



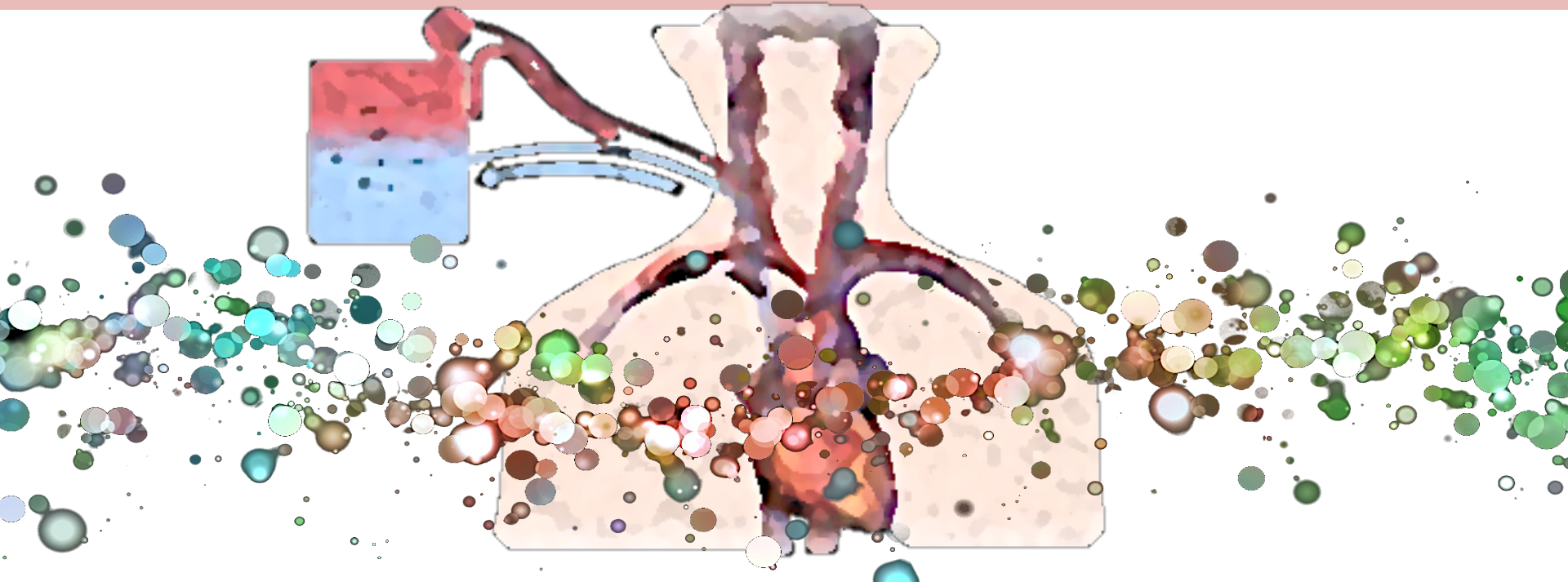
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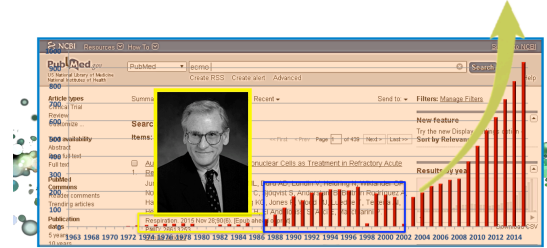


**1st UDINE ECMO
WORKSHOP**

Management of **C**ircuit **C**omponents

D. Ghitti





Yesterday



Transport

Technology

Clark Rick M.

Skills

Research

Interdisciplinary

Emergency

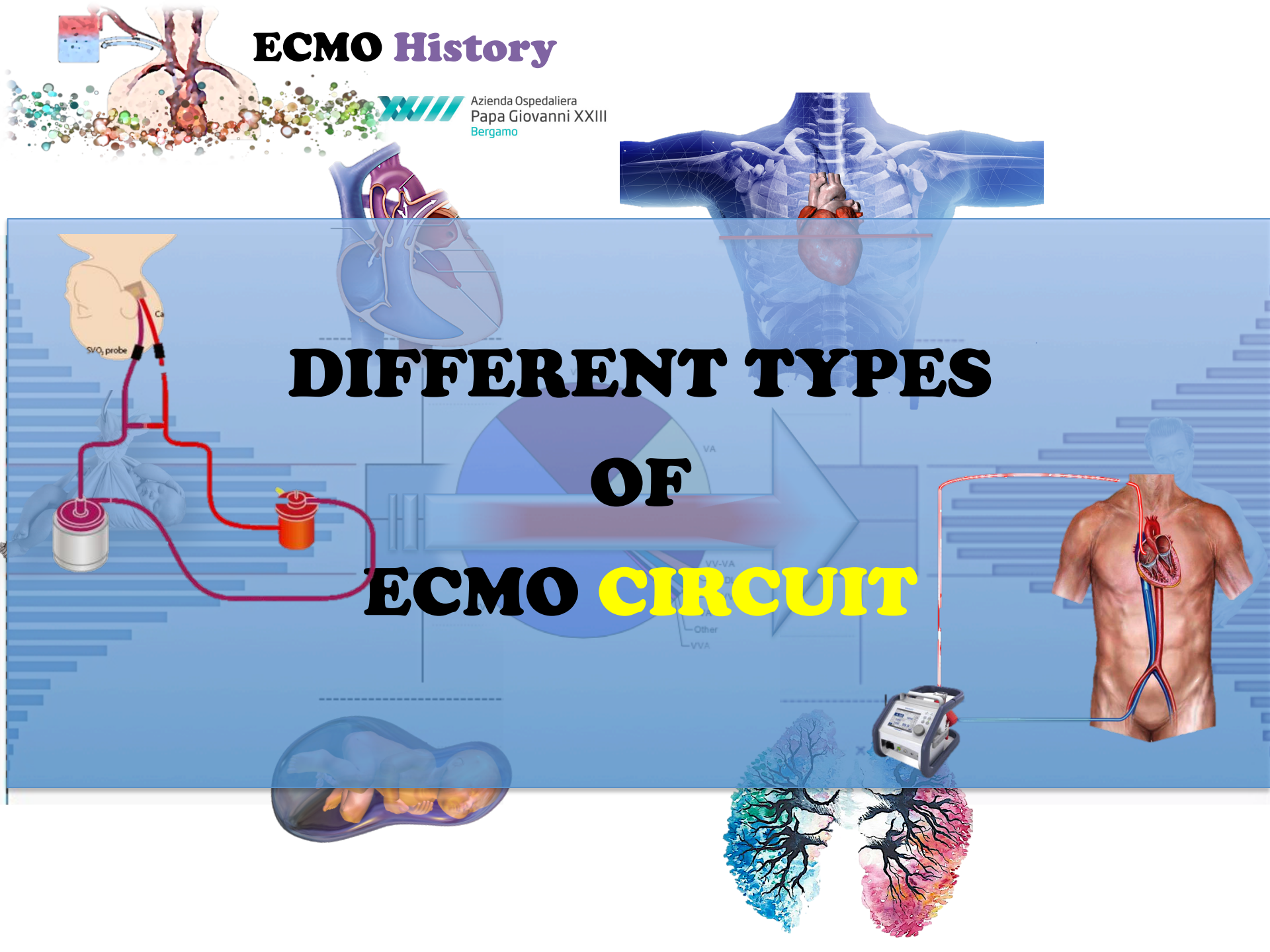
Today

ECMO History



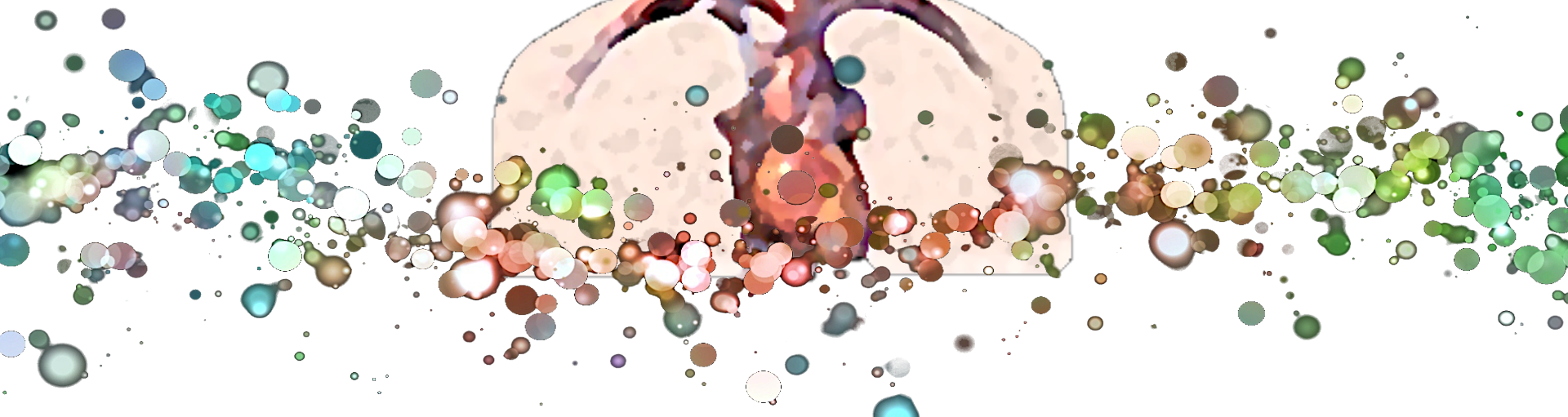
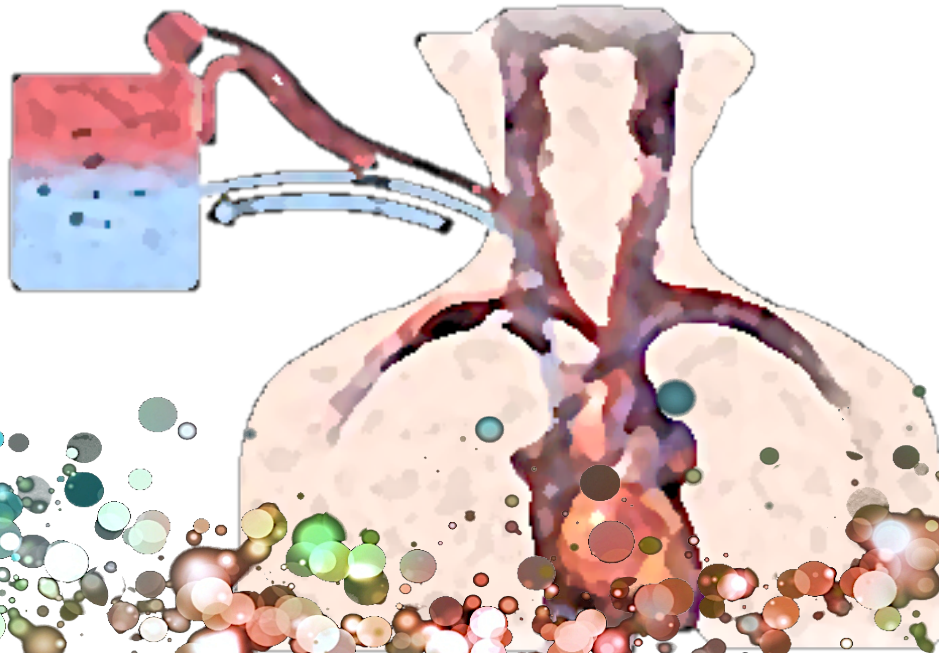
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DIFFERENT TYPES OF ECMO CIRCUIT





