

ECMO in ARDS

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ECMO for ARDS: the 4 key questions

- **Why yes ?**
- Why not ?
- How ?
- Where ?



Should We “Rescue” Patients With 2009 Influenza A(H1N1) and Lung Injury From Conventional Mechanical Ventilation?

Most clinicians become nervous when the plateau pressure exceeds 30 cm H₂O, the FIO₂ approaches 1.0, the arterial O₂ saturation falls below 90%, and/or the pH drops below 7.2.

*Rolf D. Hubmayr, MD, FCCP
J. Christopher Farmer, MD, FCCP
Rochester, MN*

Source	P/F or SaO ₂	PEEP (cmH ₂ O)	FiO ₂ (%)	P _{PLAT} (cmH ₂ O)	Time	OI	Murray score
ELSO	< 80	-	> 90	> 30	-	-	3 - 4
ITALIAN Net	< 70	> 15	-	-	> 6 h	> 30	-
EOLIA trial	< 80	> 10	> 80	> 30 - 32	> 6 h	-	-
ENGLISH Net St Thomas Hospital, London	SaO ₂ < 87%	-	-	> 30	-	-	-
AUSTRALIA Net Alfred ICU Melbourne Adelaide Royal ICU	SaO ₂ < 88%	-	-	> 35	-	-	-

And/or = severe CO₂ retention (i.e. pH < 7,25)

VILI

hypoxia
± hypercapnic acidosis

↑ Applied pressure

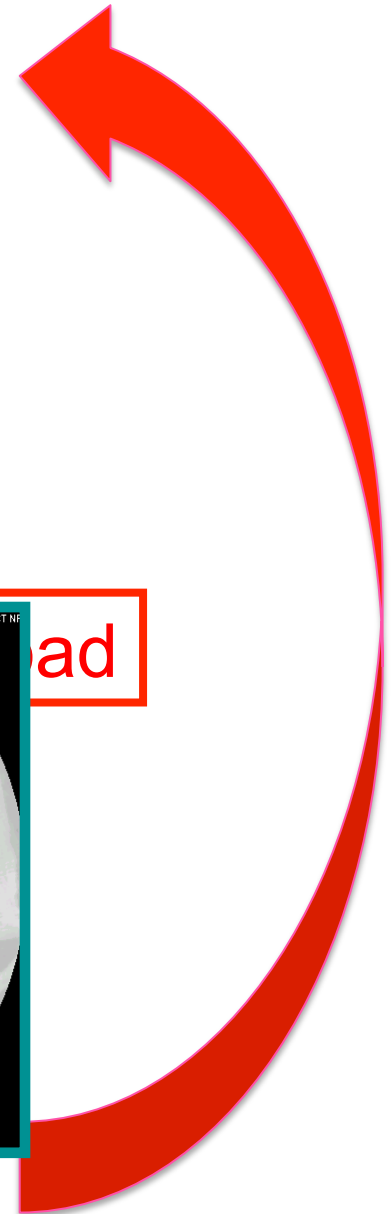
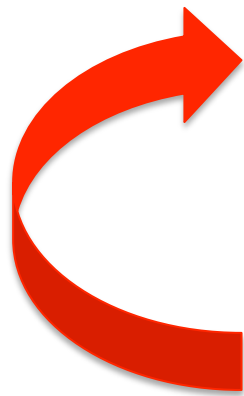
↓ v ad



END-EXP

END-INSP

Fluid overload



ECMO for ARDS: the 4 key questions

- Why yes ?
- **Why not ?**
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ELSO GUIDELINES FOR ECMO CENTERS

*There are **no absolute contraindications** to VV-ECMO,
each patient must be **considered individually** with
respect to risks and benefits*

ELSO Adult Respiratory Failure Supplement to the ELSO General Guidelines

December 2013

Common sense “absolute” contraindications:

- Severe/pre-terminal organ dysfunction
- Severe technical limitations for cannulation
- Severe brain damage, advanced cancer

	Age	Days MV	BMI	Chronic Resp Failure/ Pulmonary HTN	Immuno suppression
ELSO	-	> 7	-	-	Neutrophils < 400
ITALIAN Net	-	> 7	-	-	-
EOLIA trial	-	> 7	> 45	Long term O ₂ Long term assistance	-
ENGLISH Net St Thomas Hospital, London	70	> 7	> 40	Progressive RF Pulmonary hypertension	Advanced HIV, Transplant > 30 d BMT recipients Hematologic malignancies
AUSTRALIA Net Alfred ICU Melbourne Adelaide Royal ICU*	65 *	-	-	Progressive RF Pulmonary hypertension	Advanced HIV, Transplant > 30 d (severe sepsis)

Hot questions ...

Schmidt *et al. Critical Care* 2014, **18**:522
<http://ccforum.com/content/18/5/522>



LETTER

Patients with hematologic malignancies have many reasons to die during extracorporeal membrane oxygenation

Matthieu Schmidt*, Daniel Brodie and Alain Combes

See related research by Wohlfarth *et al.*, <http://ccforum.com/content/18/1/R20>

Extracorporeal membrane oxygenation in adult patients with hematologic malignancies and severe acute respiratory failure

Philipp Wohlfarth¹, Roman Ullrich², Thomas Staudinger¹, Andja Bojic¹, Oliver Robak¹, Alexander Hemann¹,

...7 over 14 survived...

