Future of ECLS

Zakopane

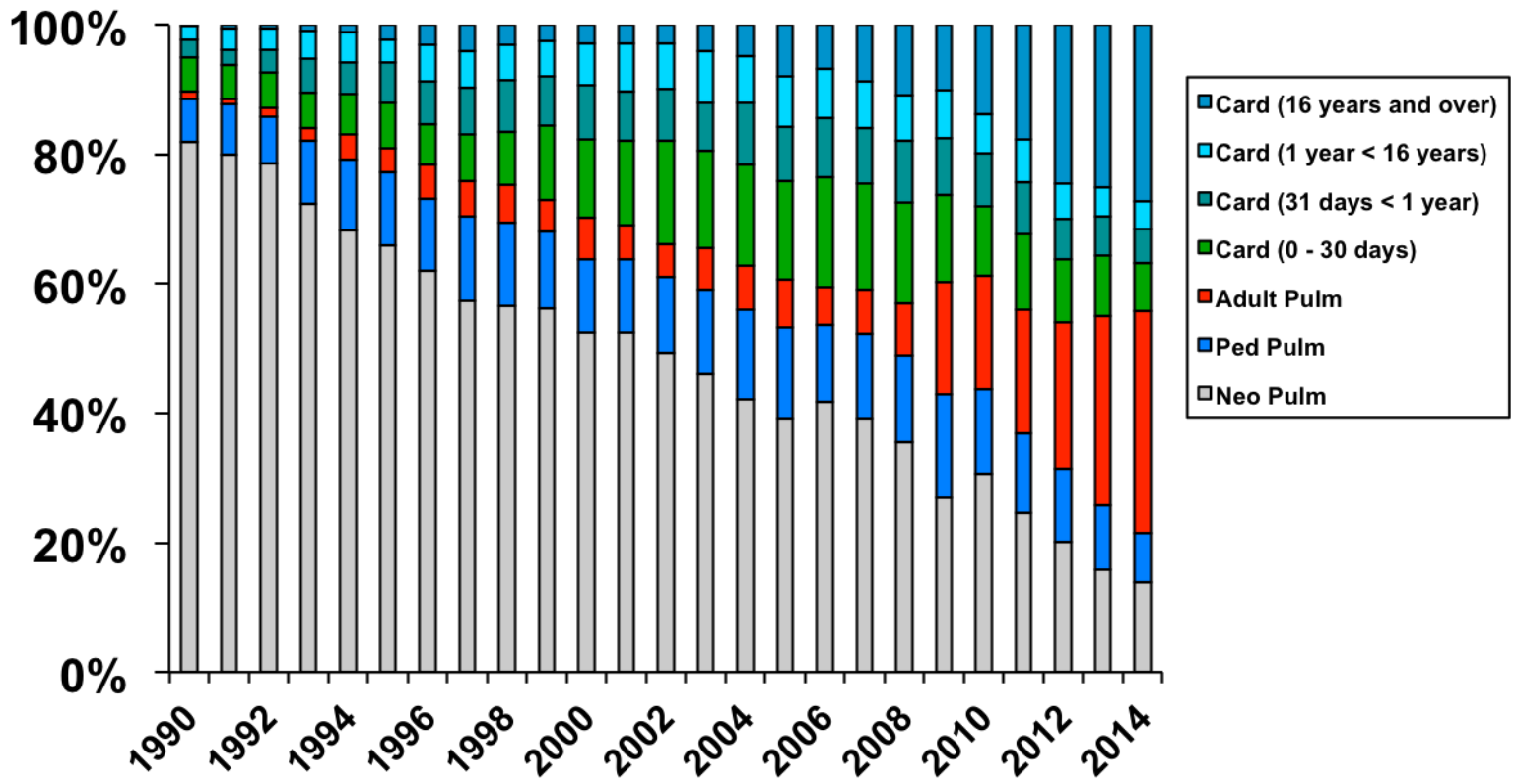
2015

F:\E

Esperanza. The first neonatal ECMO survivor, 1975

RHB Zapol Kolobow Gattinoni Fumagalli Pesenti

Runs by Year


100%
80%
60%
40%
20%
0%
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Card (16 years and over)
Card (1 year < 16 years)
Card (31 days < 1 year)
Card (0 - 30 days)
Adult Pulm
Ped Pulm
Neo Pulm

Future of ECLS, 2015-2025

- Technology
  - Automation
  - Anticoagulation
  - Physiology, Hemoglobin
- Circulatory support
  - Cardiac Failure, ECPR, EDCD
  - Sepsis
  - Placenta
- Respiratory support
  - Resp Failure,management, bridge to XP
  - Irrevesible lung injury
  - Home ECMO, implantable lung

Automation

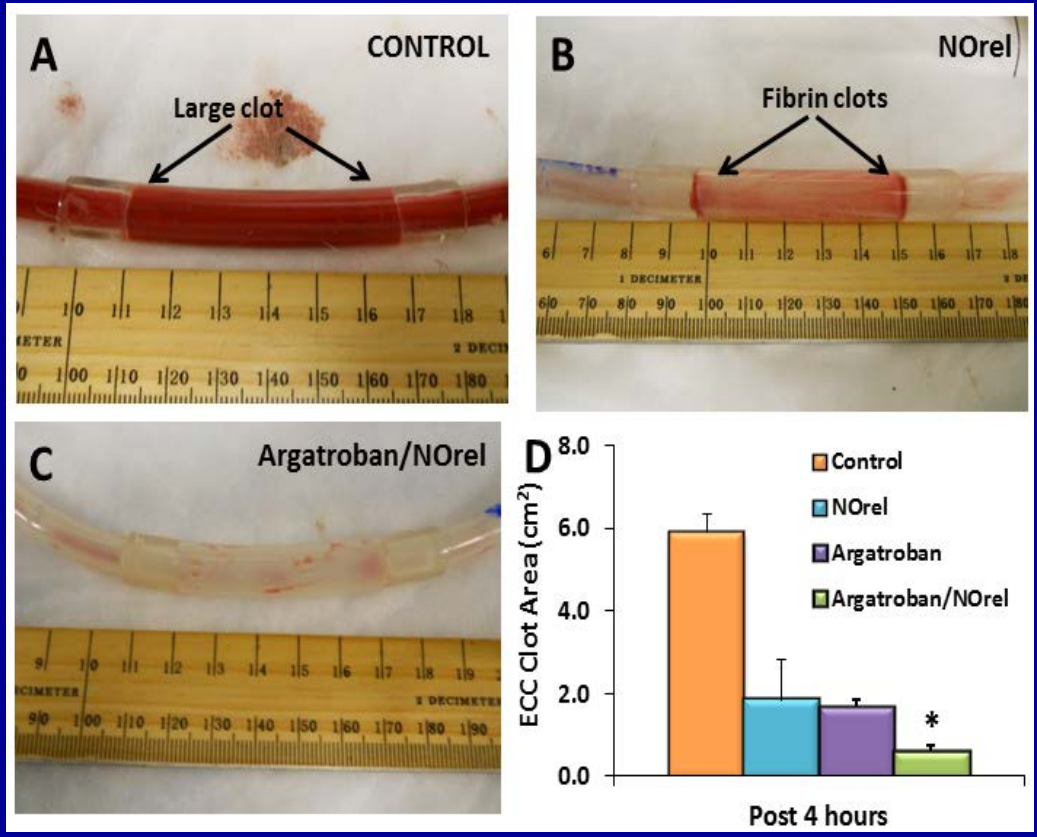
- Flow servo regulation based on SVO2
- CO2 clearance (sweep flow) servoregulation based on exhaust gas CO2

