Royal Brompton & Harefield NHS
NHS Foundation Trust

Extracorporeal Membrane Oxygenation

ECMO

Tollene Riley
CNS Blood Transfusion
Royal Brompton Hospital
February 2012

Three year old boy admitted to Local Hospital

Symptoms

- Persistent Cough
- Lethargy
- Difficulty Breathing

Condition Deteriorated

- Intubated & Ventilated
- Commenced Dopamine
- Transferred to RBH PICU

Past Medical History

- Non – Compaction Cardiomyopathy
- Long QT Syndrome
- Family History of Cardiomyopathy

Admission to RBH PICU

Echocardiography

- **Severely Dilated LV Impaired Function Mild MR & TR**

Condition

- **Low Cardiac Output**
- **Hypotensive**
- **Poor Urine Output**

Treatment

- **Adrenaline, Milrinone, Furosemide, Fentanyl, Clonidine**
- **24 hours of Levosimendan**
- **Multidisciplinary Team Meeting (MDT) - Mechanical Support & Heart Transplant**

Cardiac Arrest

Pulseless VT - VF

- CPR
- Defibrillation
- Adrenaline, Calcium Gluconate & Magnesium
- Cardiac Output Achieved in 54 Minutes

Blood Gas

- Ph. 7.3
- PCo2 4.3Kpa
- Po2 8.4Kpa
- Base Excess -1.3 mmols/l
- 5.2 KCL
- Lactate 10 mmols/l

ECMO Required

Why ECMO ?

- Witnessed Arrest
- Prolonged Resuscitation
- Sustained Return of Circulation Unlikely
- Diagnosis
- Rescue & Buy Time for Curative Intervention

Paediatric ECMO Response Team

- Active Programme
- Experienced Surgical, Medical Nursing & Perfusion Staff
- Rapid Deployment
- Circuit Ready