ECMO Circuit





ECMO Circuit: Method of management



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VA + VV + VAV

ECMO =
Circuit

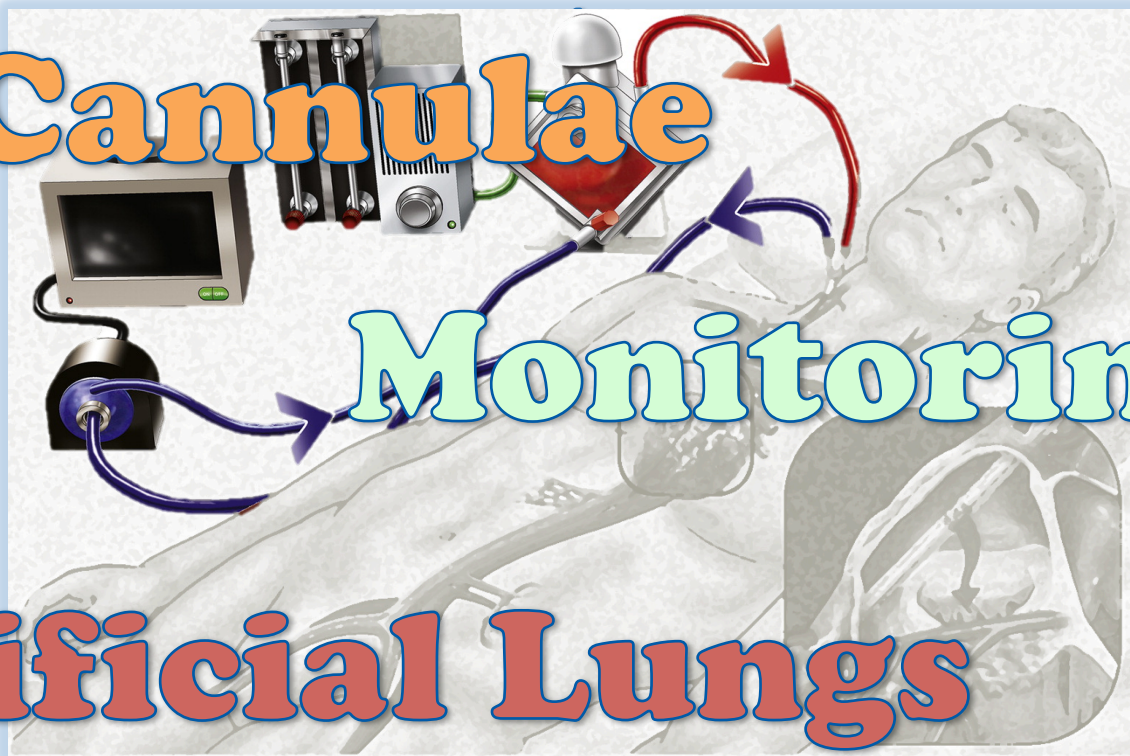
Management of circuit

Cannulae

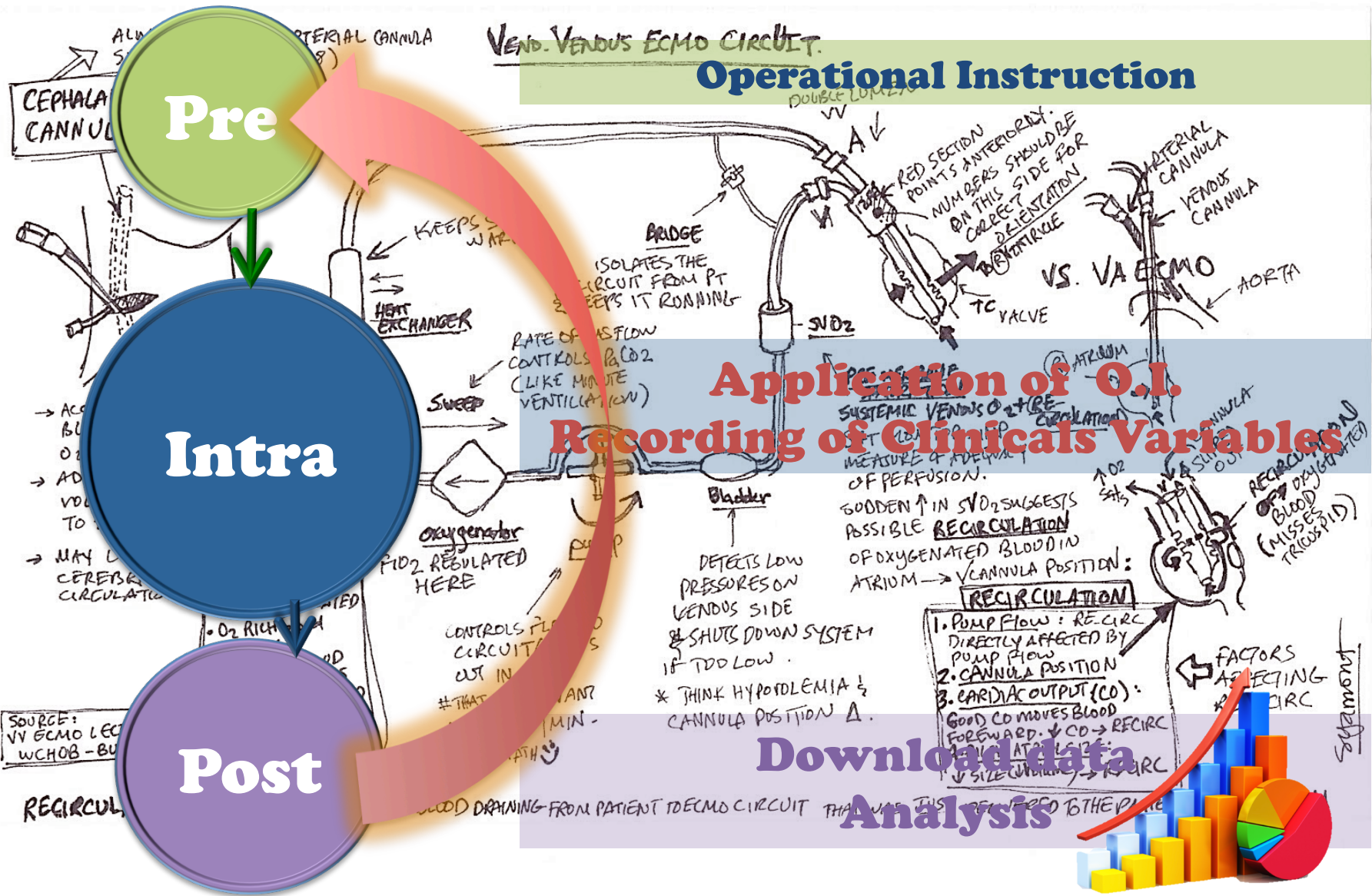
Pumps

Monitoring

Artificial Lungs



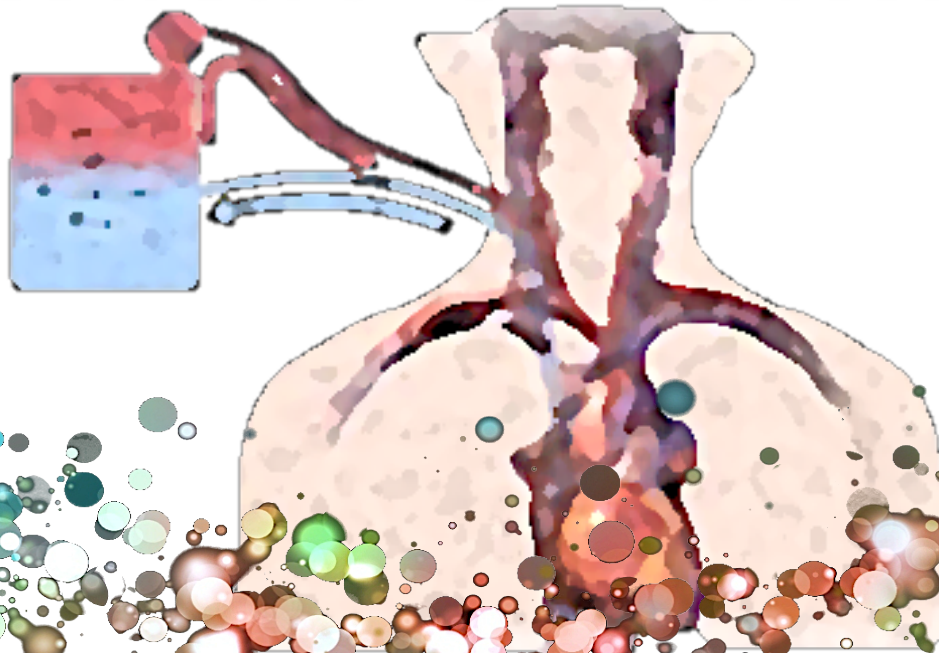
Phase of Management circuit components





ECMO

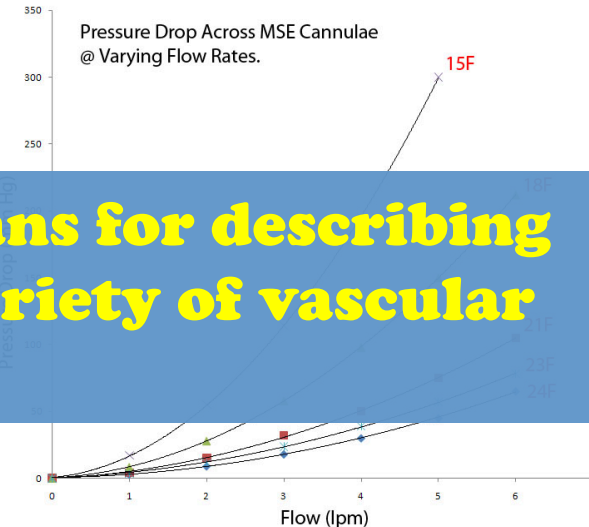
Cannulas & Cannulation



Cannula: Pre

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M number provides a standardized means for describing the flow-pressure relationships in a variety of vascular access devices



ASAIO Trans. 1991 Jan-Mar;37(1):4-8.

