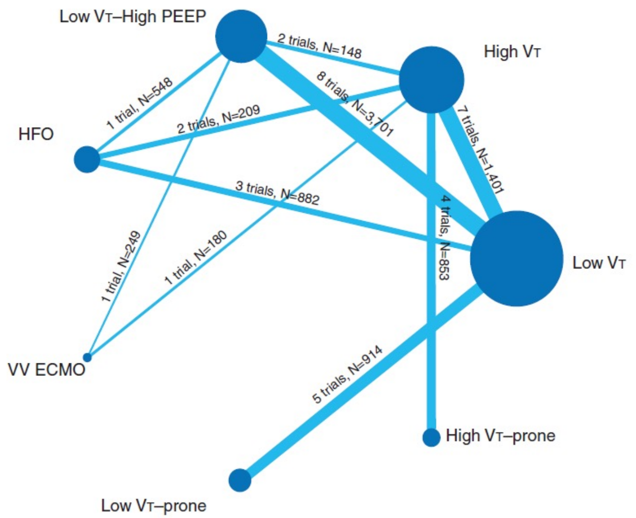
ORIGINAL ARTICLE

Comparative Effectiveness of Protective Ventilation Strategies for Moderate and Severe Acute Respiratory Distress Syndrome
A Network Meta-Analysis

Sachin Sud[1,2], Jan O. Friedrich[3], Neill K. J. Adhikari[3,4,5], Eddy Fan[3,4], Niall D. Ferguson[3,4], Gordon Guyatt[6], and Maureen O. Meade[7]



- Network Meta-Analysis of RCTs
- 34 trials
- 9085pt – mod-severe ARDS
- Median P/F 118
- ARDS therapy combinations
  - Vt (high and low)
  - High PEEP
  - Prone
  - VV ECLS

- Results
  - Low Vt + Prone
    - Best strategy
    - RR 0.74 w high certainty
  - VV ECLS
    - Rated among the best
    - RR 0.78 vs low Vt (95% CI 0.58-1.05)
    - Low certainty since restricted to very severe ARDS (P/F < 75)

AJRCCM 2021, 203(11):1366-1377.

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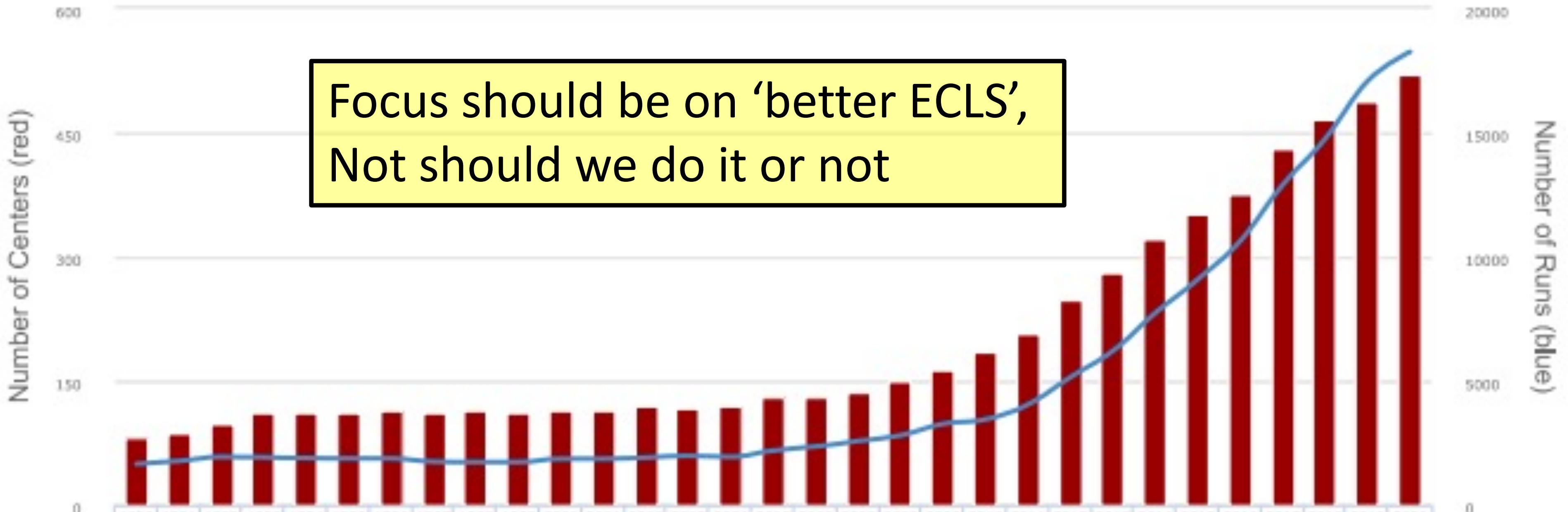
ARMA → same vent → did a better job