Anticoagulation

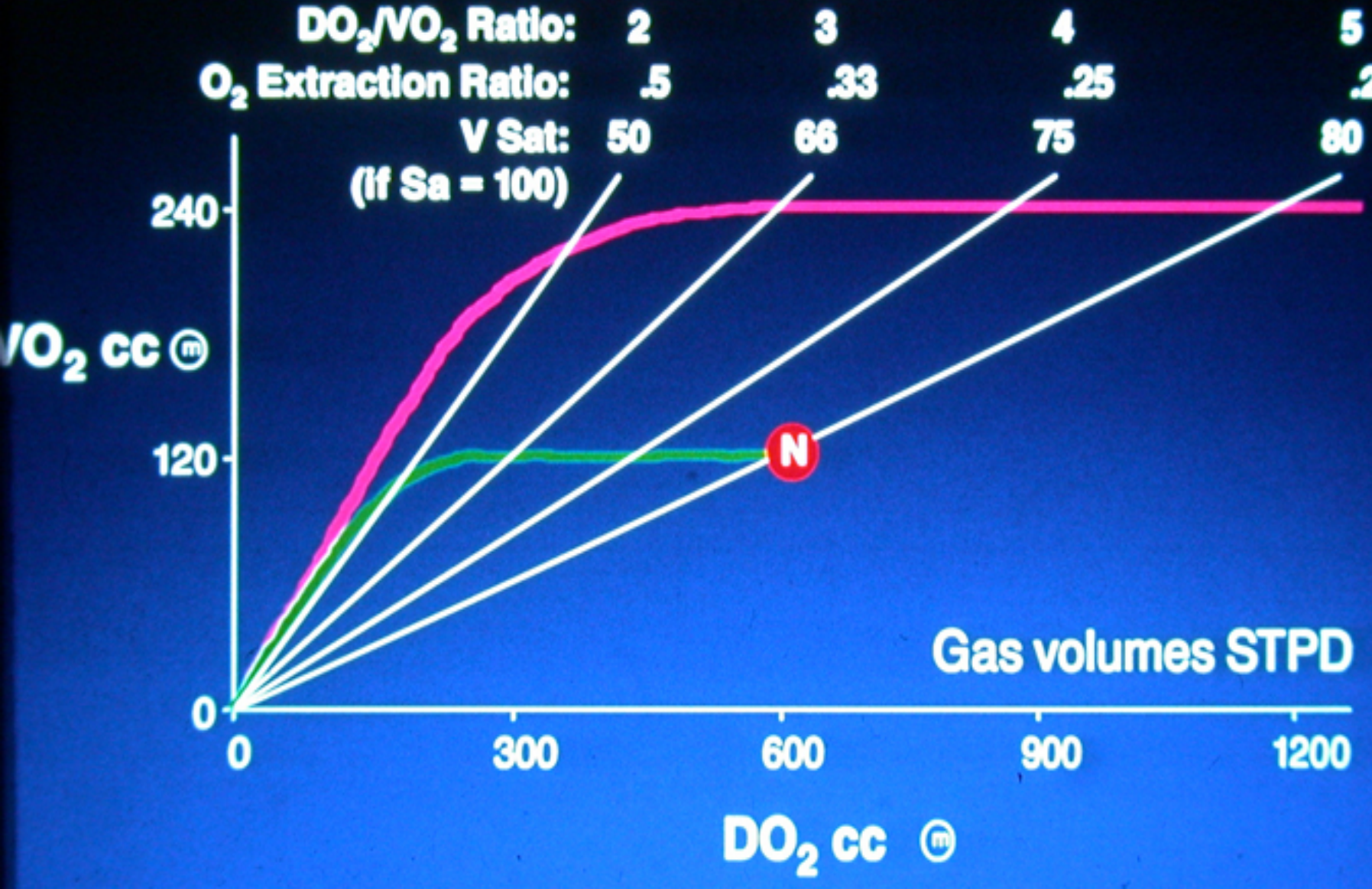
- Monitor by exam of whole blood (ACT, TEG)
- Direct thrombin inhibitors are anticoagulant of choice (Argatroban, Bivalrudin)
- No more heparin

Nonthrombogenic circuits with no systemic anticoagulation

Decreased Thrombus Formation in NO/argat Polymer Rabbit ECC test system with no anticoagulation