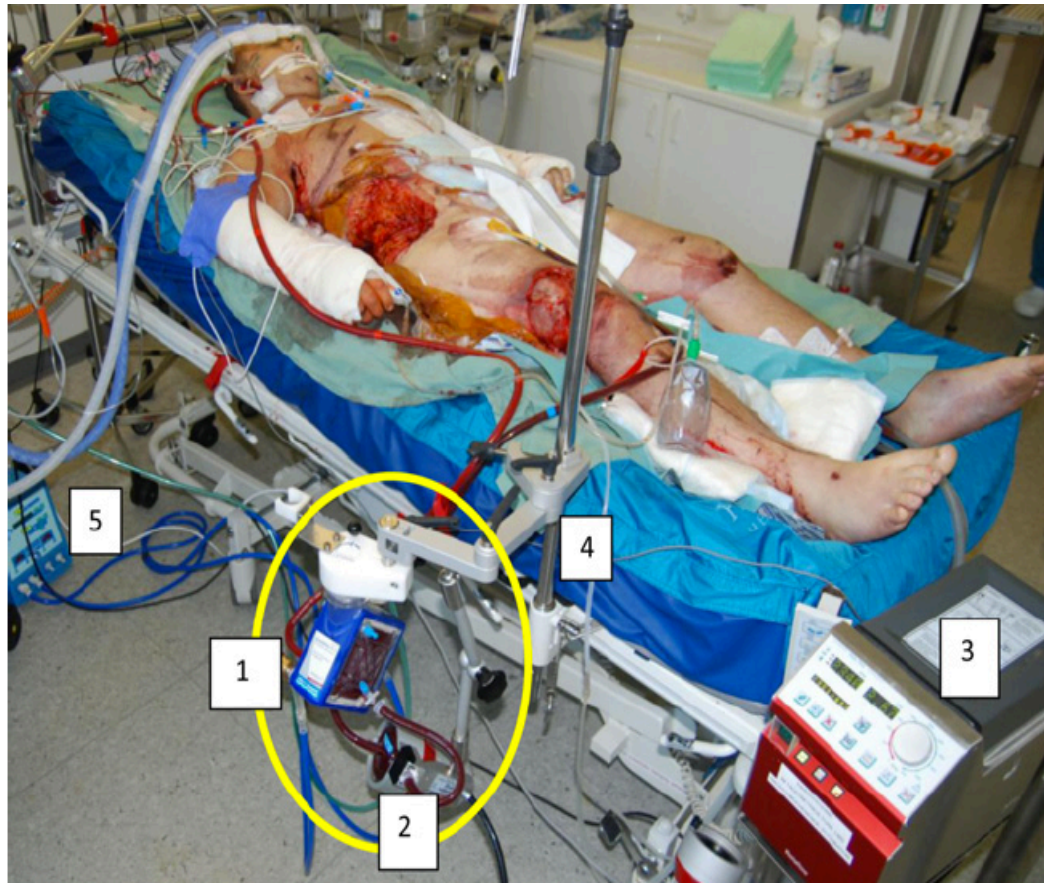
Table 1 Individual characteristics and outcomes

Patient number	Malignancy	Therapy status (days since therapy)	Etiology of ARF	SAPS II	LIS	ECMO days	Bleeding	ICU and hospital outcome
1	CNS NHL	Chemotherapy (51)	Pneumonia	45	3.7	9	Minor	Died
2	Hodgkin lymphoma	Allo SCT (111)	Pneumonia	34	3.3	28 ^b	Major	Died
3	ALL	Consolidation (13)	Abdominal sepsis	78	2.3	4 ^c	-	Alive
4	ALL ^a	Induction on ECMO	TRALI	62	3.3	3	-	Alive
5	Burkitt lymphoma	Induction (16)	Pneumonia	63	3.8	8	-	Alive
6	ALL	Allo SCT (31)	Pneumonia	39	3.5	7	Major	Died
7	Hodgkin lymphoma	Allo SCT (33)	Pneumonia	65	3.3	18	-	Died
8	ALL	Allo SCT (203)	Pneumonia	68	3.3	10	-	Died
9	DLBCL	Induction on ECMO	Pneumonia	102	4.0	4	-	Died
10	Multiple myeloma	Auto SCT (789)	Pneumonia	43	3.7	9	Major	Alive
11	Anaplastic T-cell NHL ^a	Induction on ECMO	Pneumonia	46	3.0	25 ^d	Major	Alive
12	DLBCL ^a	Induction on ECMO	NHL	36	3.3	3 ^c	-	Alive
13	AML	Consolidation (34)	Pneumonia	48	3.3	34	Major	Died
14	DLBCL ^a	Induction on ECMO	NHL	56	2.3	4 ^d	-	Alive

ALL, acute lymphoblastic leukemia; allo SCT, allogeneic stem cell transplantation; AML, acute myeloid leukemia; ARF, acute respiratory failure; auto SCT, autologous stem cell transplantation; CNS, central nervous system; DLBCL, diffuse large B-cell lymphoma; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit; LIS, lung injury score at ECMO baseline [30]; NHL, non-Hodgkin lymphoma; SAPS II, simplified acute physiology score at ICU admission [27]; TRALI, transfusion-related acute lung injury. ^aDiagnosis of hematologic malignancy on ECMO; ^bTwo episodes of ECMO; ^cventoarterial ECMO; ^dthree episodes of ECMO.