ELSO: Centers by year



Focus should be on 'better ECLS',
Not should we do it or not

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Centers	83	86	98	111	112	112	115	112	115	112	115	115	119	117	119	131
Runs	1643	1775	1932	1910	1880	1876	1868	1743	1718	1722	1862	1855	1908	1977	1928	2191

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Centers	132	136	151	165	185	207	247	280	321	351	376	431	467	488	521
Runs	2346	2570	2884	3262	3446	4042	5152	6206	7732	9086	10644	12895	14758	17079	18260

https://www.elso.org/Registry/Statistics.aspx

ELSO: VV ECLS (US 2015-2020)

Survival to DC – 57%

	Total	Survived to DC or Transfer
Total	21,491	58%
Neonatal	**727**	**76%**
Pulmonary	707	77%
Cardiac	19	52%
ECPR	N/A	N/A
Pediatric	**1,861**	**69%**
Pulmonary	1,732	71%
Cardiac	92	57%
ECPR	37	40%
Adult	**18,903**	**56%**
Pulmonary	17,364	57%
Cardiac	1,288	45%
ECPR	251	39%

*N/A - Data elements with n<5 are not displayed.

https://www.elso.org/Registry/Statistics.aspx

Mercy Hospital

- Established 2016
- Low to moderate volume center

Mercy Hospital ELSO Registry Report - July-19

Mortality Reports//Mortality By Patient Cohort *Mortality Rate*

Show O/E

FILTERS

CENTERS

Mercy Hospital St. Louis

Select All

APPLY

INDEX RUN MODE

All

DEFAULT PERIODS

2007 To Date

TRENDING INTERVAL

Annual

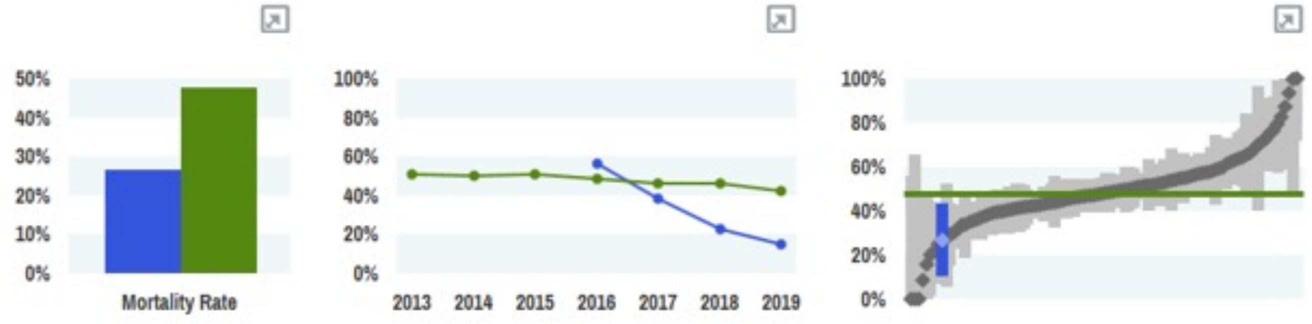
PEER GROUPS

ELSO - All

Select All

APPLY

LEGEND: Mercy Hospital St. Louis | ELSO - All | Other Centers | ELSO - All | 95% Confidence Interval