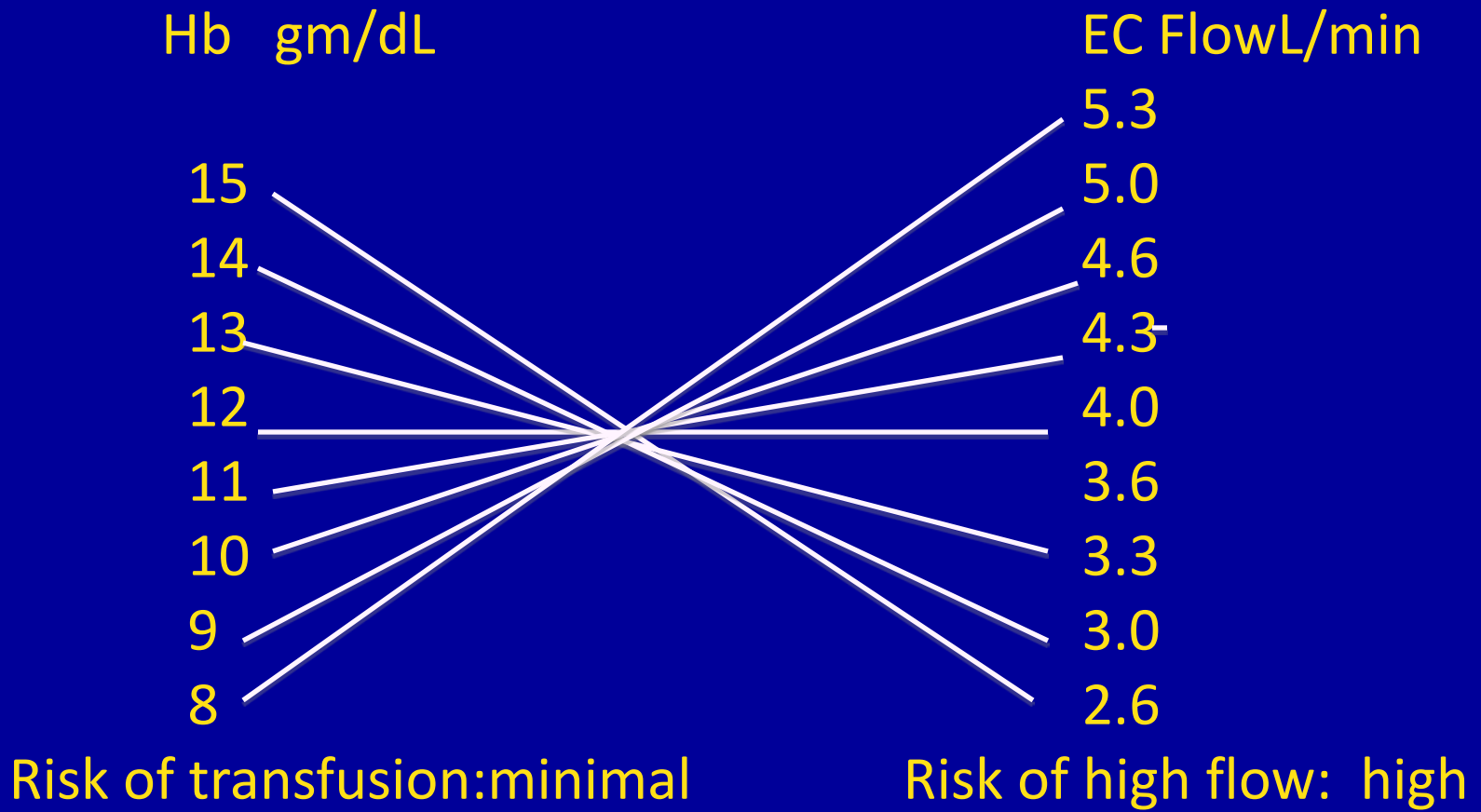


OXYGEN CONSUMPTION/DELIVERY AND SHOCK

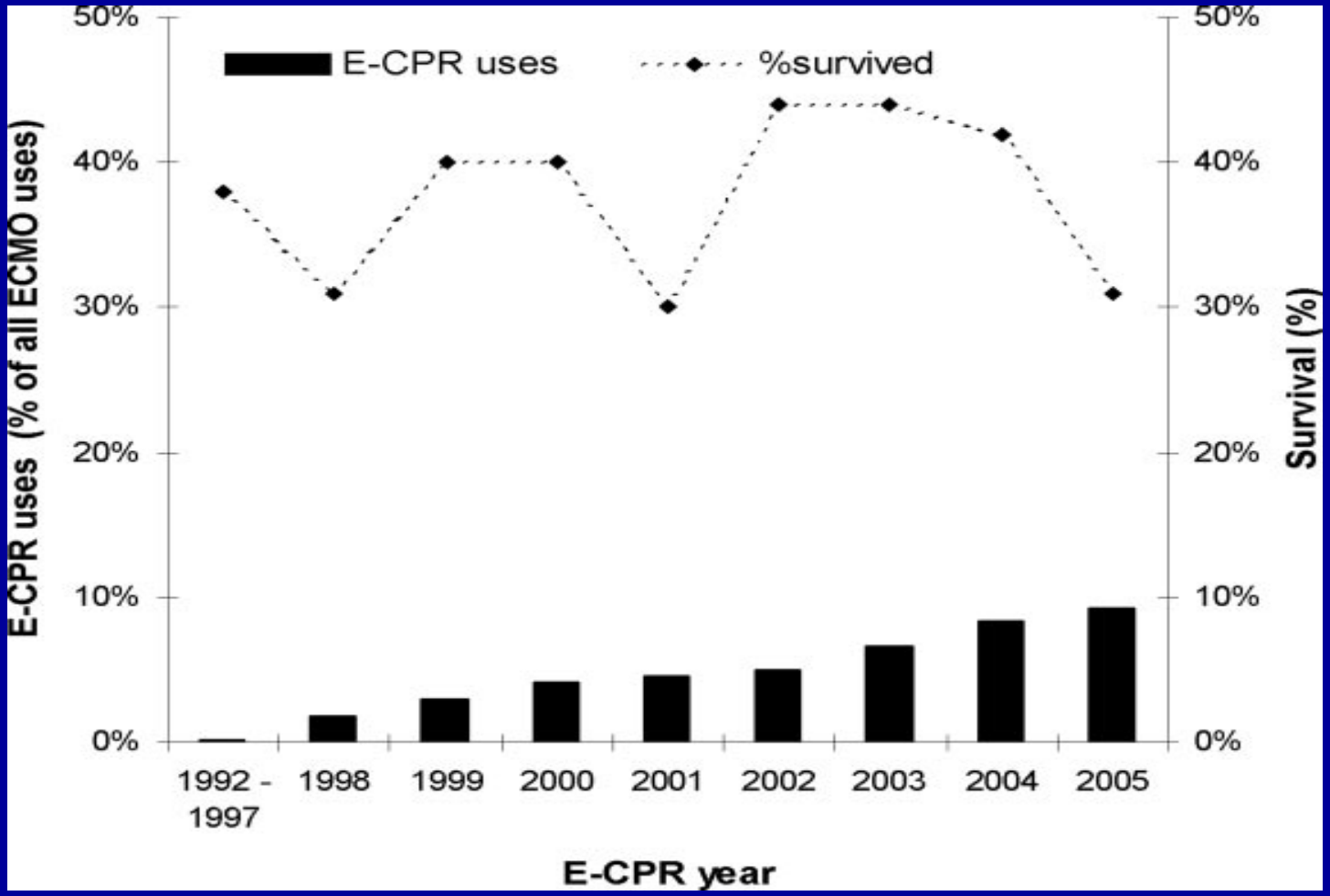


Hb and flow in ECLS

Typical 80 kg adult: total O2 support 240cc/min




VA support, no cardiac function
Bridge to LVAD, then cardiac recovery



ELSO Registry: Pediatric ECPR.
Thiagarajian AnnTS 2007

Resuscitation 83 (2012) 966–970

Contents lists available at SciVerse ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Emergency physician-initiated extracorporeal cardiopulmonary resuscitation☆

Joseph M. Bellezzo[a,*], Zack Shinar[a,b], Daniel P. Davis[c], Brian E. Jaski[b], Suzanne Chillcott[b], Marcia Stahovich[b], Christopher Walker[b], Sam Baradarian[b], Walter Dembitsky[b]

[a] Sharp Memorial Hospital, Emergency Department, 7901 Frost Street, San Diego, CA 92123, United States
[b] Sharp Memorial Hospital, 7901 Frost Street, San Diego, CA 92123, United States
[c] University of California, San Diego, Emergency Medicine, 200 West Arbor Drive #8676, San Diego, CA 92103-8676, United States

42 patients CPR

18 met protocol criteria for ECPR
8 resuscitated on ECLS (hospital admission)
5 discharged, neuro intact (61%)

Resuscitation 86 (2015) 88–94

Contents lists available at ScienceDirect

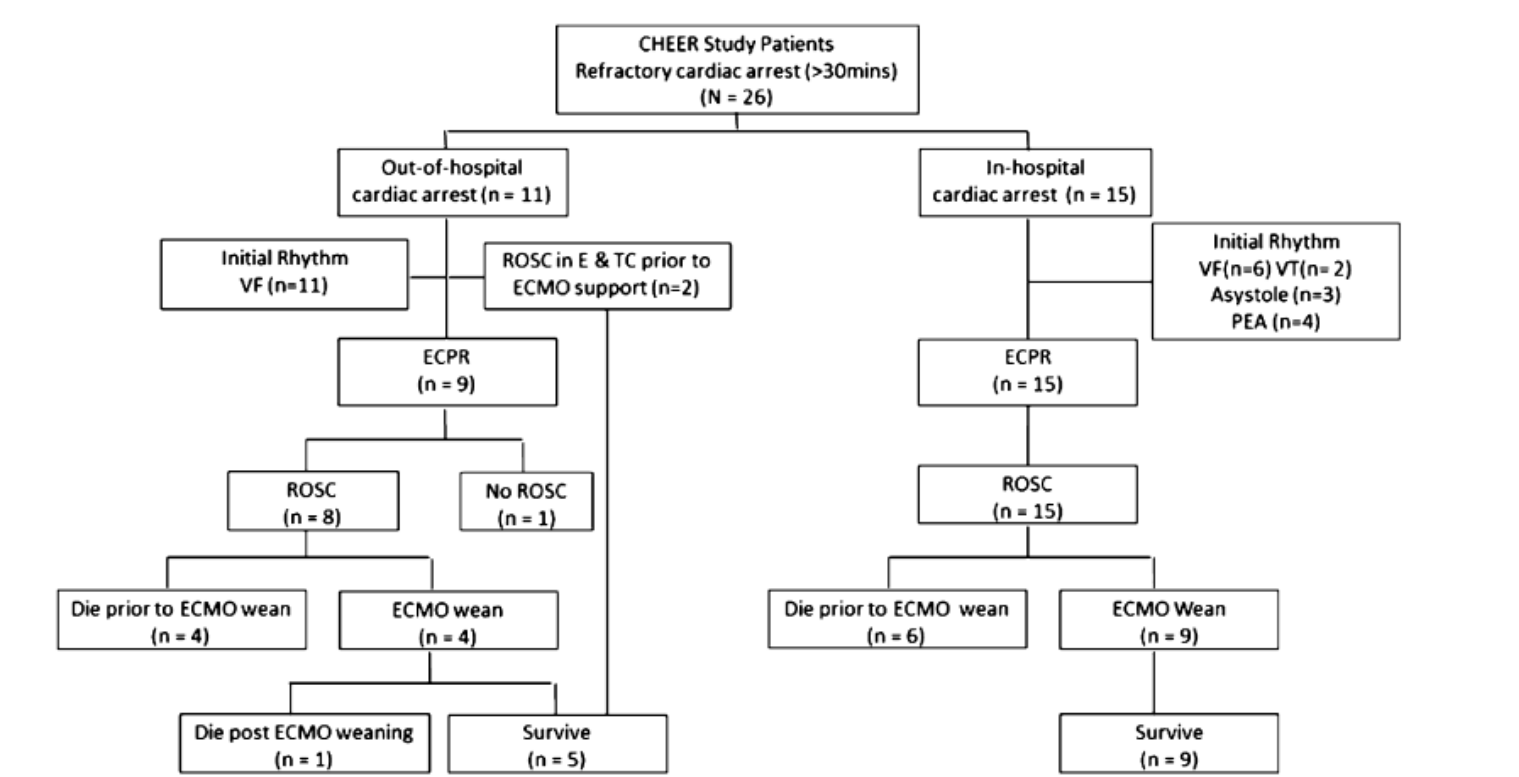
Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical Paper