Hot questions ...

Anticoagulation *versus* risk of bleeding

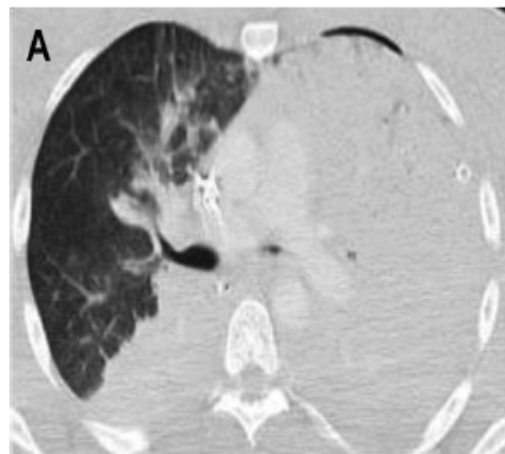


Prolonged heparin-free extracorporeal membrane oxygenation in multiple injured acute respiratory distress syndrome patients with traumatic brain injury

Ralf M. Muellenbach, MD, Markus Kredel, MD, Ekkehard Kunze, MD, Peter Kranke, MD, Julian Kuestermann, MD, Alexander Brack, MD, Armin Gorski, MD, Christian Wunder, MD, Norbert Roewer, MD, and Thomas Wurmb, MD, Würzburg, Germany



Entry



Entry



10 severe trauma patients at risk of bleeding

6 survived without disability

Clinical paper

Extracorporeal membrane oxygenation in severe trauma with bleeding shock[☆]

Matthias Arlt^{*}, Alois Philipp, Sabine Voelkel, Leopold Michael Hilker, Bernhard M. Graf, Christof Schmid