A standardized system for describing flow/pressure relationships in vascular access devices.

Montoya JP¹, Merz SI, Bartlett RH.

ASAIO Trans. 1991 Apr-Jun;37(2):60-4.

Evaluation of extracorporeal perfusion catheters using a standardized measurement technique--the M-number.

Sinard JM¹, Merz SI, Hatcher MD, Montoya JP, Bartlett RH.

$$M = \text{Log} (L D e^{-4,75})$$

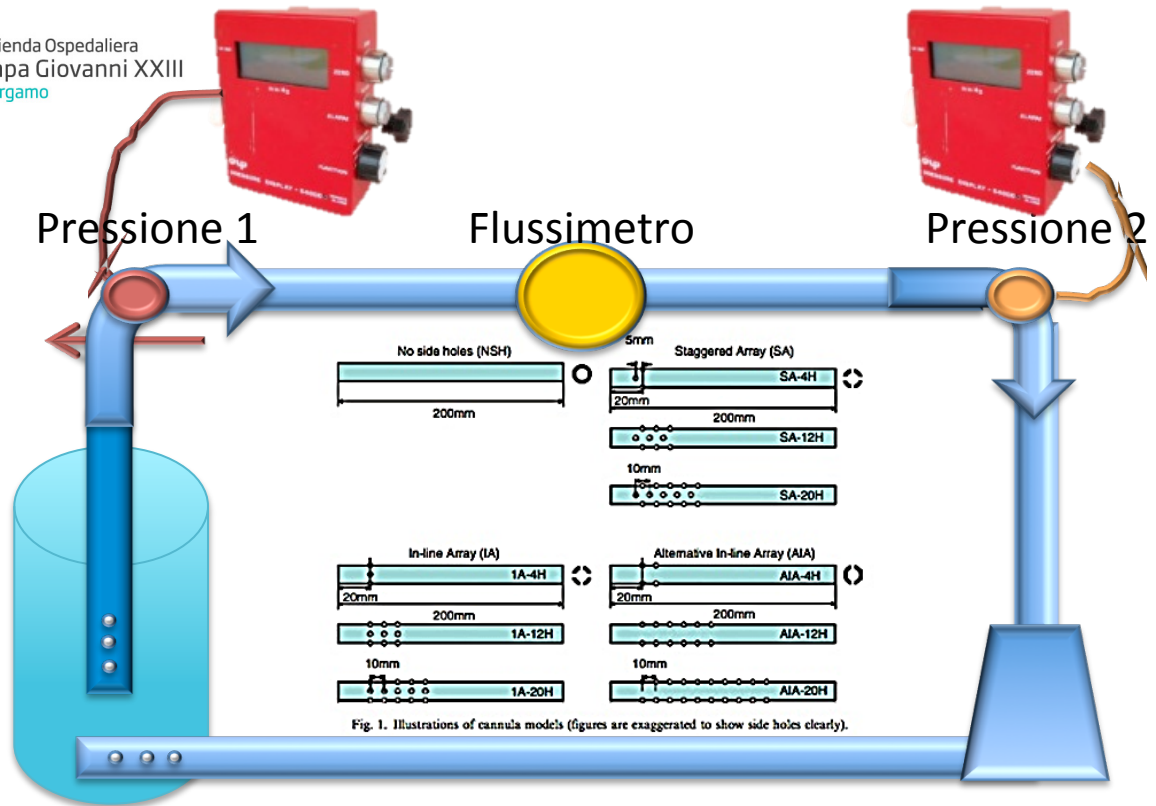
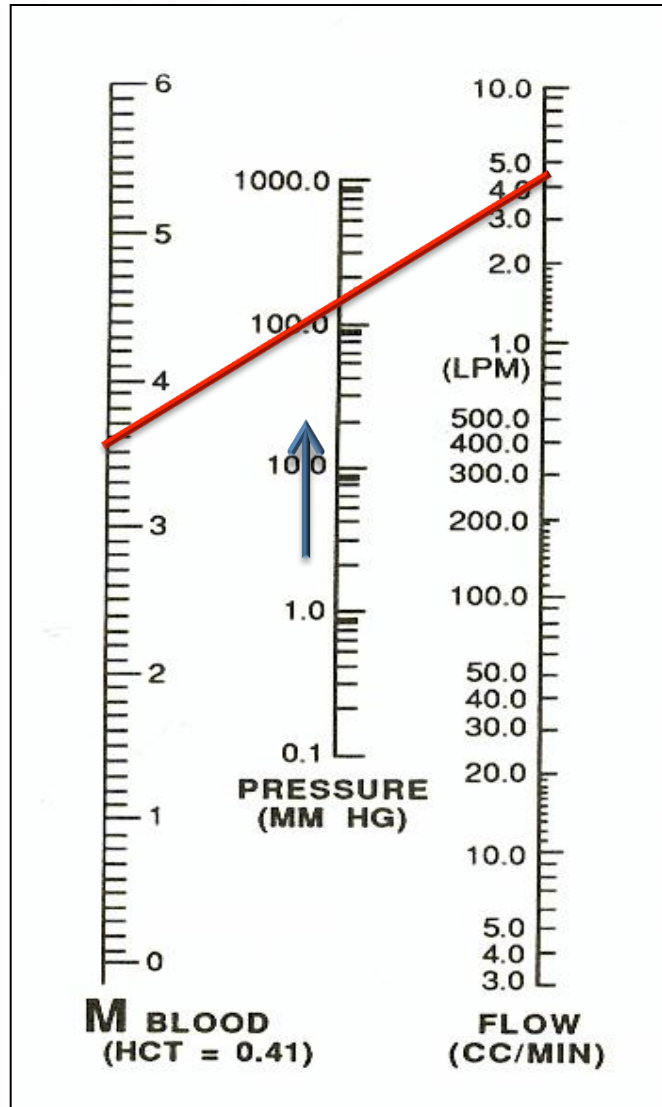
M number

Resistences



Cannula: Pre

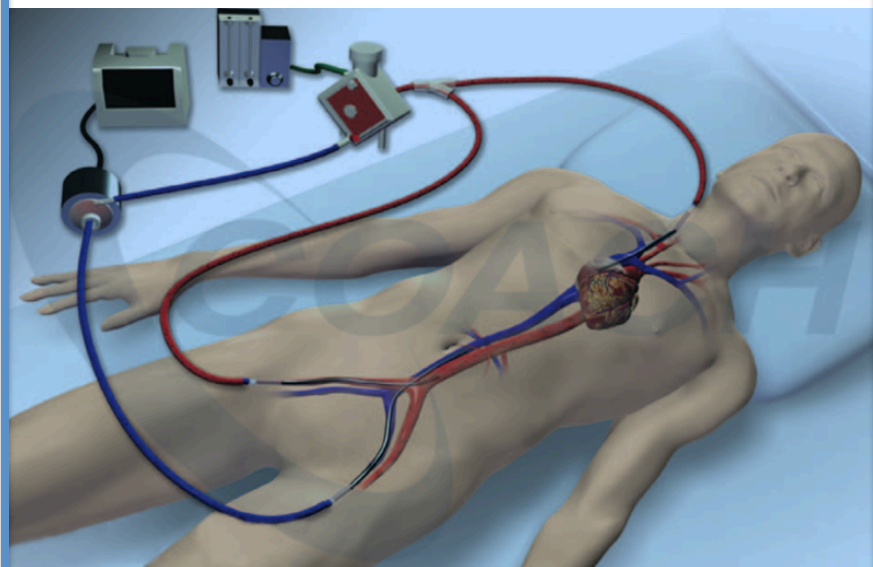
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Ø Tubo	Lunghezza	M
¼	1 metro	3,1
3/8	1 metro	2,0
½	1 metro	0,9

ECMO

VV o VA o VA+V



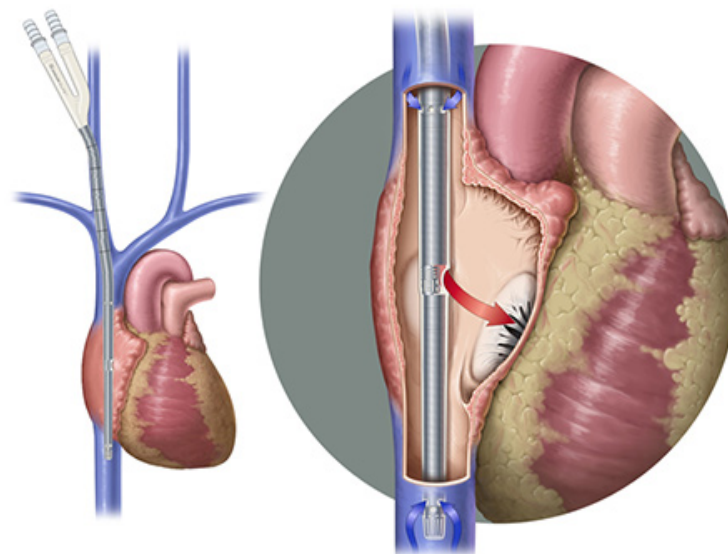
Pressure

Position: Echo, Xray

Check (Kinking, clots, ..)