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

Dion Stub[c,f,g], Stephen Bernard[a,b,d,*], Vincent Pellegrino[a], Karen Smith[b,d,e], Tony Walker[d], Jayne Sheldrake[a], Lisen Hockings[a], James Shaw[a,b,c], Stephen J. Duffy[a,b,c], Aidan Burrell[a,b], Peter Cameron[a,b], De Villiers Smit[a], David M. Kaye[a,b,c]



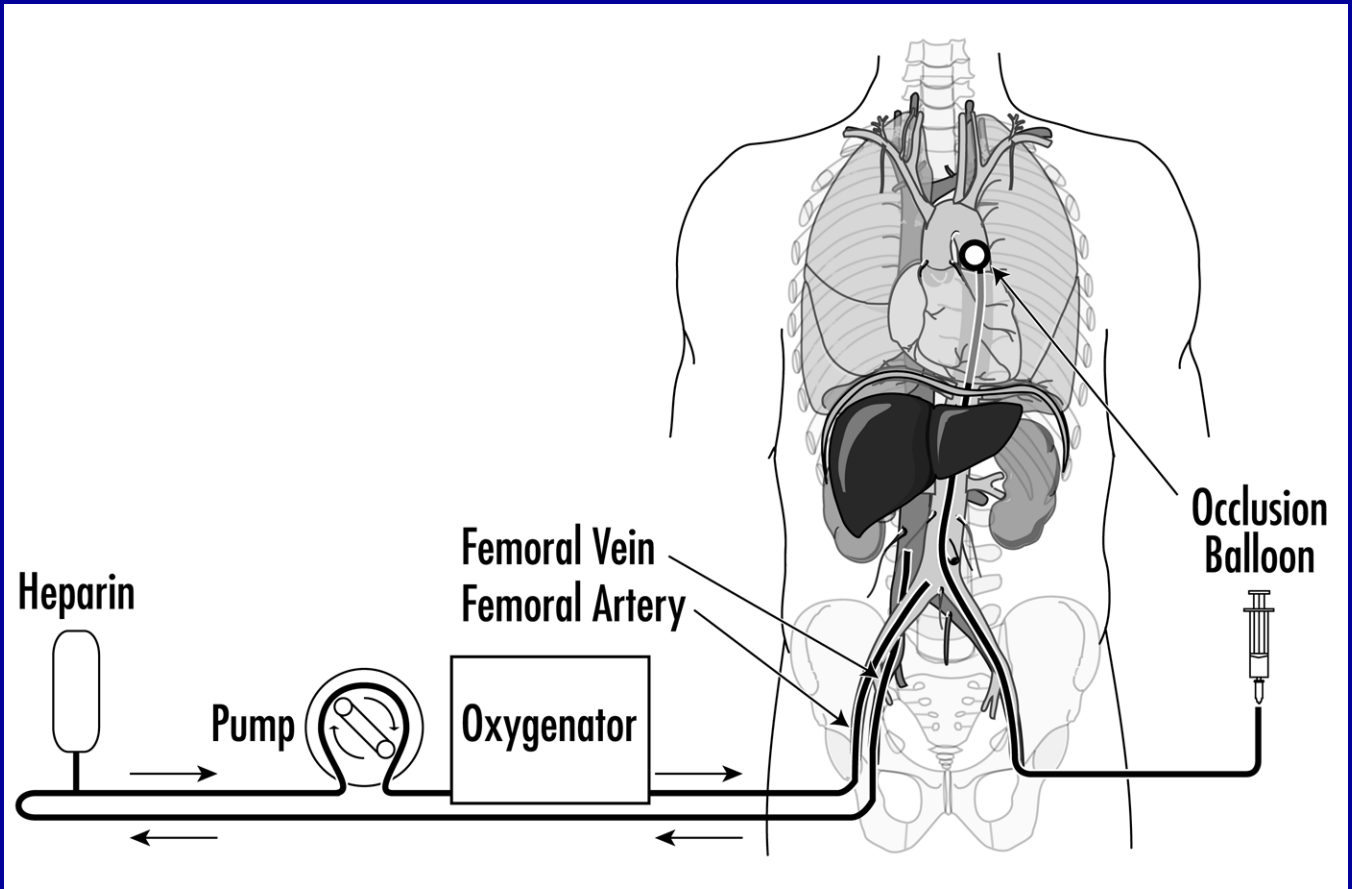
ig. 1. Outcome of 26 non-post cardiotomy patients with refractory cardiac arrest. CHEER – Mechanical CPR, Hypothermia, ECMO and Early Reperfusion, E&TC – Emergency nd Trauma Center, VF – ventricular fibrillation, ROSC – return of spontaneous circulation, ECMO – extracorporeal membrane oxygenation, ECPR – extracorporeal membrane oxygenation facilitated cardiopulmonary resuscitation.

CHEER ECPR study

Out of hospital arrest
3/9 ECMO survivors

In hospital arrest
9/15 ECMO survivors

ECMO for DCD Donation



Clin Transplant 2011: 25: 511–516 DOI: 10.1111/j.1399-0012.2010.01333.x

Clinical Transplantation

Kidney from uncontrolled donors after cardiac death with one hour warm ischemic time: resuscitation by extracorporal normothermic abdominal perfusion "*in situ*" by leukocytes-free oxygenated blood

Reznik O, Skvortsov A, Loginov I, Ananyev A, Bagnenko S, Moysyuk Y. Kidney from uncontrolled donors after cardiac death with one hour warm ischemic time: resuscitation by extracorporal normothermic abdominal perfusion "*in situ*" by leukocytes-free oxygenated blood. Clin Transplant 2011: 25: 511–516. © 2010 John Wiley & Sons A/S.

Oleg Reznik[a], Andrej Skvortsov[a], Igor Loginov[a], Alexey Ananyev[a], Sergey Bagnenko[a] and Yan Moysyuk[b]

[a]Transplant Department, St. Petersburg State

ECLS for septic shock

- 45 children in Melbourne, Australia
- Maximum vasopressors,18 arrested
- 47 % survived to D/C
- Very high flow with central cannulation,73% survived
- 62/24/14 % had no, mild , moderate disability

(MacLaren,Ped CCM, 2007)

Michigan pediatric sepsis ECMO and plasmaphersis

14 children in septic shock

Vasoactive/ Inotropic score 24 -5.0

Organ Failure Index 4.1 – 2.9

10 survived (71%)

Kawai, PCCM. Epub ahead of print 2015

La Pitie Sepsis study

- 14pts in septic shock,

  max pressors, age 28-66

  pH 7.16 lactate 9

  CI 1.3 LVEF 16% SVR 3162

  SOFA 18 APACHEIII 84
- 12 weaned from ECLS
- 10 survivied to D/C (71%)

Brechot CCM 2014

IJAO
ISSN 0391-3988

Int J Artif Organs 2015; 00(00): 000-000
DOI: 10.5301/ijao.5000382

SHORT COMMUNICATION

First successful combination of ECMO with cytokine removal therapy in cardiogenic septic shock: A case report