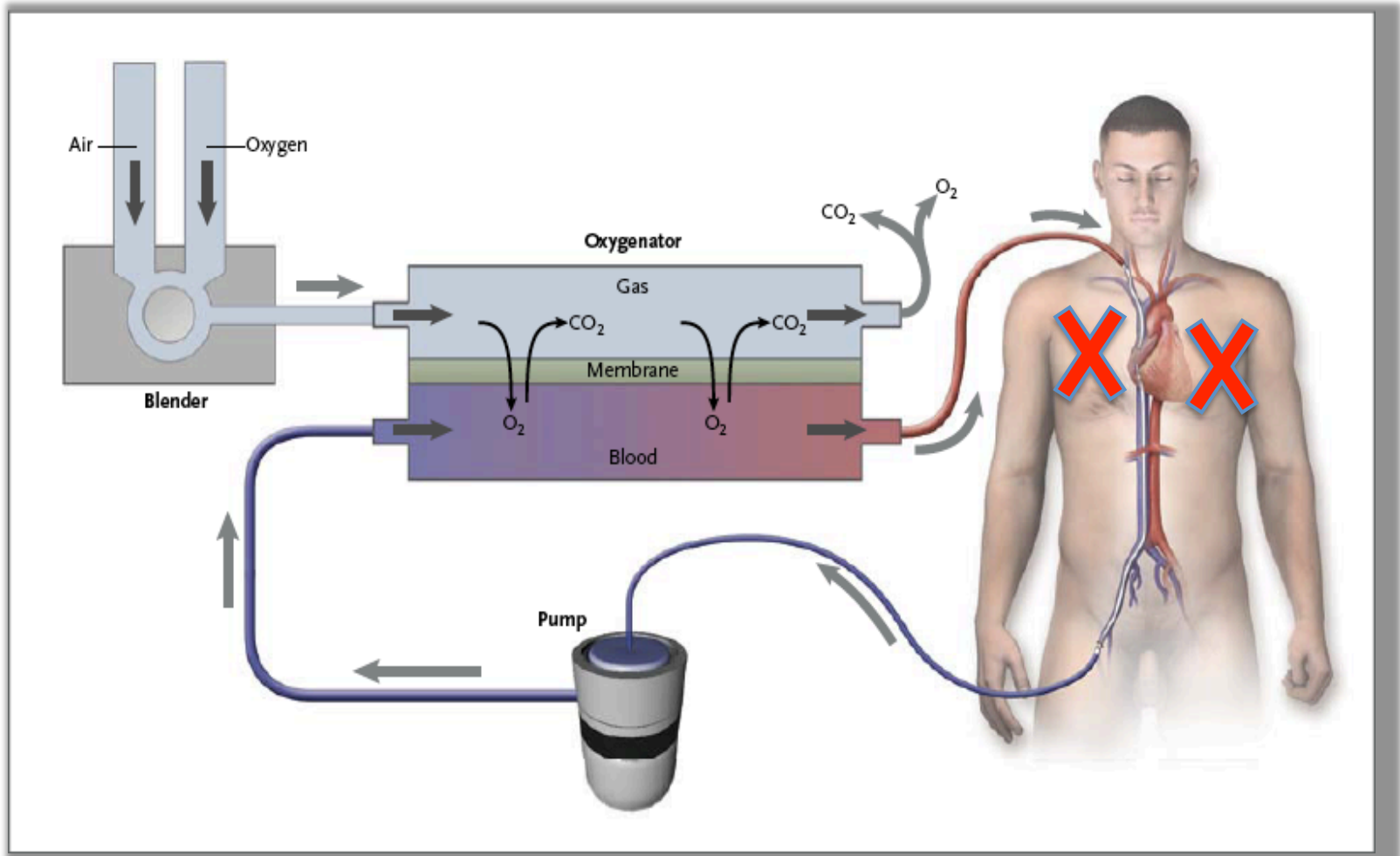
University Hospital Regensburg, Germany

Patient/ gender/age	ECMO type	Trauma	Diagnosis	APACHE II scores SS/SOFA	paO ₂ /FiO ₂ pre-ECMO	PaCO ₂ [mm Hg] pre-ECMO	Norepinephrine [mg/h] pre-ECMO	Treatment on ECMO	Transfusion ECMO	Days on ECMO	Outcome
H.R./m/22 years	v-v	Car crash	Polytrauma Bleeding shock ARDS	66/13	41	50	5.0	Damage control surgery CT-scan Damage control surgery CT-scan Kinetic therapy	3	4	Survived without handicap
K.M./m/30 years	v-v	Car crash	Polytrauma ICB Bleeding shock ARDS	75/14	39	80	1.0	Damage control surgery CT-scan		6	Survived without handicap
D.V./m/56 years	v-v	Car crash	Polytrauma Bleeding shock ARDS	75/12	58	59	1.1	CT-scan Kinetic therapy	0	5	Survived without handicap
B.S./m/27 y	v-v	Car crash	Polytrauma Bleeding shock ARDS	75/14	64	36	1.4	Damage control surgery CT-scan Kinetic therapy	2	2	Died 20 days post-ECMO in septic multiple organ failure
W.T./m/21 years	v-v	Car crash	Polytrauma Bleeding shock ARDS	75/10	36	84	2.0	CT-scan Kinetic therapy CT-scan Kinetic therapy	4 2 1	3	Died on ECMO in septic multiple organ failure
K.P./m/17 years	v-v	Motorcycle c	Polytrauma Open chest Bleeding shock ARDS	75/12	48	67	13.5	Laparotomy Trauma surgery	0	5	Died on ECMO in septic multiple organ failure
K.N./f/24 years	v-v	Car crash	Polytrauma Bleeding shock ARDS	66/12	69	38	1.0	Trauma surgery Kinetic therapy CT-scan Damage control surgery		7	Survived without handicap
T.P./m/39 years	v-a	Truck crash	Polytrauma Bleeding shock ARDS	75/10	46	53	5.6	Damage control chest surgery	2	7	Survived without handicap
P.S./f/23 years	v-a	Suicid fall	Polytrauma Bleeding shock ARDS	75/10	40	85	5.0	Damage control chest surgery	5	0.5	Died on ECMO intractable retroperitoneal bleeding
A.S./m/62 years	v-a	Open chest t	Polytrauma ICB Bleeding shock ARDS	29/11	105	89g	4.0	Damage control chest surgery	2	11	Survived without handicap

ECMO for ARDS: the 4 key questions

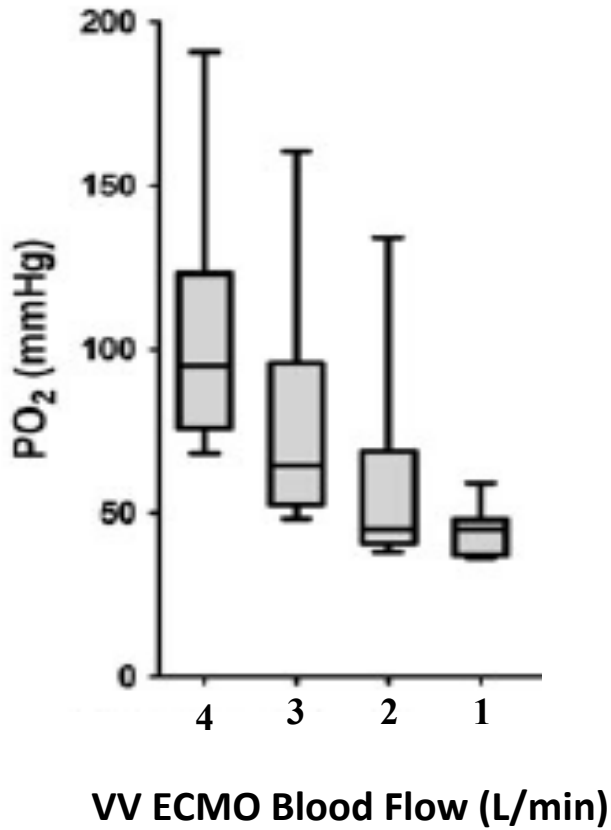
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Venous-Venous ECMO: supports the failing lungs