ECMO

VVDL



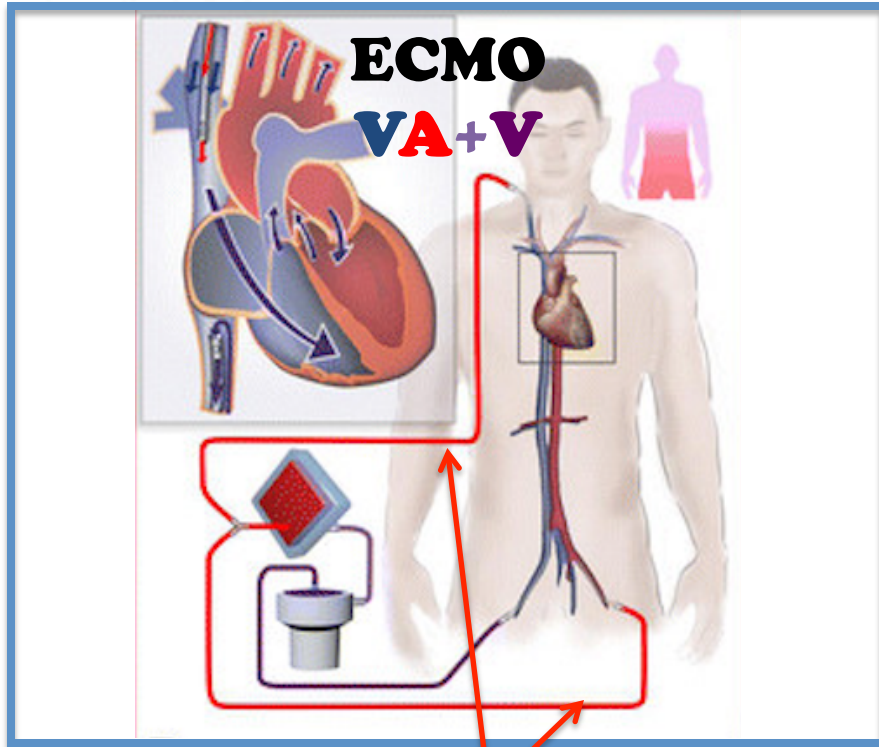
Pressure In & Out

Position: Echo, Xray

Check (Kinking, clots ..)

ECMO Intra : Cannule Monitoring

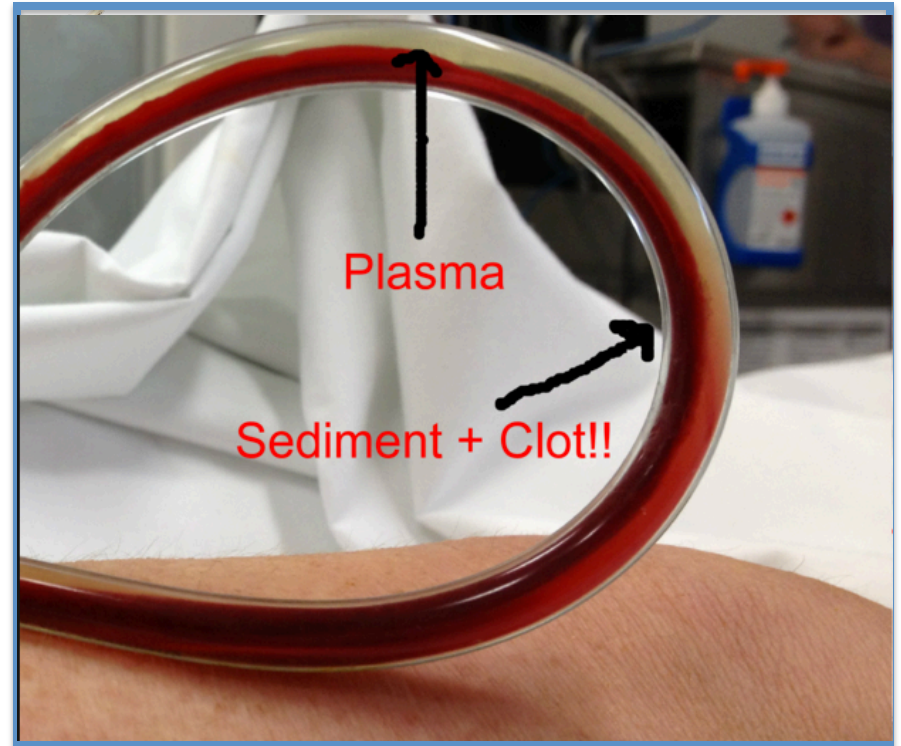
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Pressure & Flow

Position: Echo, Xray

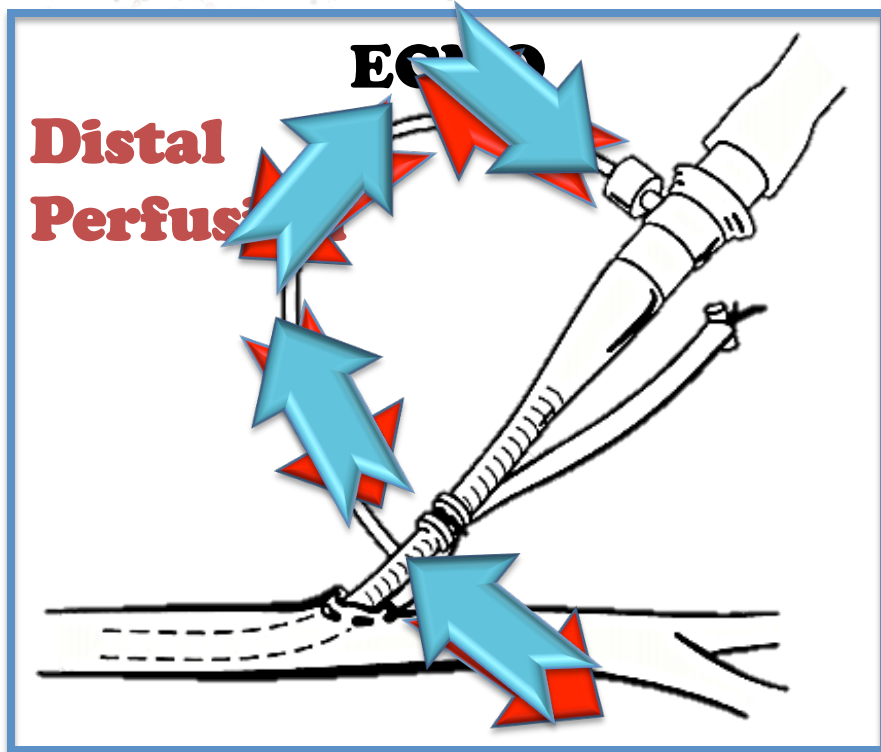
Check (Kinking, clots...)



Negative Pressure & Flow

Position: Echo, Xray

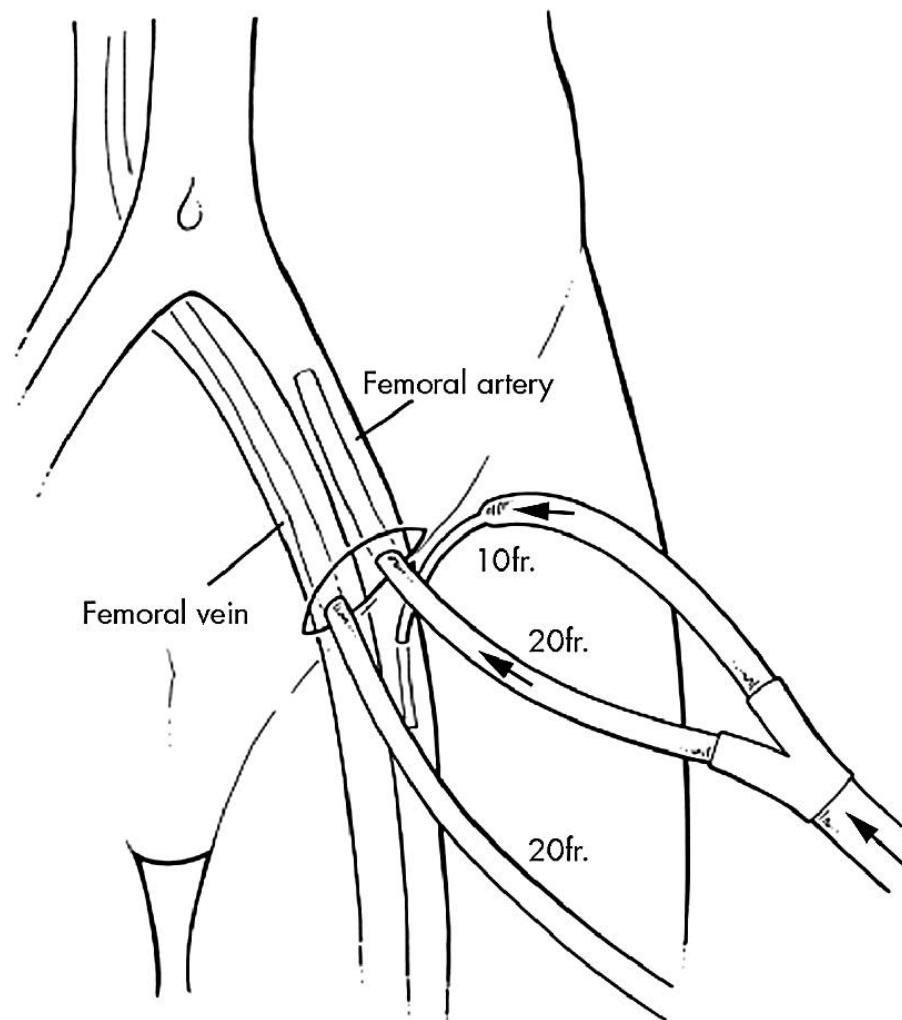
Check (Kinking, clots...)