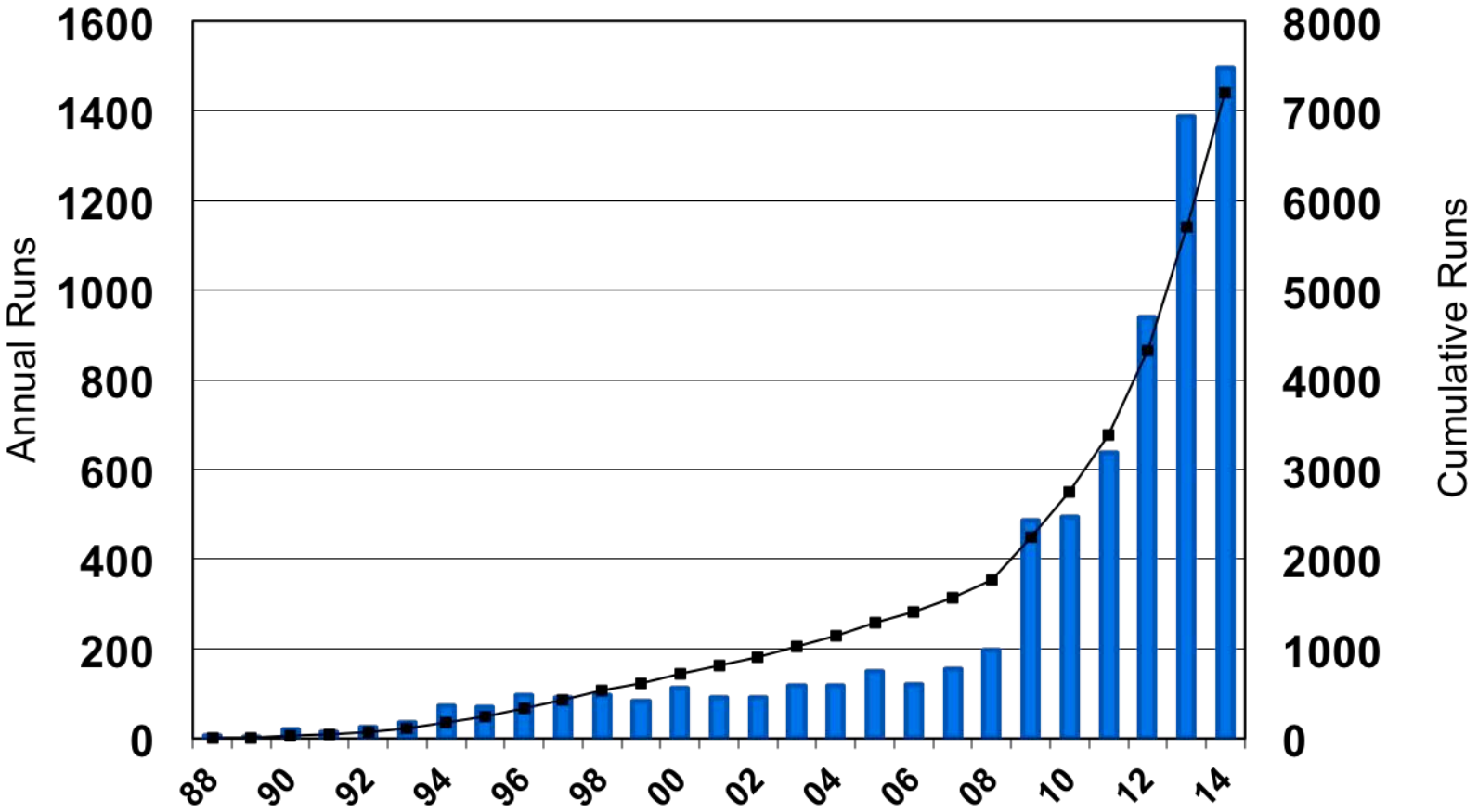
Frank Bruenger[1], Lukasz Kizner[1], Jan Weile[2], Michael Morshuis[1], Jan F. Gummert[1]

[1] Clinic for Thoracic and Cardiovascular Surgery, Heart and Diabetes Center North Rhine-Westphalia, Bad Oeynhausen - Germany
[2] Institute for Laboratory and Transfusion Medicine, Heart and Diabetes Center North Rhine-Westphalia, Bad Oeynhausen - Germany

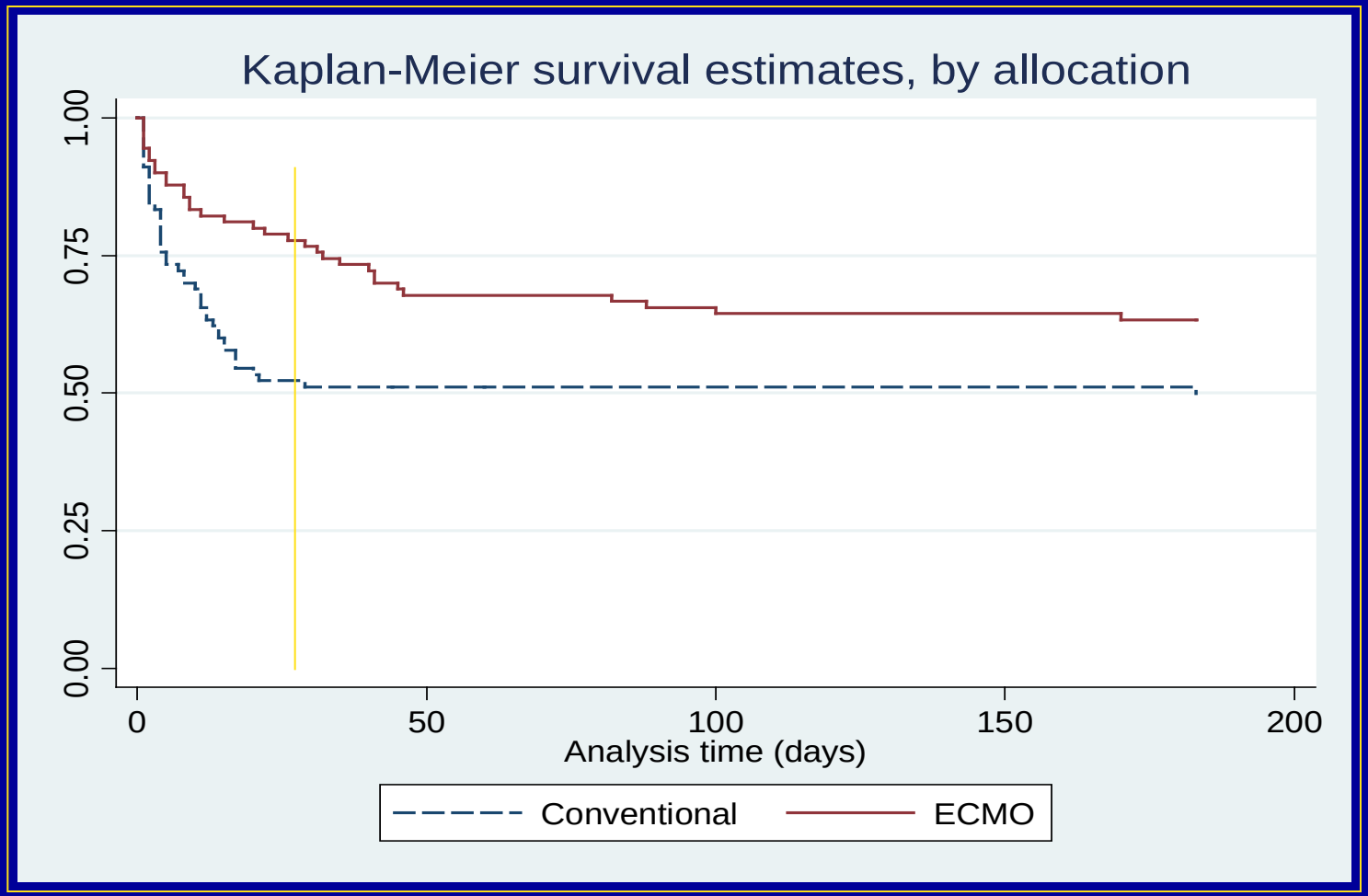
Cytosorb : Absorbs molecules 10-70K mw
Including cytokines