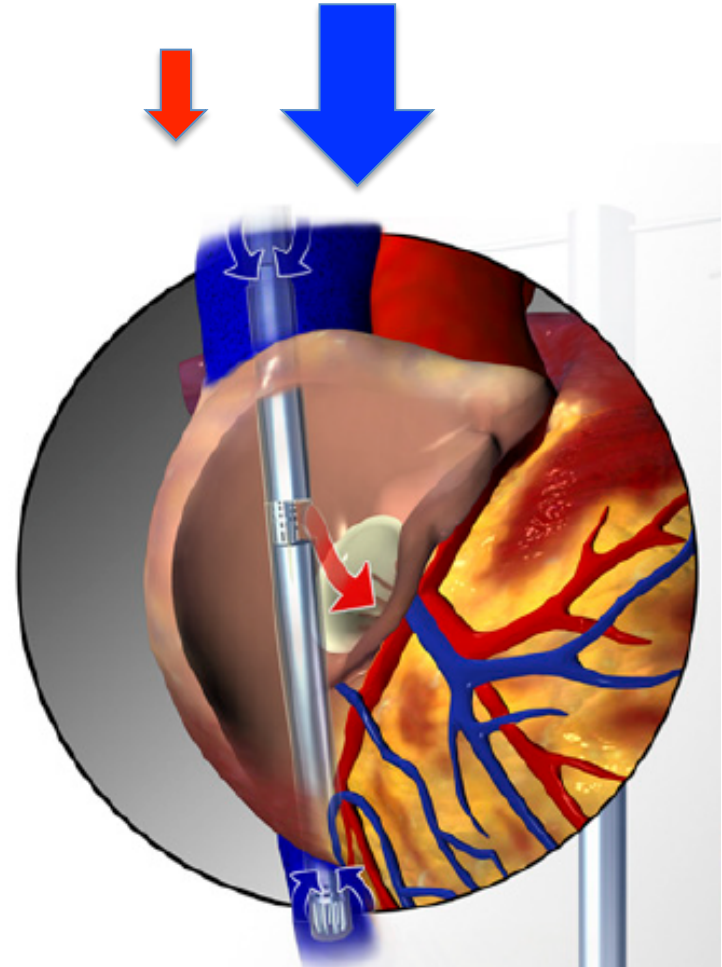


Matthieu Schmidt
Guillaume Tachon
Christine Devilliers
Grégoire Muller
Guillaume Hekimian
Nicolas Bréchet
Sybille Merceron

Blood oxygenation and decarboxylation determinants during venovenous ECMO for respiratory failure in adults

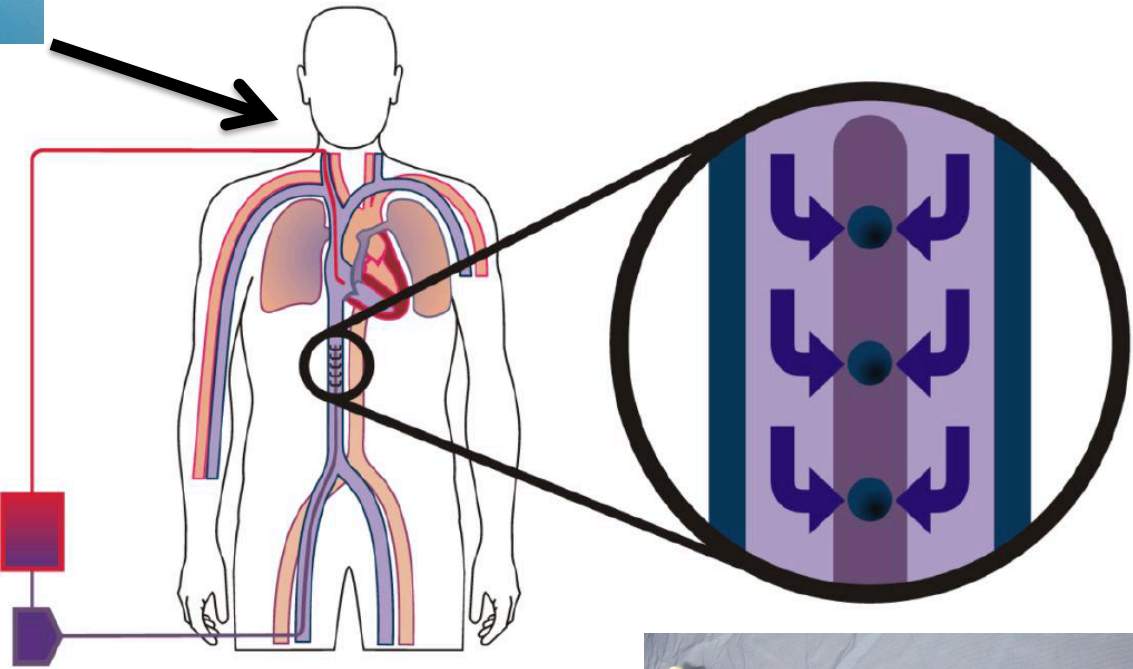


ECMO Venous Return
No ECMO Venous Return





Jugular cannula
13 to 19 fr
(from 4 to 6 mm)