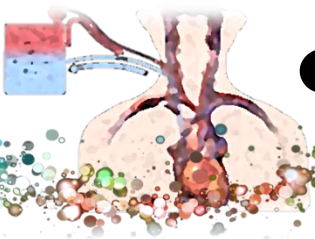


Doppler, Temperature

Position: Echo, Xray

Check (Kinking, clots...)



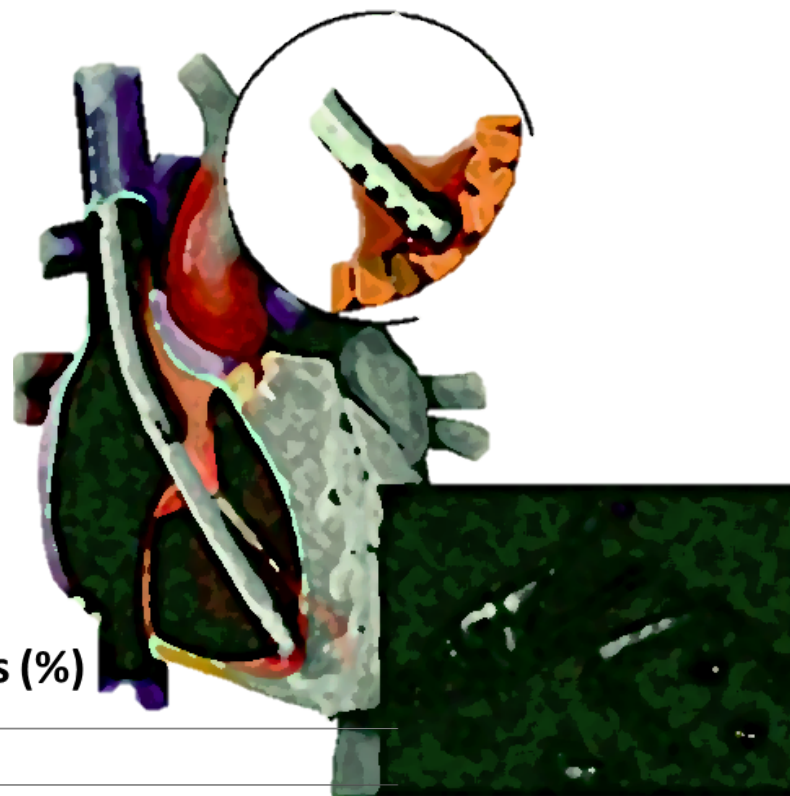
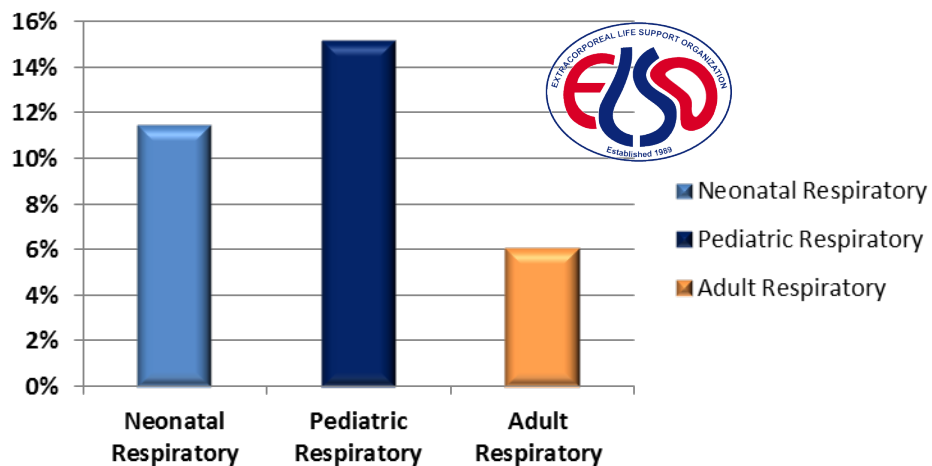


Cannula Problems

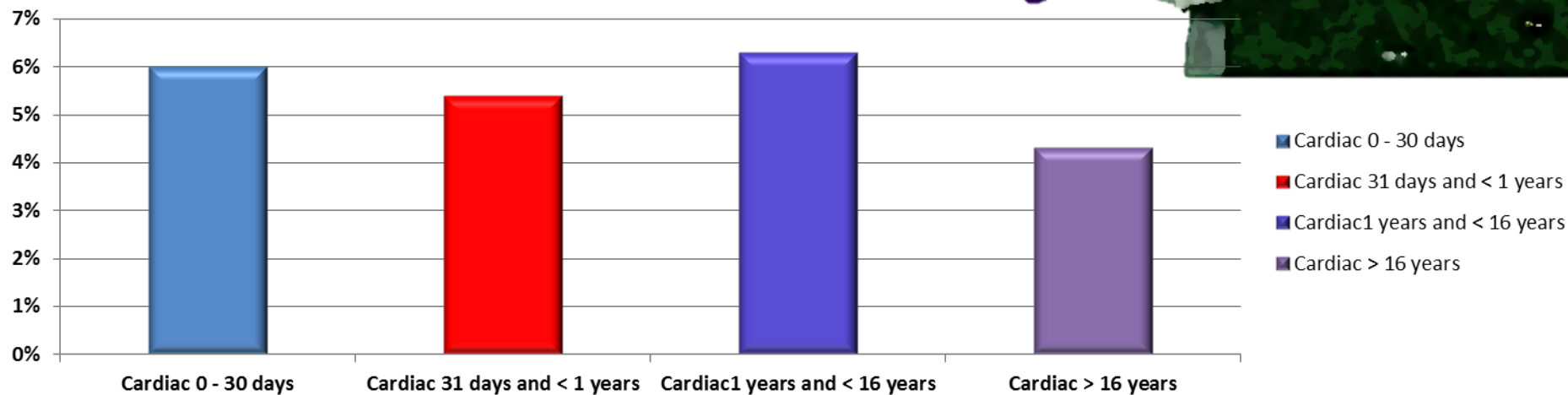


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Cannula problems (%)

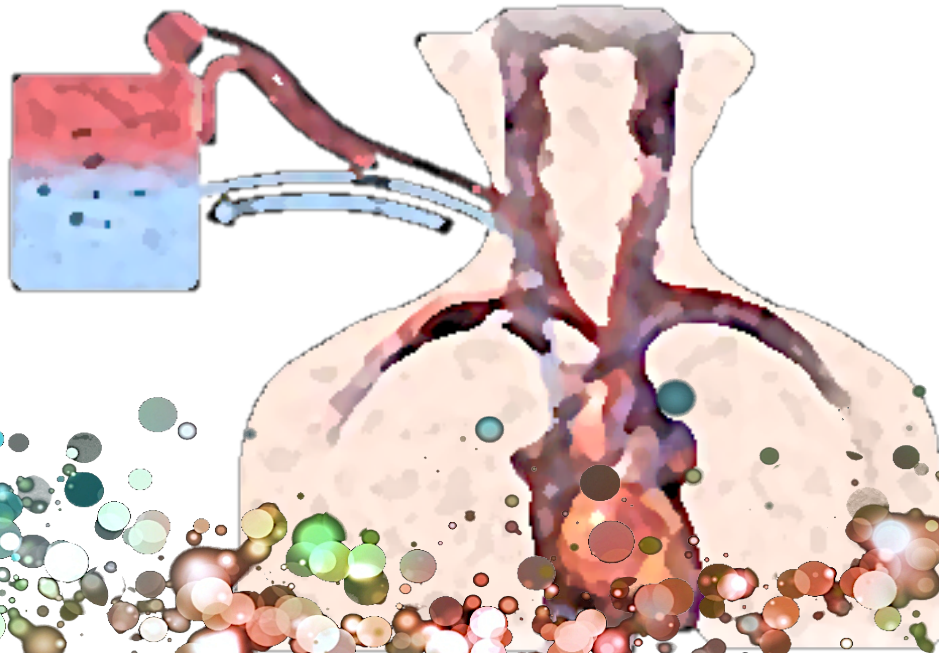


Cannula problems (%)





ECMO Tube



Resistance to flow

Pre

Intra

Post

Length
of

Radius
of
tubing

Viscosity
of fluid

Example of current velocity patterns in a river

Cross-section of a river showing the general
pattern of current velocity



ECMO Tube – Flow - Pressure



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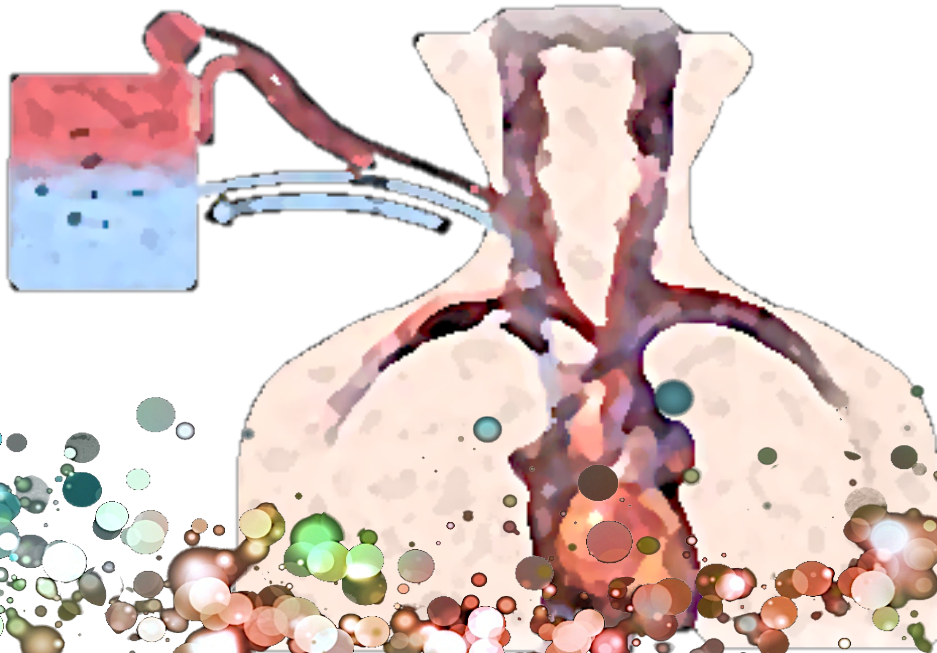
2000 – 3000 (ml/min) → -35 / -40 mmHg