Cytosorbents Inc.
Dr Bartlett has a financial interest

Adult Respiratory Cases



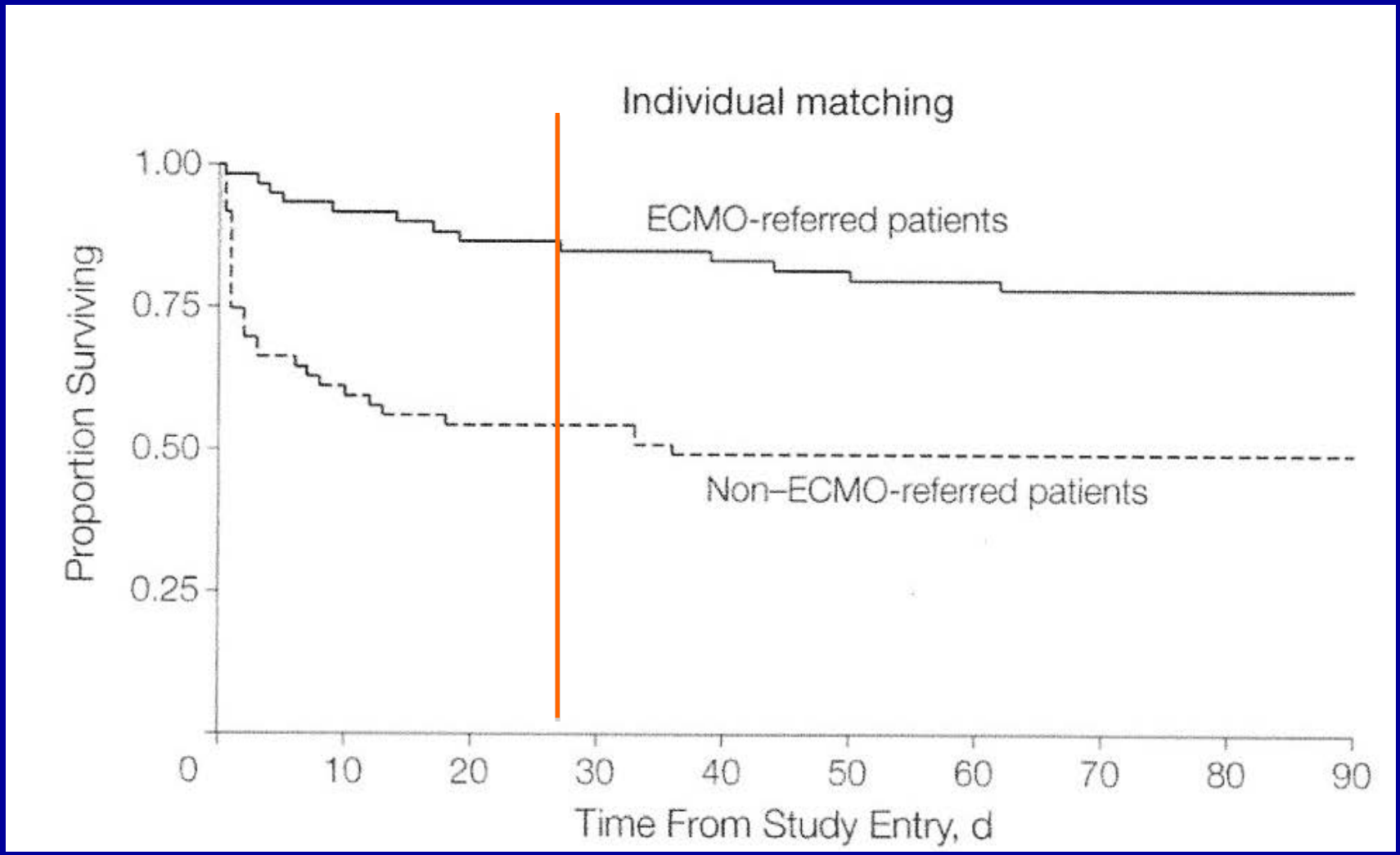
ECLS in ARDS (The CESAR Trial) Prospective Randomized Trial 2008



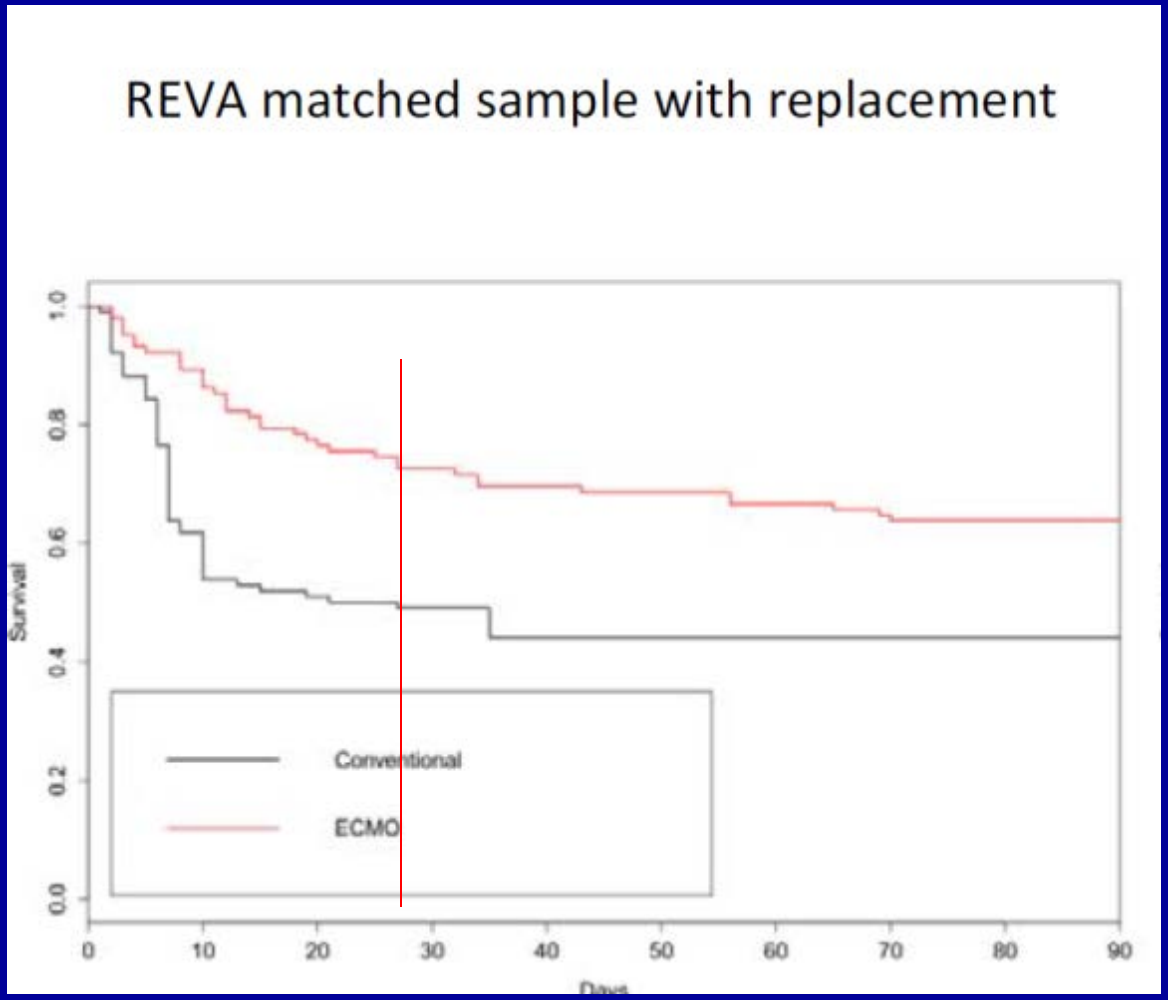
Peek and Firmin CESAR 2009

Noah. H1N1 ECMO vs control. Matched pairs trial

JAMA 2011, 366:1659



ECMO in H1N1 ARDS REVA study (France)
123 ECMO pts matched to 157 Conv Care database



Pham, AmJ Resp CC Med 187:276 2013

Article

Journal of Intensive Care Medicine
1-10
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DOI: 10.1177/0885066614550278
jic.sagepub.com
SAGE