RBH Accepted Criteria for Neonatal / Paediatric Respiratory ECMO Support

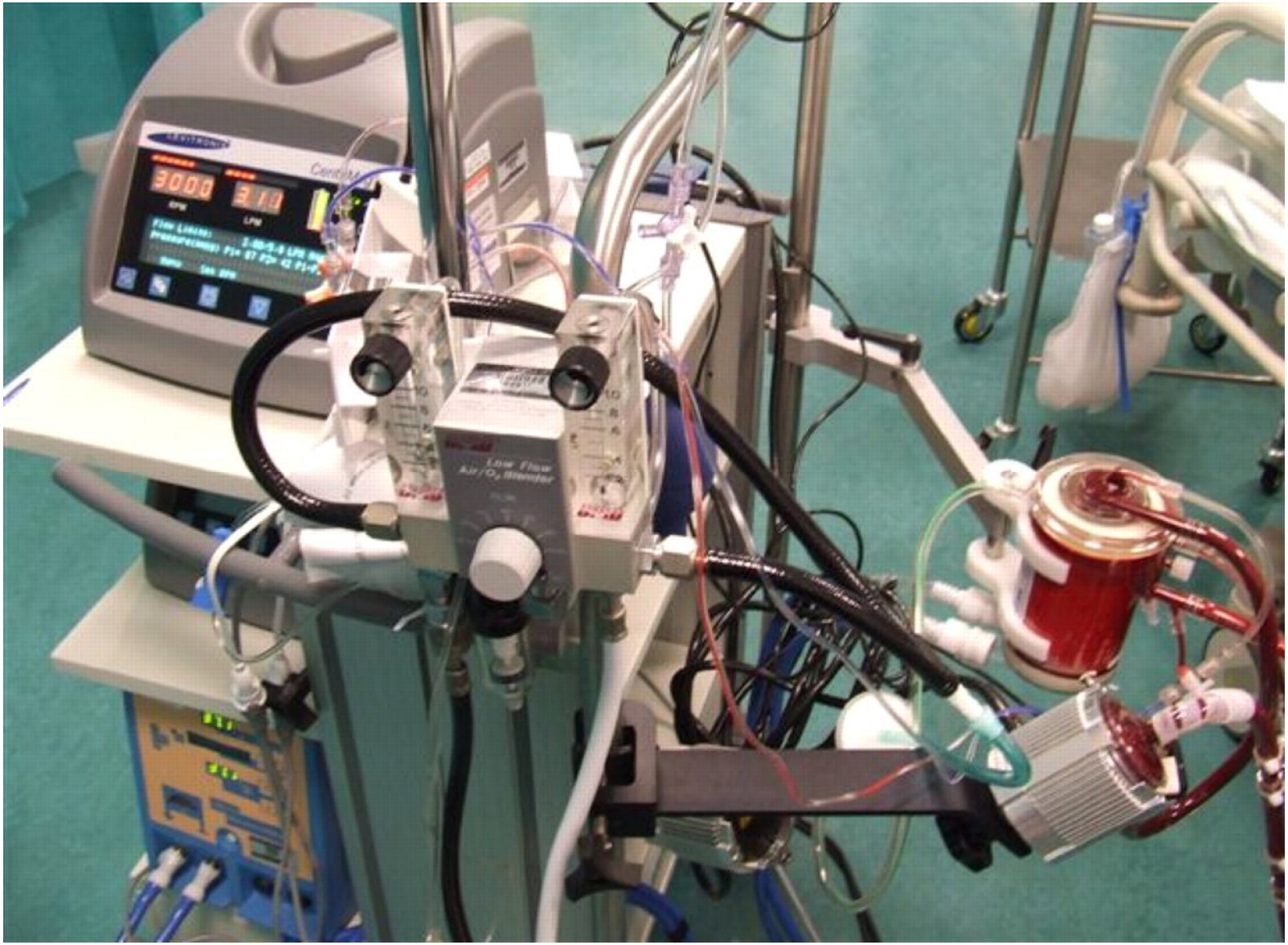
Inclusion Criteria

- Gestational Age >34 weeks
- Birth Weight >2 kg
- Reversible Process
- Multiple Pneumothoraces Unlikely to Respond to Conventional Management