3000 – 5000 (ml/min) → -80/ -90 mmHg





ECMO Pumps



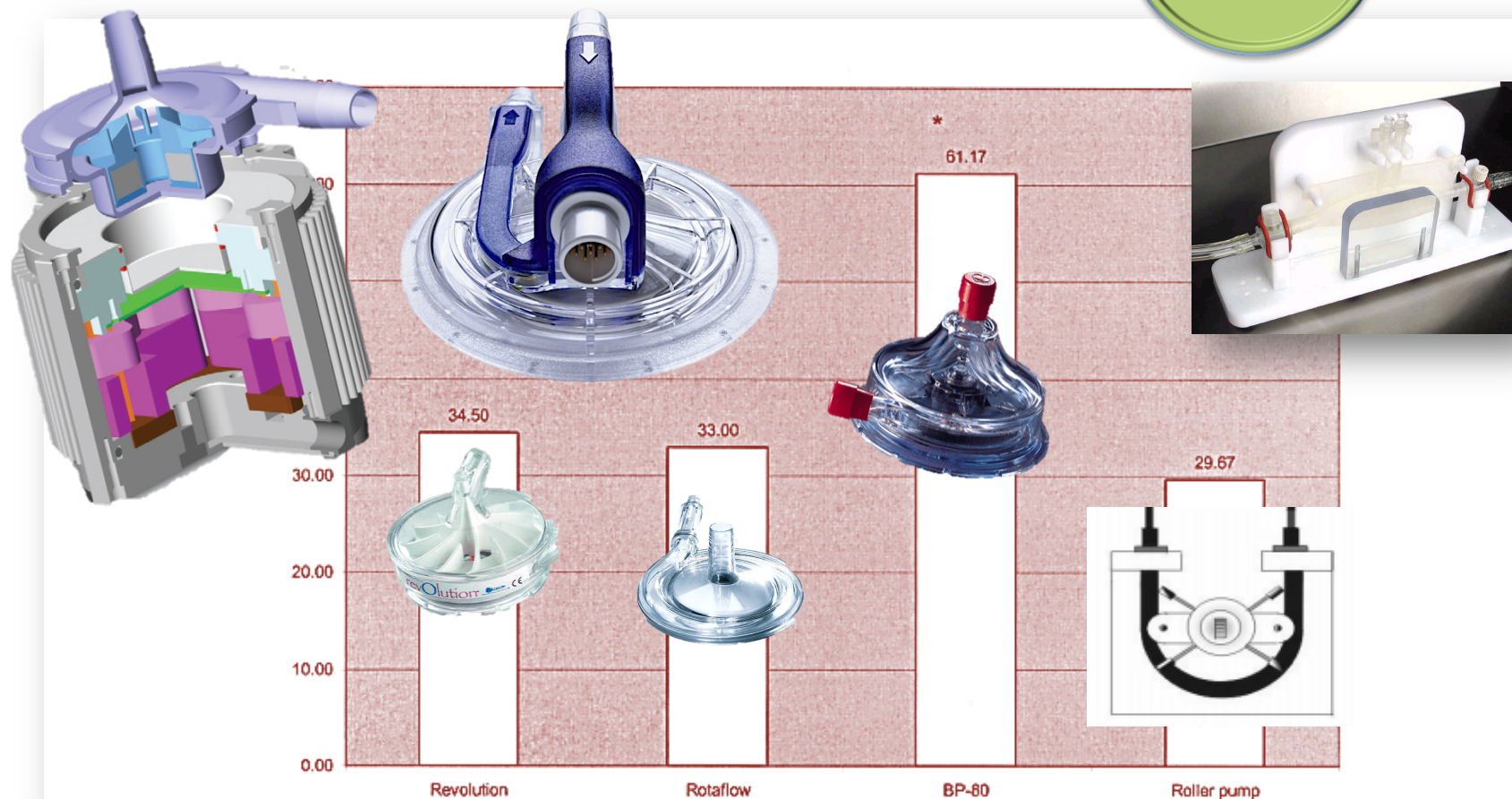


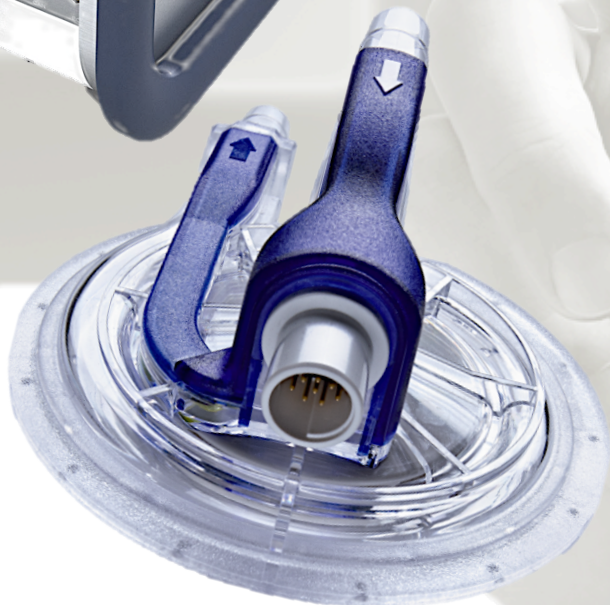
Figure 4. Mean normalized index of hemolysis (NIH) values in g/100 L. * $p < .05$ compared with the roller pump.

ECMO Pump & Technology

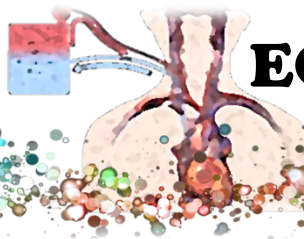


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Intra



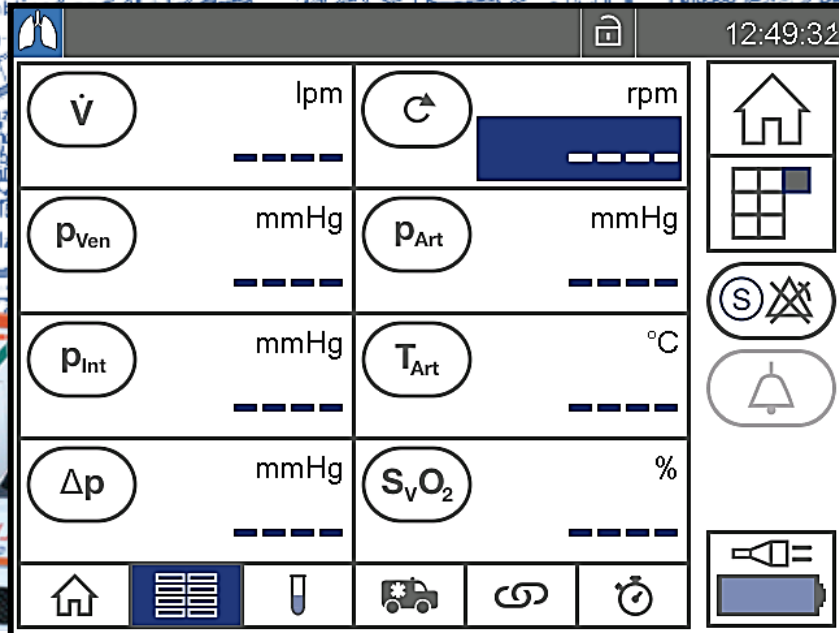
				12:49:32	
	lpm		rpm		
	mmHg		mmHg		
	mmHg		°C		
	mmHg		%		



ECMO Pump & Technology: Case Report



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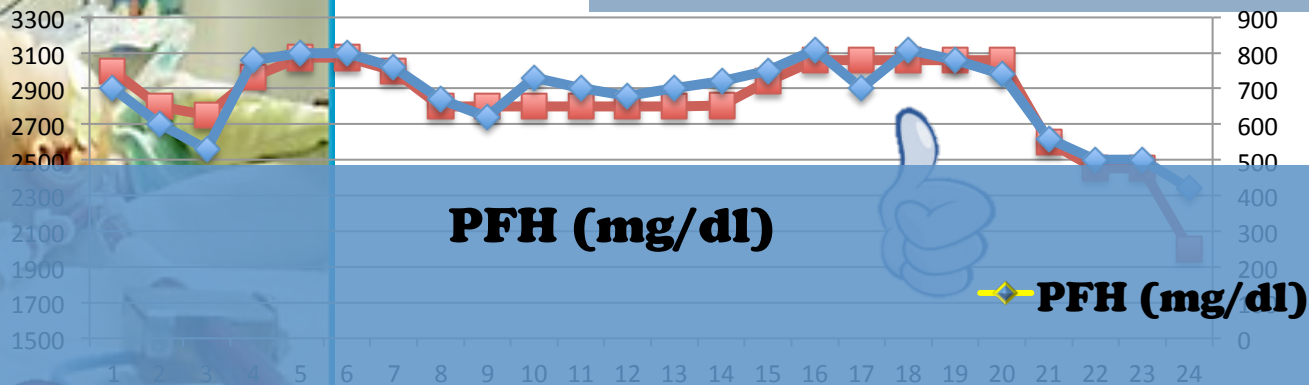
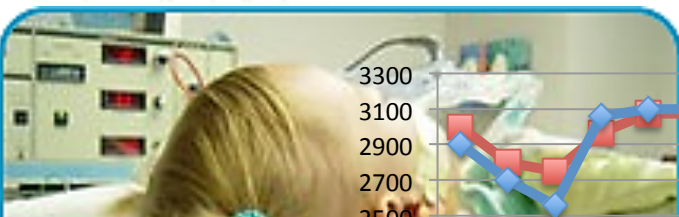