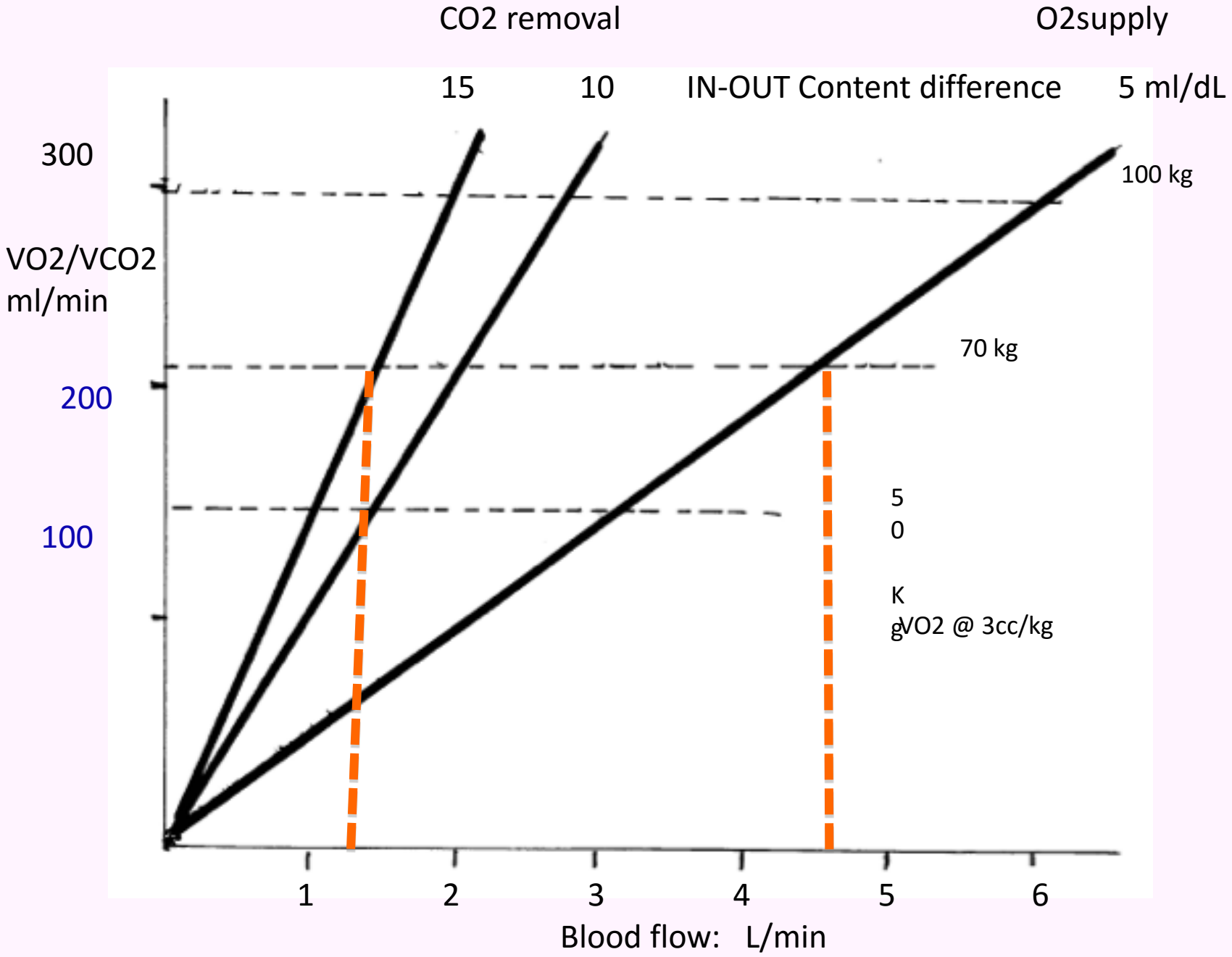
Clinical Research in Acute Fatal Illness: Lessons From Extracorporeal Membrane Oxygenation

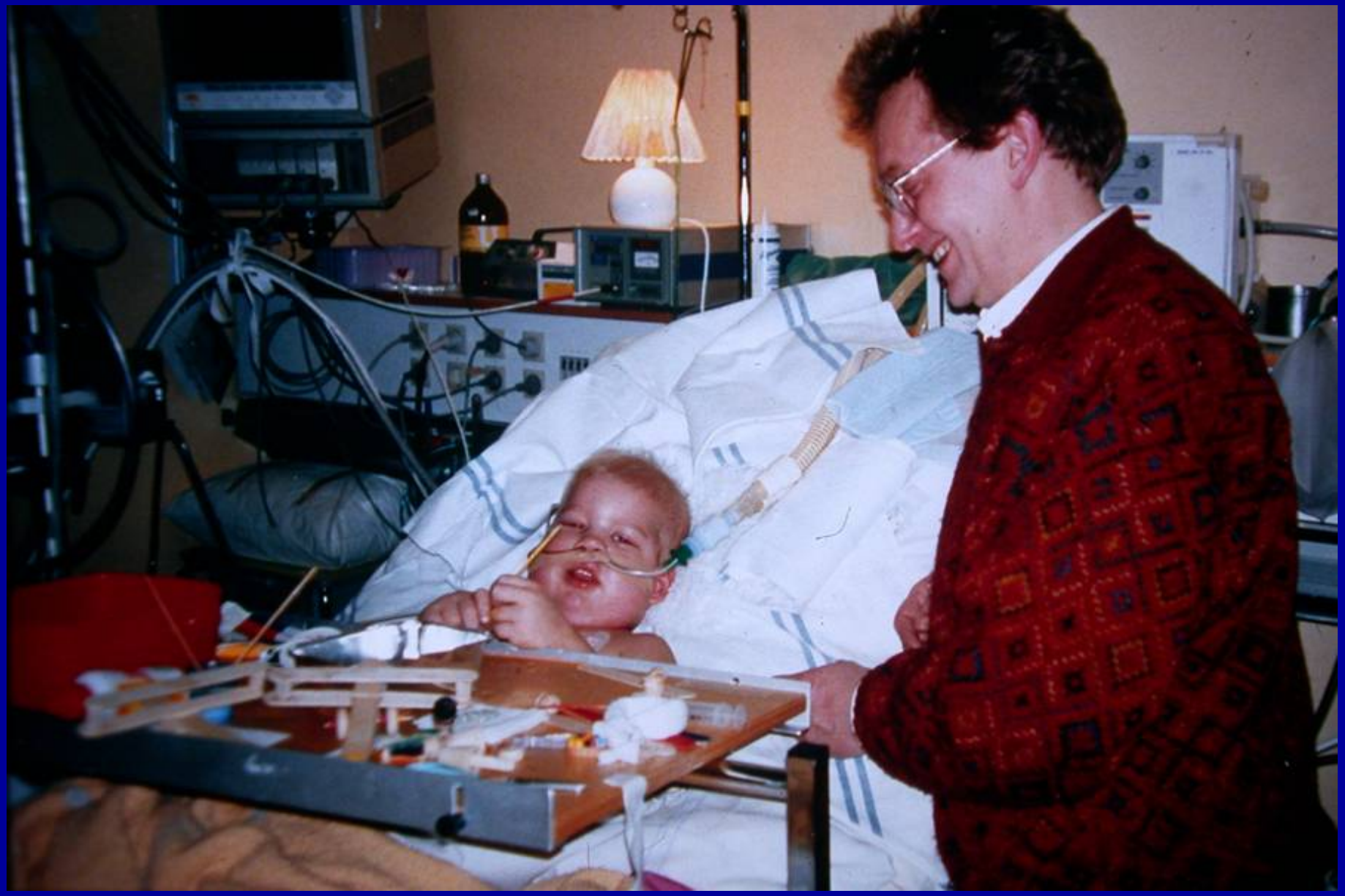
Robert H. Bartlett, MD[1]

Abstract

Clinical research to evaluate the effectiveness of life support systems in acute fatal illness has unique problems of logistics, ethics, and consent. There have been 10 prospective comparative trials of extracorporeal membrane oxygenation in acute fatal respiratory failure, utilizing different study designs. The trial designs were prospective controlled randomized, prospective adaptive randomized, sequential, and matched pairs. The trials were reviewed with regard to logistics, ethics, consent, statistical methods, economics, and impact. The matched pairs method is the best study design for evaluation of life support systems in acute fatal illness.