Mortality by Patient Cohort	Patients	Mercy Hospital St. Louis - Unadj	Mercy Hospital St. Louis - Adj	ELSO - All - Adj
Mortality Rate	34	29.4%	26.7%	47.7%
Mortality Rate -Pediatric Patients	1	0%	0%	42.2%
Mortality Rate -Adults Patients	33	30.3%	29.5%	50.7%

Survival

Mercy- 70%

ELSO 49.3%

Mercy Hospital ELSO Registry Report 10-21 COVID

Mortality Reports//Mortality By Patient Cohort *Mortality Rate*

Show O/E

FILTERS

CENTERS
Mercy Hospital St. Louis
Select All
APPLY

INDEX RUN MODE
All

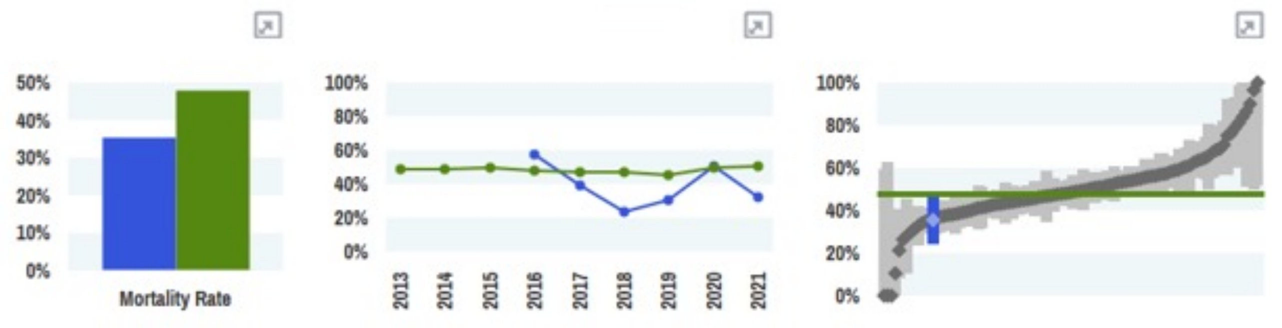
INDEX UNIT WHERE ECLS REC'D
All

DEFAULT PERIODS
2013 To Date

TRENDING INTERVAL
Annual

PEER GROUPS
ELSO - All
Select All
APPLY

LEGEND Mercy Hospital St. Louis | ELSO - All | Other Centers | ELSO - All | 95% Confidence Interval



Mortality by Patient Cohort	Patients	Mercy Hospital St. Louis - Unadj	Mercy Hospital St. Louis - Adj	ELSO - All - Adj
Mortality Rate	76	36.8%	35.5%	47.9%
Mortality Rate -Pediatric Patients	1	0%	0%	42%
Mortality Rate -Adults Patients	75	37.3%	37.5%	50.5%

* ICU location data only available January 2018 to present.

*Only completed and submitted runs will display in reports. Follow this link to investigate data that may be missing (Note that up to 7 days may be required after data entry for data to be displayed)
https://registry.elso.org/?riskreport=42sw345k-1w3q-sd41-p02a-1344wa2acfew

Survival
Mercy- 63.5%
ELSO 49.5%

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ECLS: Are there risks?

- Heck yes
- Complications
  - Patient (Neurologic*/Pulmonary/Cardiac/Renal/Infection/Hematologic)
  - Mechanical (Cannulation/Circuit)
- Management risks
  - Novice vs Experienced programs
  - Center
    - Low vs High volume
    - Simulation?

NEJM. 378.21 (2018): 1965-1975.
JAMA. 2019;322(6):557-568

ECLS: When to cannulate

ELSO	CESAR	EOLIA
Risk of mortality 80% P/F < 100 on FiO2 > 0.9 and/or LIS 3-4 AOI > 80 APPS 8 Despite optimal care x 6hr CO2 retention on MV despite Ppl > 30 cmH2O	LIS > 3 (despite opt Tx) and/or Uncompensated hypercapnia with pH < 7.2	P/F<50 on FiO2>0.8 x >3h P/F<80 on FiO2 >0.8 x >6h pH < 7.25 with pCO2 > 60mmHg x 6h bc of Ppl < 32 If you believe EOLIA to hold true