- Failure of Maximal Medical Management

Exclusion Criteria

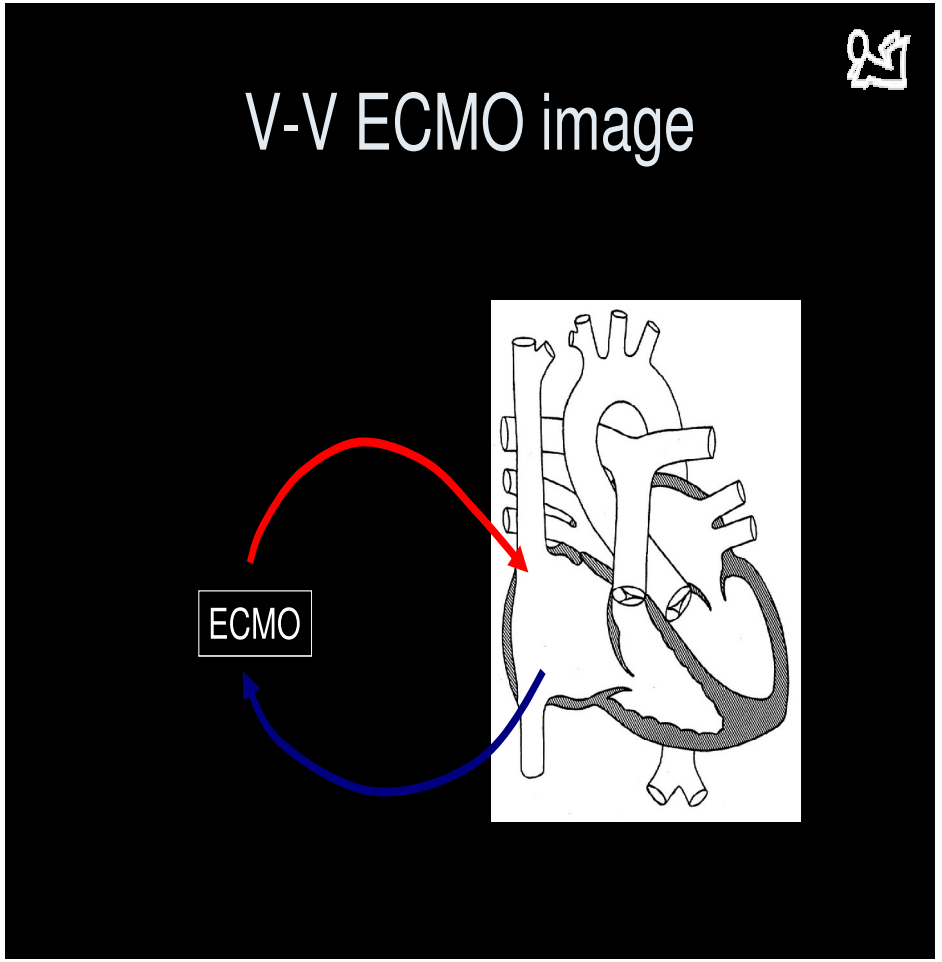
- Uncontrolled Bleeding or Coagulopathy
- Severe or Irreversible Brain Injury
- Lethal Genetic Disorder
- Prolonged High Pressure Ventilation
- Fixed Elevated Pulmonary Vascular Resistance