ECMO Pump & Technology: Case Report



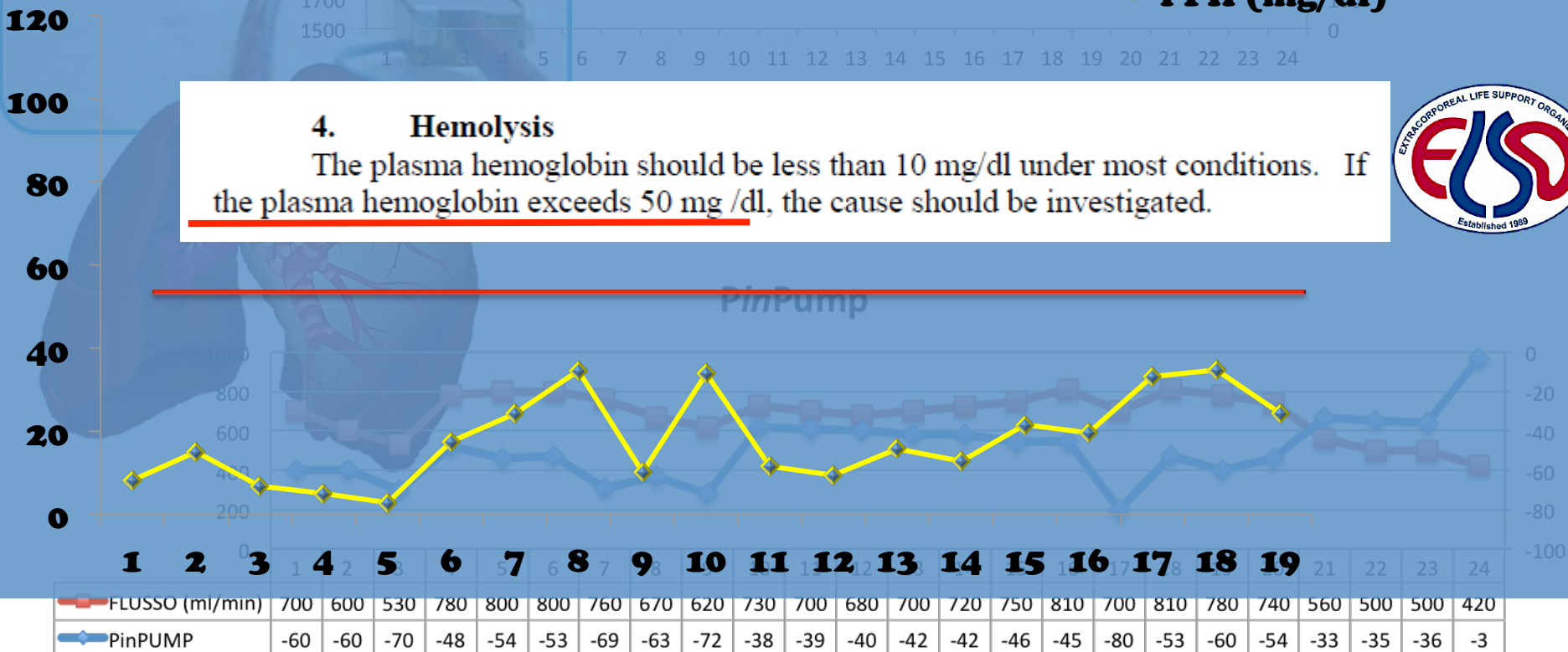
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**Hours of ECMO VV : 261 hrs
(10 days)**



4. Hemolysis

The plasma hemoglobin should be less than 10 mg/dl under most conditions. If the plasma hemoglobin exceeds 50 mg /dl, the cause should be investigated.

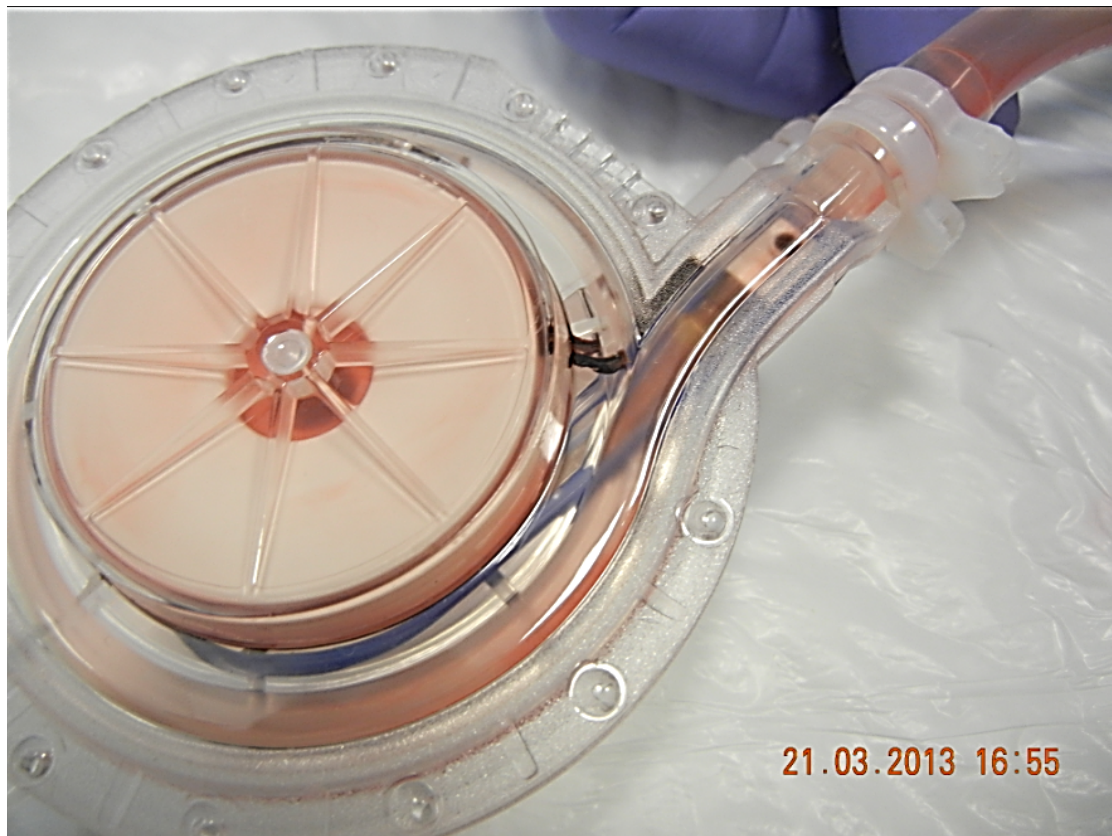




ECMO Pump & Technology: Case Report



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21.03.2013 16:55



ECMO Pump & Technology: Case Report

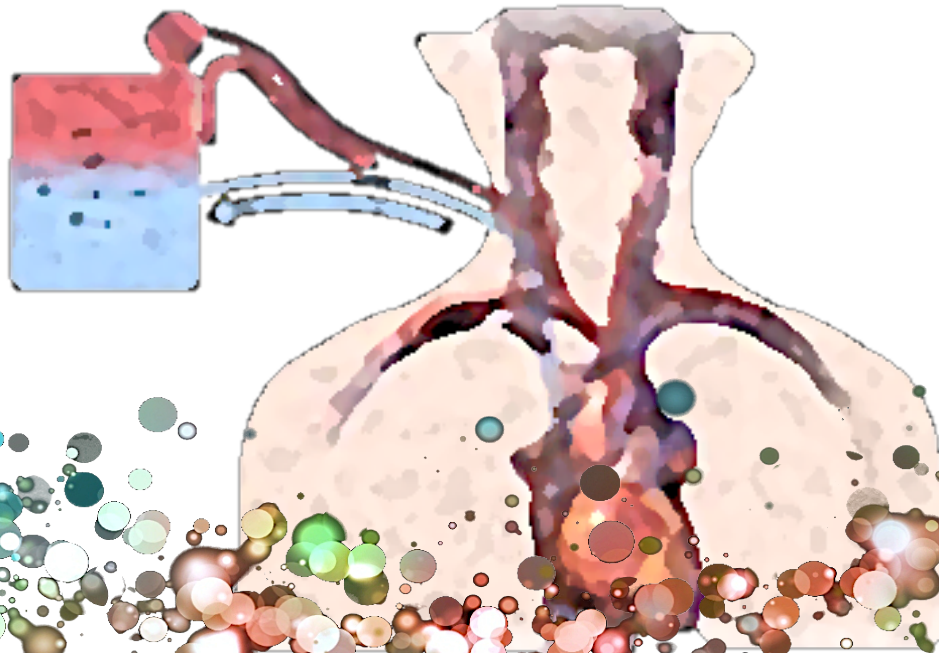


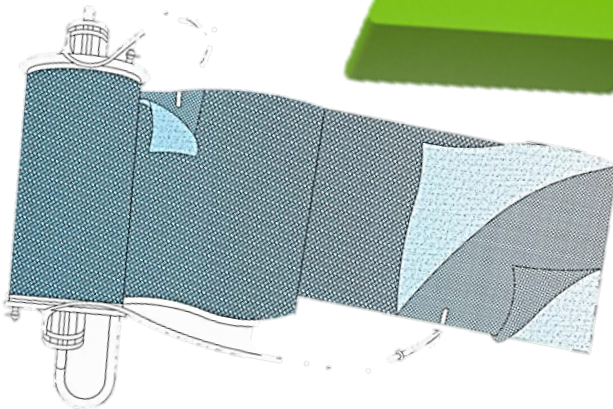
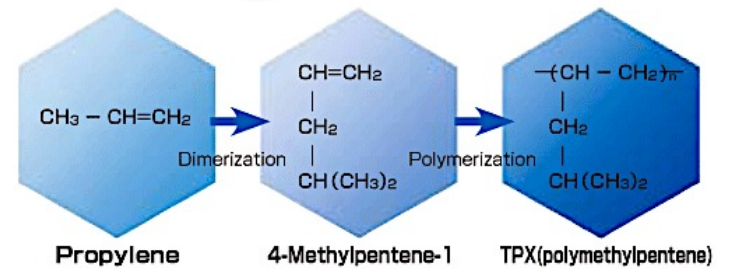
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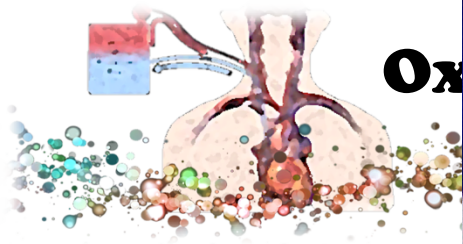