Center specific

ELSO Guidelines for ECLS V1.1 2017
Lancet 2009:1351-63.
NEJM 2018;378:1965-1975

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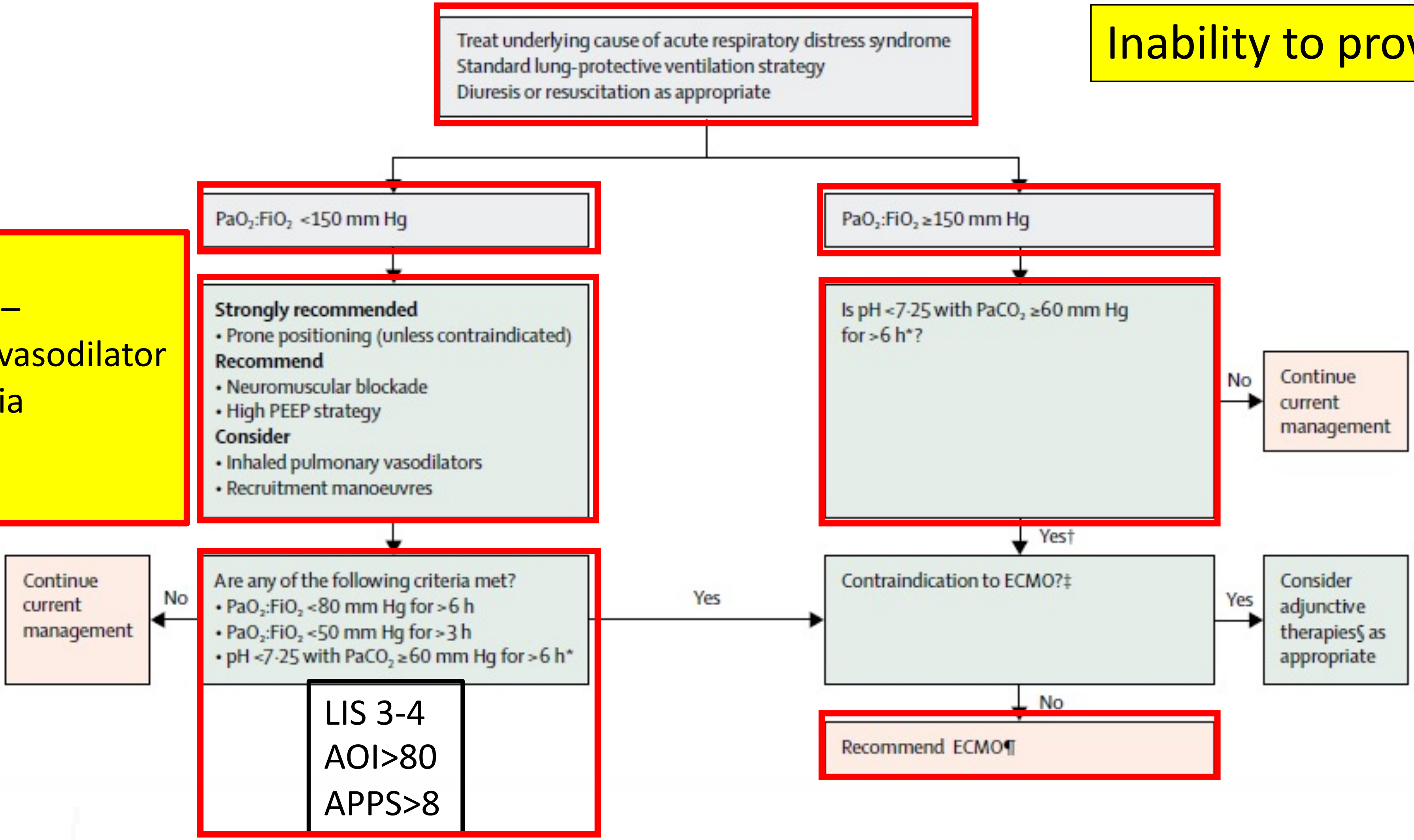
Proposed Algorithm