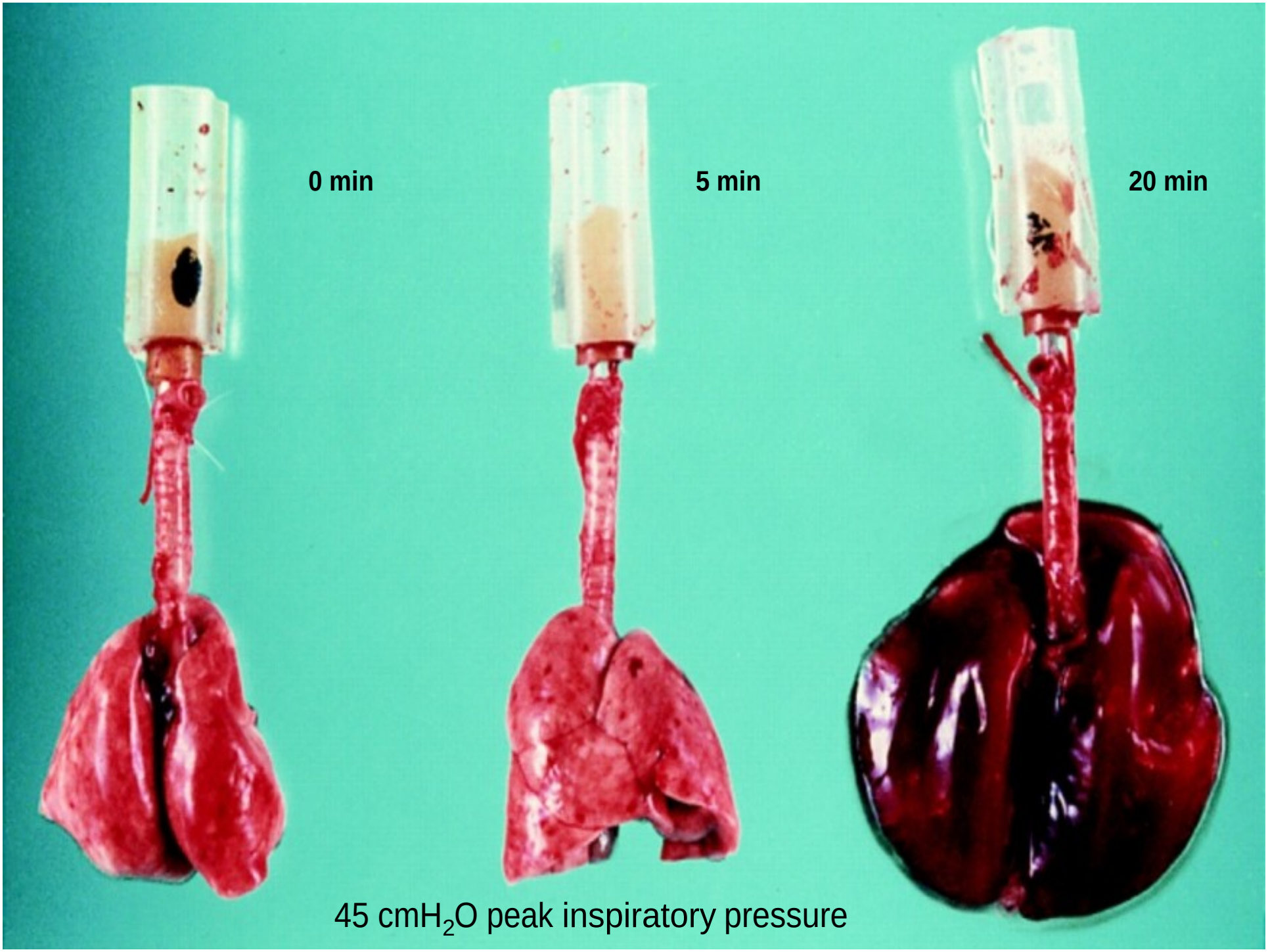
Extracorporeal Membrane Oxygenation



Veno-Venous ECMO

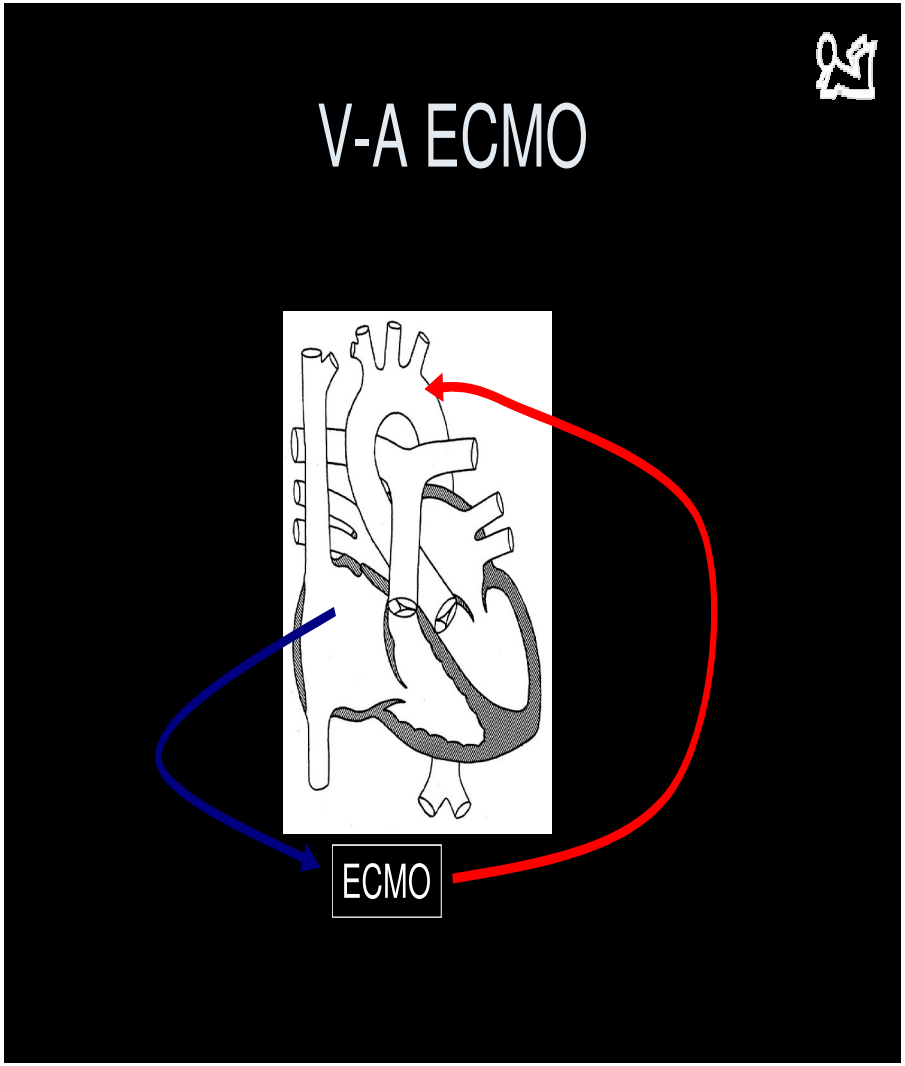
- **Isolated Respiratory Failure**
- **Removes Co2**
- **Improves Oxygenation**
- **Reduced Risk of Ventilator-Induced Lung Injury**