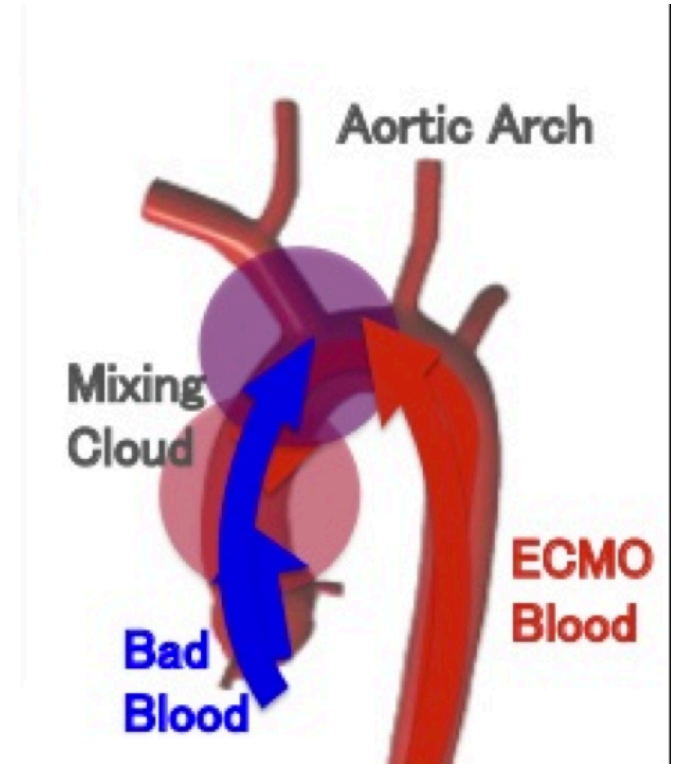
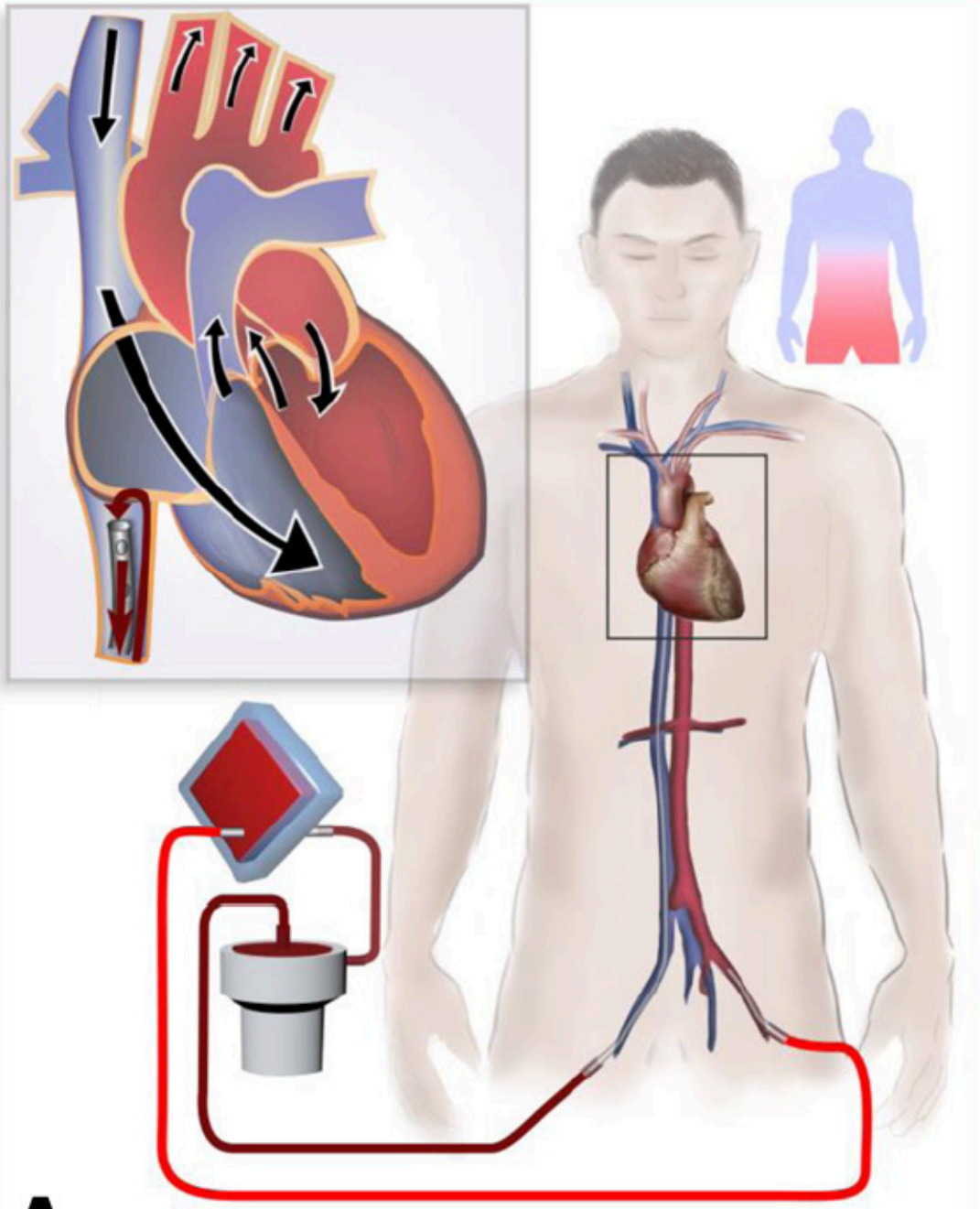
Femoral cannula
21 to 31 fr
(from 7 to 10 mm)