Inability to provide LPV

<u>Center specific</u>
What defines a 'trial'–
-RM, inh pulmonary vasodilator
Center specific criteria
Depends on capacity
Depends on gestalt



The Lancet Respiratory Medicine, 2019;7(2), pp.108-110

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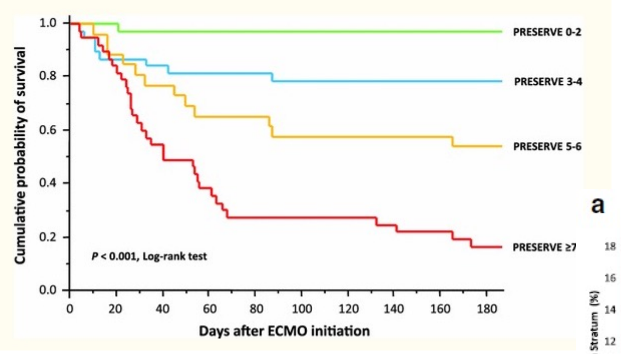
Who not to use it on

- ELSO guidelines (CI)
- Suspecting no change trajectory:
  - RESP > -2 (hospital mortality 67%)
  - PRESERVE >5 (6mo mortality >50%)
  - PRESET > 6 (ICU mortality >50%)
- Family not 'on board'
- COVID
  - ?

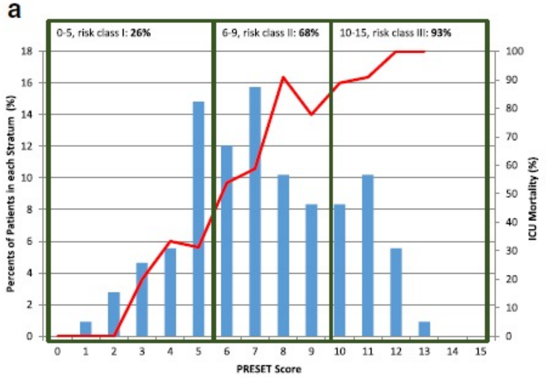
Parameter	Score
Age (years)	
<45	0
45–55	2
>55	3
Body mass index >30	−2
Immunocompromised	2
SOFA>12[a]	1
MV >6 days	1
No prone positioning before ECMO	1
PEEP < 10 cm H_2O	2
Plateau pressure >30 cm H_2O	2
Total score[c]	0–14

Table 4 PRESET-Score at ECMO initiation

Variable	Points
Mean arterial pressure (mmHg)	
> 100	0
91–100	1
81–90	2
71–80	3
≤ 70	4
Lactate concentration (mmol l^{-1})	
≤ 1.50	0
1.51–3.00	1
3.01–6.00	2
6.01–10.00	3
> 10.00	4
pH_a	
> 7.300	0
7.201–7.300	1
7.101–7.200	2
≤ 7.100	3
Platelet concentration (×1000 μl^{-1})	
> 200	0
101–200	1
≤ 100	2
Hospital days pre ECMO	
≤ 2	0
3–7	1
> 7	2
Total score	0–15
ICU mortality by risk class	Mortality (%)
PRESET-Score 0–5, risk class I	26
PRESET-Score 6–9, risk class II	68
PRESET-Score 10–15, risk class III	93



a



The patient's RESP Score is
0

Age (years:)
18-49
50-59
≥60
Immunocompromised
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
Acute associated (non-pulmonary) infection
Neuro-muscular blockade before ECMO
Nitric oxide use before ECMO
Bicarbonate infusion before ECMO
Cardiac arrest before ECMO
$PaCO_2$ ≥75 mmHg / 10kpa
Peak inspiratory pressure ≥42cmH_2O

AJRCCM. 2014 Jun 1;189(11):1374-82
Intensive Care Med (2013) 39:1704–1713
Crit Care. 2017 Dec 12;21(1):301

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ECLS: When to move 'fast'

- Rapidly progressing and trajectory looks like… death
- Rescue (proven therapies not possible)
  - Inability for LPV
    - TBI
    - Pregnancy
  - Inability to prone
    - CI (trach/C collar/Sternotomy)
    - OSH cannot d/t safety
    - Inability to transfer
- Salvage:
  - Failed LPV/prone
  - RVF
  - Barotrauma and inability to PEEP