0 min
5 min
20 min
45 cmH2O peak inspiratory pressure

Veno-Arterial ECMO

- Severe Cardiac Failure
- Cardiogenic Shock Associated with Myocarditis, Poisoning or Hypothermia.
- Complete Haemodynamic & Respiratory Support



Principal Causes of Mortality & Morbidity are Thrombosis & Bleeding

Achieve Balance between Procoagulant & Anticoagulant Factors to Prevent Thromboembolic Complications or Excessive Bleeding

Extracorporeal Life Support Organization

ELSO Registry of 1373 Adult Respiratory ECMO

30.1%complicated by significant clot in the circuit

40.5%complicated by significant bleeding

ELSO Registry of 830 Adult Cardiac ECMO

20.1%complicated by significant clot in the circuit

52.9%complicated by significant bleeding

The Circuit & Abnormal Coagulation

- **Abnormal Vascular wall**
  - Unsmooth
  - Non-biological
- **Abnormal Coagulation**
  - **adsorbs fibrinogen on to plastic**
  - **activates platelets**
  - **activates contact clotting system**
  - **activates plasminogen**
- **Abnormal Blood Flow**
  - Areas of low blood flow/ stasis
- **Heparin Infusion Essential**

Monitoring

- **Activated Clotting Time (ACT)**
  - Influenced by heparin, clotting factors, platelet count, dilution

- **Routine Anticoagulation**
  - PT
  - APTT
  - Fibrinogen
  - Platelet count
  - Heparin anti-Xa

- **Thromboelastography (TEG)**

- **Platelet Function Assays**

RBH PICU Coagulation Guidelines

Reference Values

- Hb 12-14g/dl
- HCT >40
- ACT 180 – 210 seconds
- Heparin Level 0.2-0.4
- APTT 60-100 seconds
- PT 14-16 seconds
- Platelets 75-100 10^9/l

Patient Values

- Hb range btw 12-14g/dl
- HCT > 38
- ACT 200-215 seconds
- Heparin Level 0.23
- APTT 63 seconds
- PT 13.6 seconds
- Platelets 63 – 106 10^9/l

RBH PICU ECMO Blood Component Use Guideline

Weight	2 - 5 kg	5 - 10 kg	10 - 20 kg	> 20 kg
Red Blood Cells (Units)	3	4	5	5
Red Blood Cells (Pedipak)	4	4	_	_
Platelets	Pedipool	Pedipool	Large Pool	Large Pool

Blood Component Use in Ten Adult ECMO Episodes

Dr S. Finney 2011 RBH

	Cryo	FFP	Platelets	RBC
A	12	31	20	119
B	17	16	16	98
C	-	2	8	63
D	-	26	16	49
E	-	4	11	23
F	-	46	44	60
G	-	-	-	13
H	-	-	-	17
I	-	-	-	13
K	-	8	3	26
Median	**0**	**6**	**16**	**33**

Conventional Ventilatory Support v Extracorporeal Membrane Oxygenation for Severe Adult Respiratory Failure