!0 controlled trials of ECMO in Respiratory Failure
J Intensive Care Med 2014

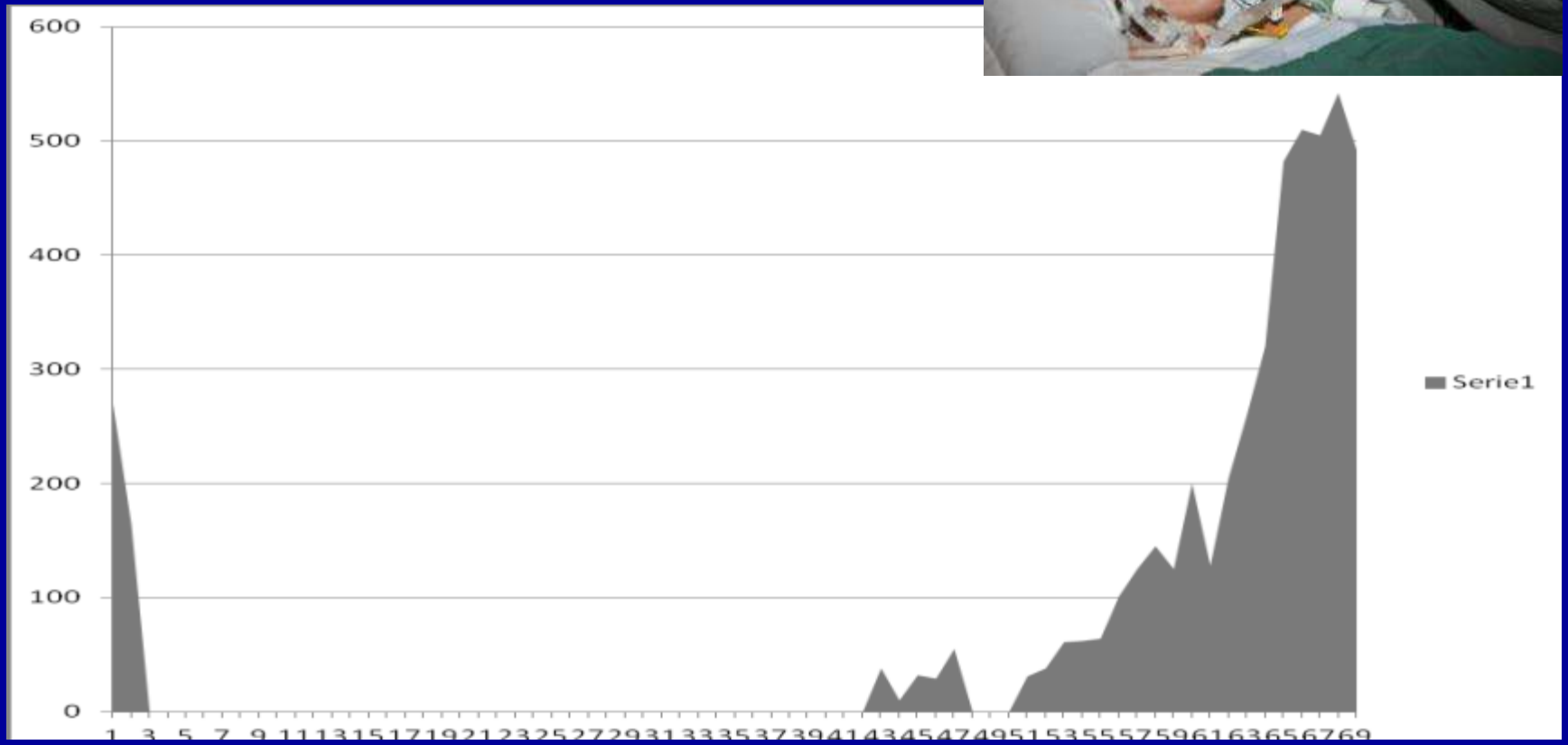

CO2 removal
O2supply
15
10
IN-OUT Content difference
5 ml/dL
300
VO2/VCO2
ml/min
200
100
100 kg
70 kg
5
0
K
gVO2 @ 3cc/kg
1
2
3
4
5
6
Blood flow: L/min



Palle Palmer, Stockholm 1997

ECMO bridge to XP: Hoopes, 2009

Tidal volumes long run ECMO



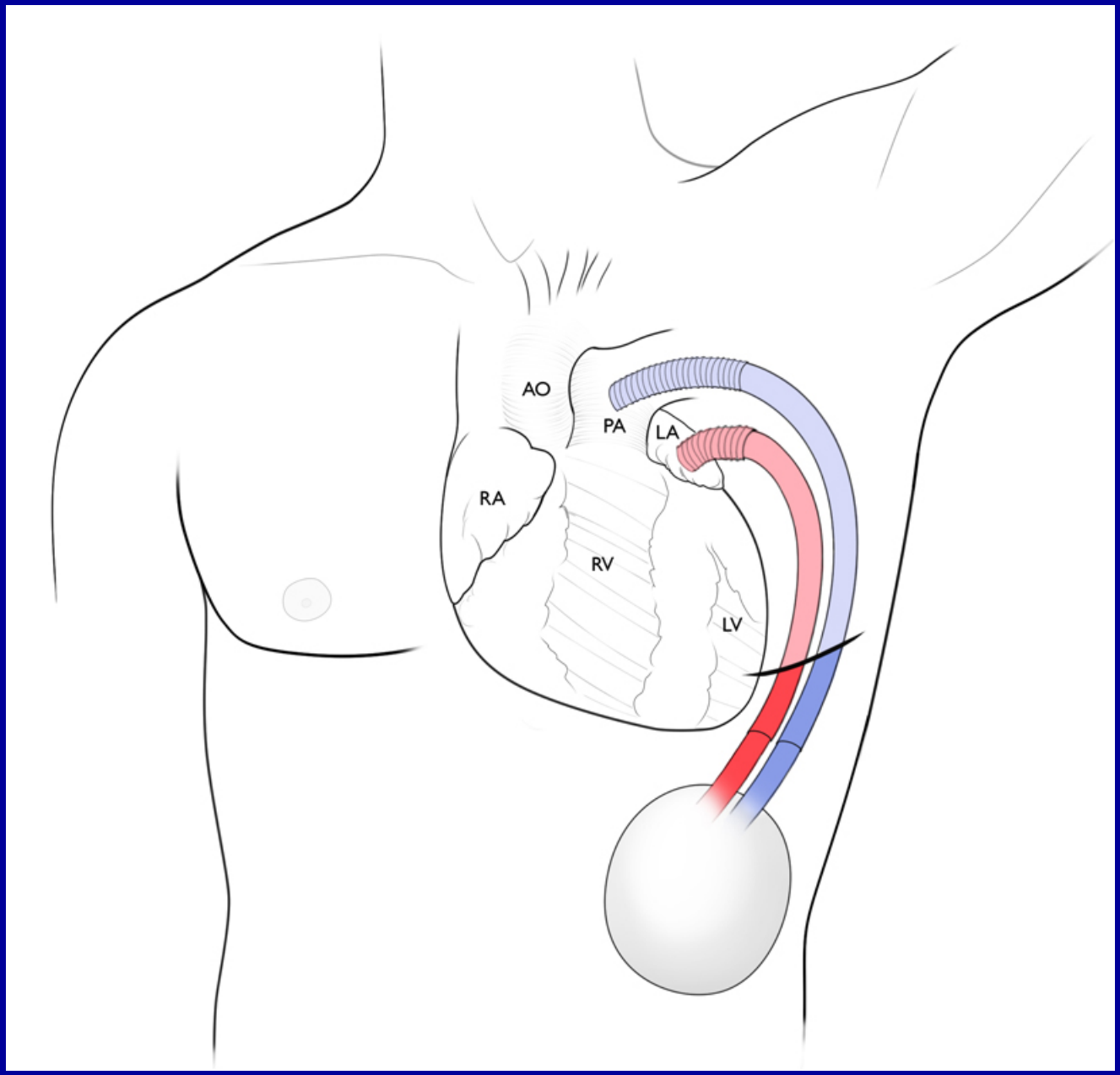
40 yo, viral ARDS, Awake alert on ECMO,
total consolidation for 50 days

courtesy of Palle Palmer, Karolinska

Redefining irreversiblelung injury

- Lung has unexpected regenerative capacity, during prolonged mechanical support, similar to acute kidney injury
- Late follow up: minimal disability
- New scientific opportunities

- Out of ICU, Home ECMO


AO
PA
LA
RA
RV
LV

Ambulatory Lung Assist
PA-LA implantation, 5 weeks, bridging to transplant
Regensberg, 2007

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