Disrupting differential hypoxia in peripheral
veno-arterial extracorporeal membrane
oxygenation



Matthew Edward Cove



ECMO for ARDS: the 4 key questions

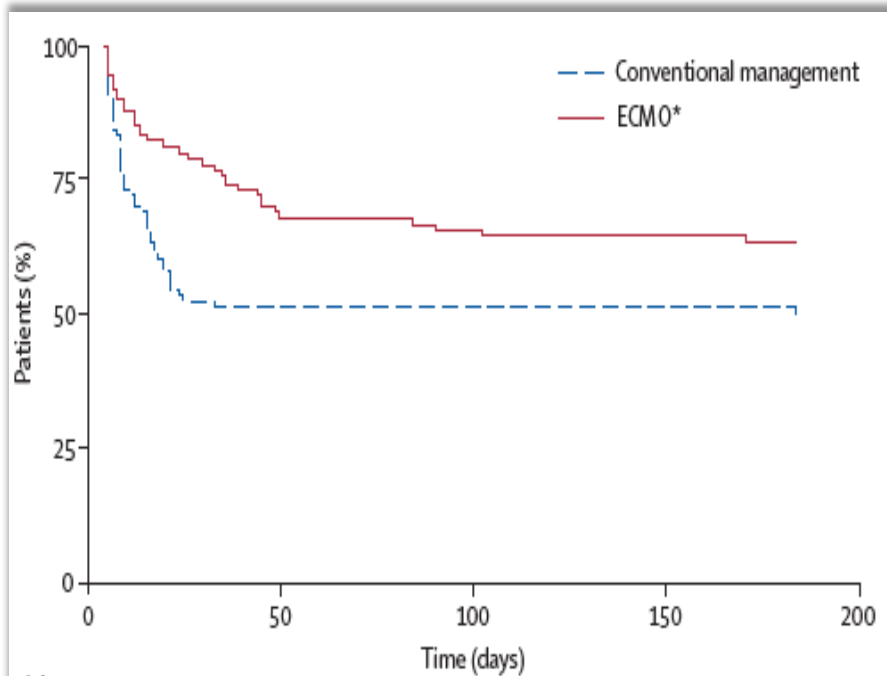
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- Why not ?
- How ?
- **Where ?**

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

Lancet 2009; 374: 1351-63



75 % actually received ECMO

90 pt referred to the ECMO center

63 % survived at 6 months

87 pt left in peripheral ICU

47 % survived at 6 months

**ARDS Treatment
2015**

- iNO ?
- Low flow CO₂ removal ?
- HFO ??
- Transpulmonary approach

**ARDS Network
PROTOCOL**

OLA (LRM and PEEP titration) ?!

Prone Positioning !

Neuromuscular blockade !

Low Tidal Volume + high PEEP

ECMO

Mild ARDS

Moderate ARDS

Severe ARDS

300 (40) 250 (33.3) 200 (26.7) 150 (20) 100 (13.3) 50 (6.7)

PaO₂/FiO₂ at CPAP/PEEP > 5 cmH₂O

CLINICAL EXPERTISE

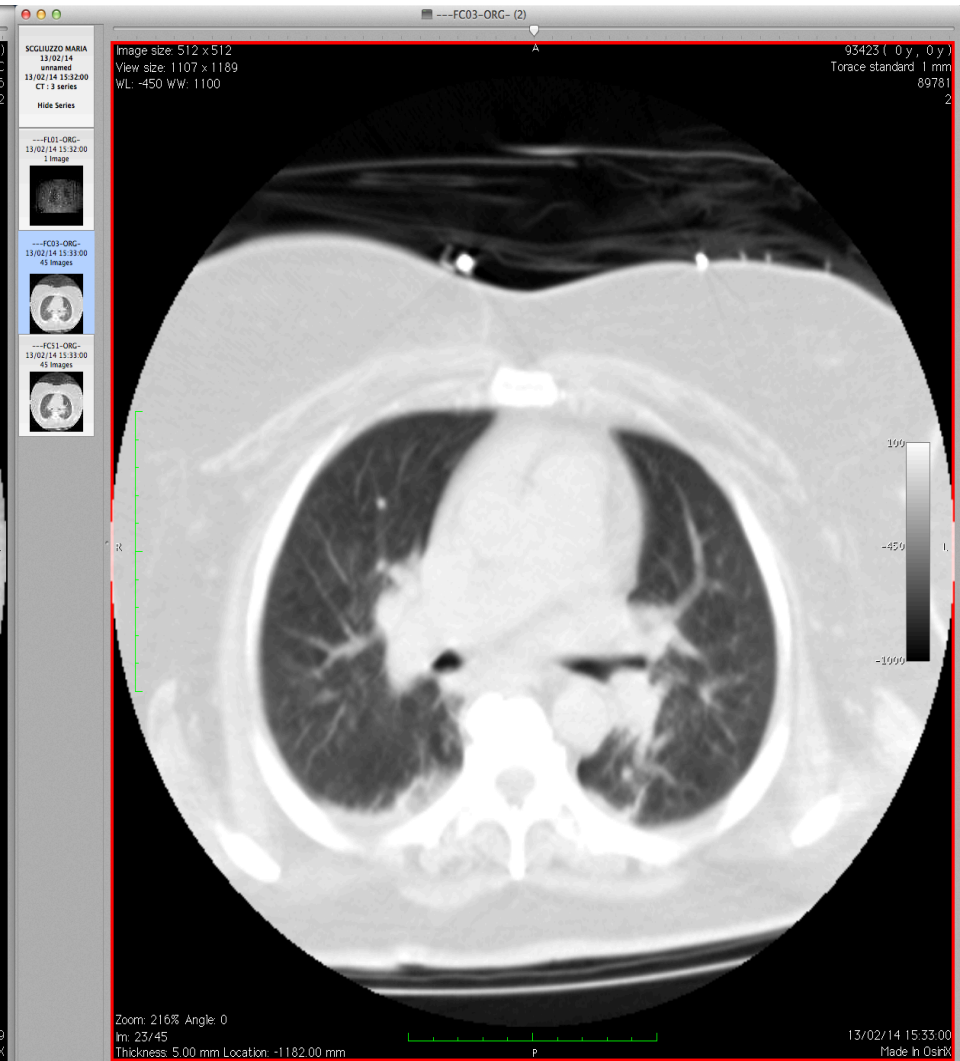
- 8 Northern Italy
- 4 Central Italy
- 4 (2) Southern Italy