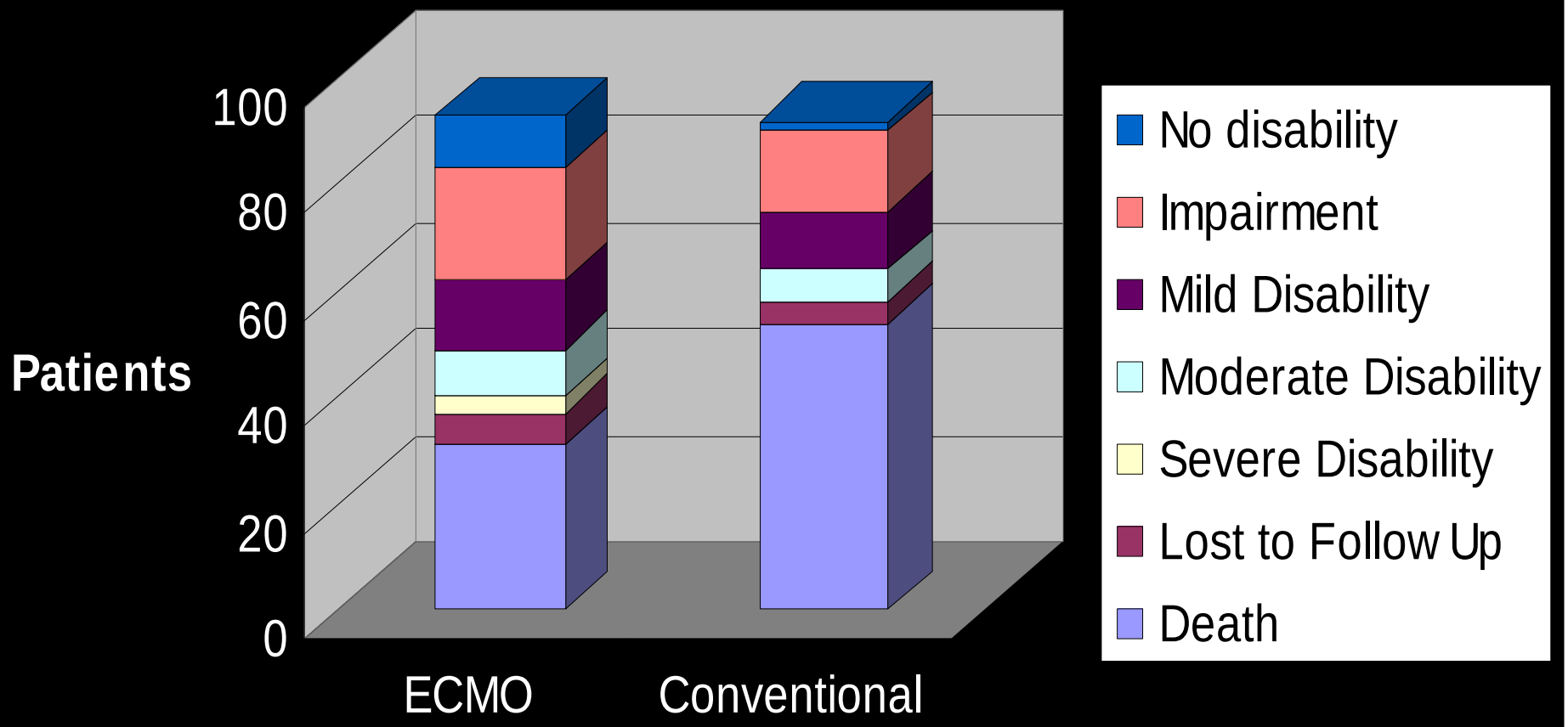
- Of those who received ECMO 63% survived to 6 months without disability compared with 47% of those allocated to conventional management.

- *"To clinicians who have witnessed first hand ECMO's ability to salvage an unstable life that would presumably be lost without it, today's study will represent the sentinel paper on adult ECMO for years to come"*

- *"To those who question ECMO's role in adult critical care this study will do little to change their minds."*

Zwiscenberger & Lynch 2009

Randomized Trial of Neonatal ECMO: Follow-Up to Age 7 yrs



In Summary

- ECMO can rescue and buy time to allow for curative interventions or for recovery
- ECMO is a constant battle to balance clotting and bleeding
- ECMO requires a close working relationship between the Critical Care Team and the Blood Transfusion and Haematology Service
- ECMO is controversial with the best results for neonates receiving ECMO for respiratory failure
- ECMO for H1N1 is providing rich research material

References

- UK collaborative randomised trial of neonatal extracorporeal membrane oxygenation: follow-up to age 4 years (Bennett et al The Lancet vol 357 April 7 2001)

- United Kingdom collaborative randomised trial of neonatal extracorporeal membrane oxygenation: follow-up to age 7 years (McNally et al Paediatrics 2006)

  http://www.pediatricsdigest.mobi/content/117/5/e845.full.pdf+html

- Efficacy and economic assessment of conventional Ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR) a multicentre randomised controlled trial (Peek et al The Lancet vol474 October 17 2009)

- Will CESAR answer the adult ECMO debate? (Zwischenberger et al The Lancet Vol374 Issue9698)

- Neonatal & Paediatric Respiratory ECMO Guideline (RBH PICU)