Sometimes you have to take a chance

- TBI with ICH, cardiac arrest
- TBI with refractory ICP
- TBI with DAI/card arrest, no neuro exam
- Obese pt with burns on >50% of body

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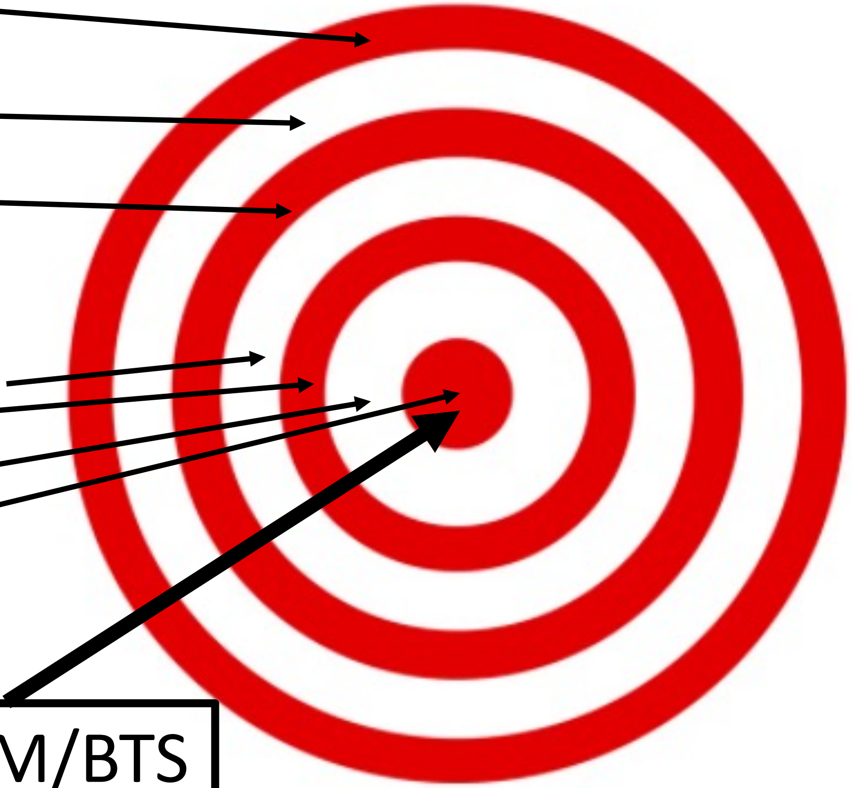
How we 'fix' with ECLS

- Buy time to let lungs 'rest'
- Advances in technology
  - Pumps/biocompatible circuits and catheters
- Improved techniques
  - Cannulation – US
  - Anticoagulation – less needed
  - Smaller set up – more mobile
  - Improved lung rest
- Greater experience with time
  - Better management

ECLS hits the Mark

- Multidisciplinary selection process
- Right patient
- Right ARDS treatment pre/post cannulation
  - MV + ECLS
- Right timing – don’t wait until death imminent
- Right Center
- Right Management
- Right dose of ECLS



ATS/ESICM/SCCM/BTS Guidelines

ECLS: It takes a village

- Medical Directors
  - Vinaya Sermadevi MD
  - Chakradhar Venkata MD
- ECLS Coordinator
  - Robert Longenecker
- CVICU staff of nurses/RTs and ECLS specialists
- Steven Trottier (CCM Chairman)
- CCM dept
- CT surgeons
- Perfusionists
- Labs techs/blood bank/consultants/radiology
- Administration
- Local ECLS Network

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-ECLS-

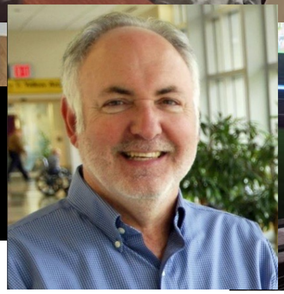


JUST DO IT.







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SHOCK
SYMPOSIUM

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