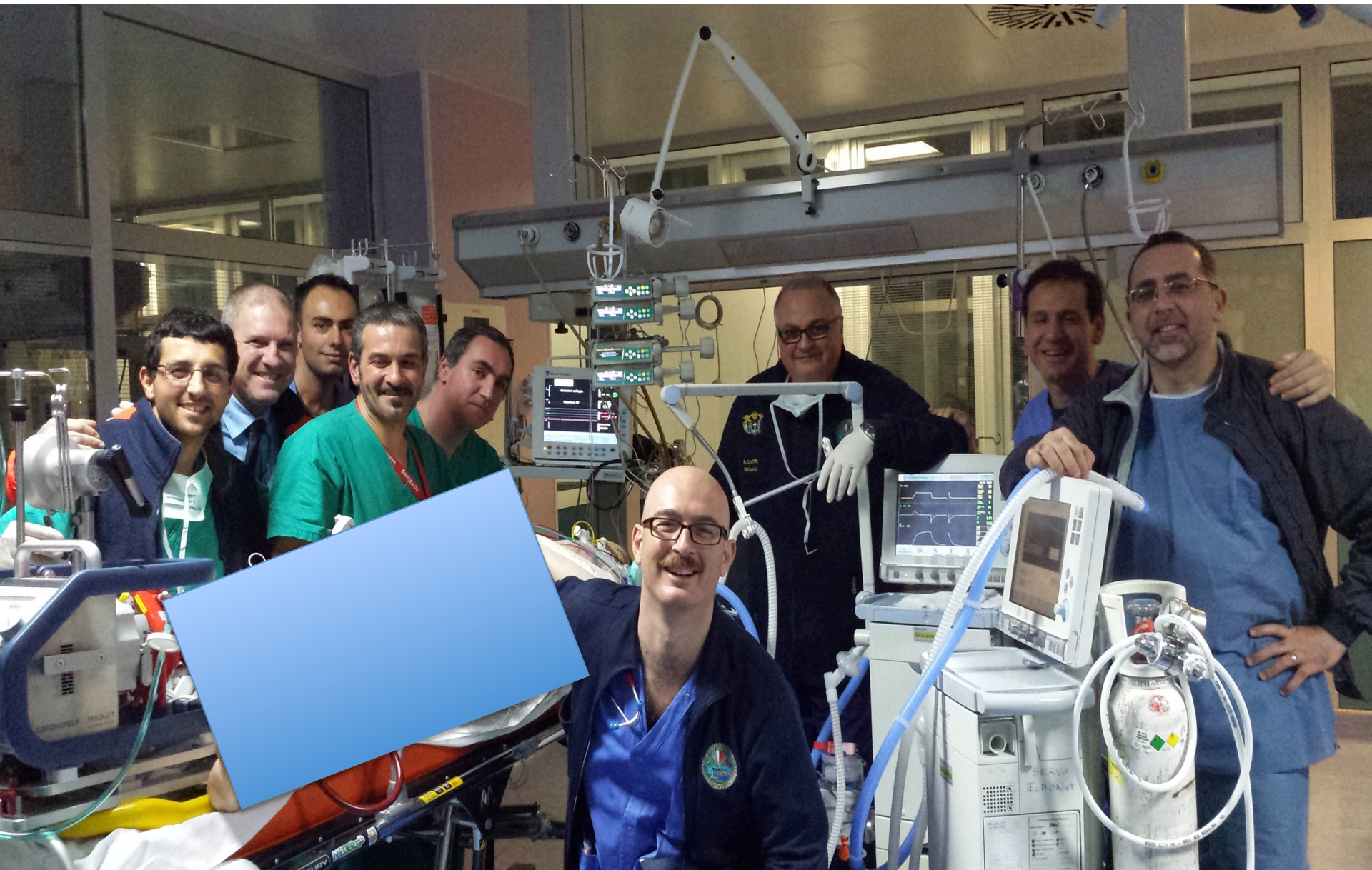
H1N1; SM, Gallipoli (LE) 4/02/2014



4_02_2014



13_02_2014



Gallipoli 4_02_1014