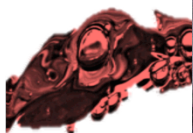
ECMO Oxygenator



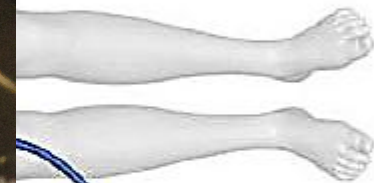
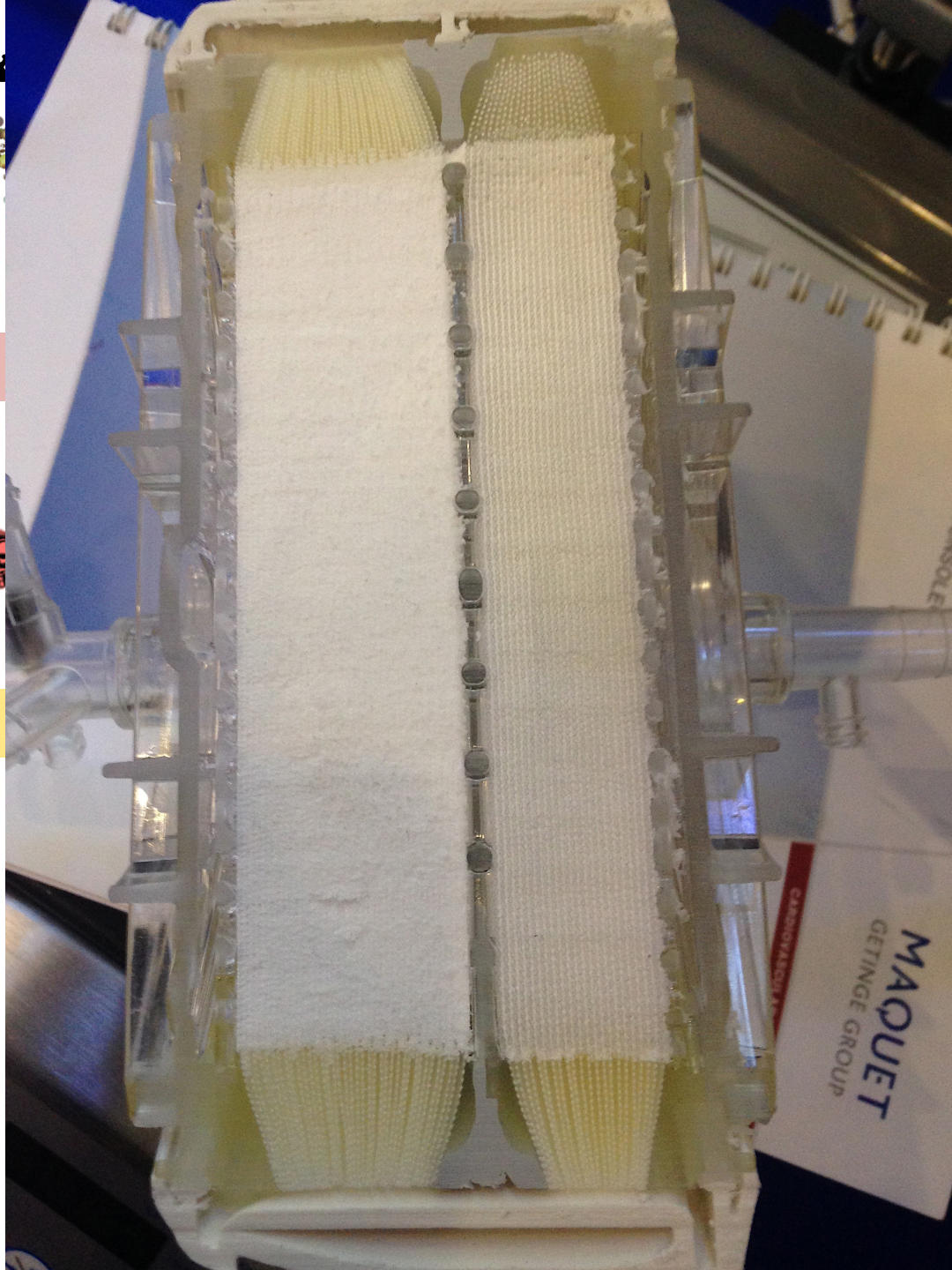




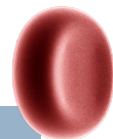
Flow - ΔP



BGA

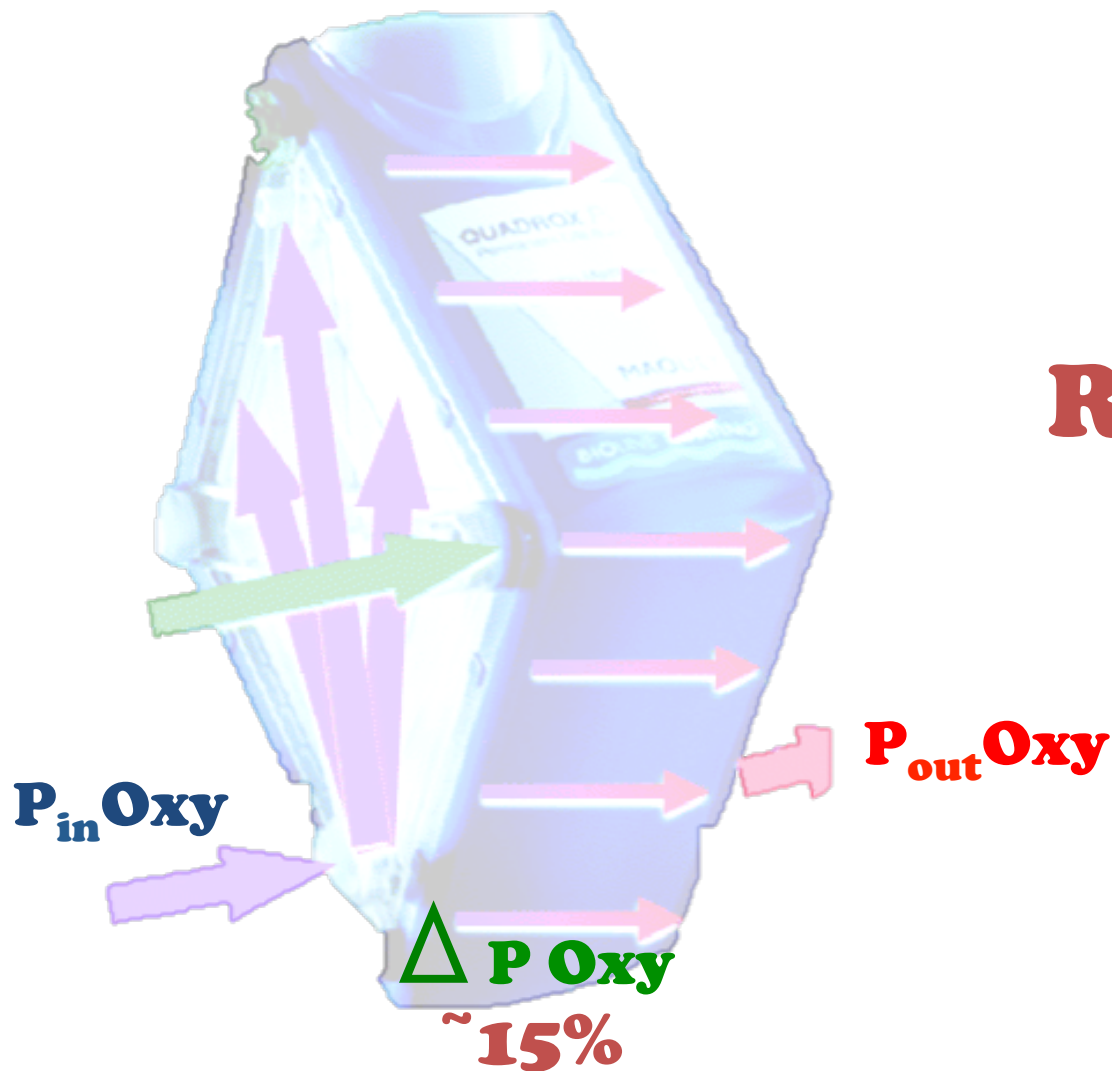


**Oxygenator
Evaluation**



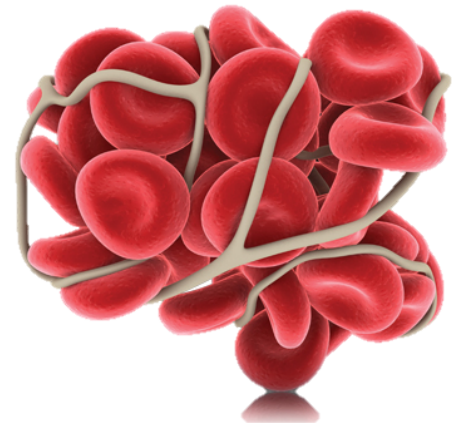


Intra



$$R_{oxy} = \Delta P / FLOW$$

$$R_{oxy} > 40$$

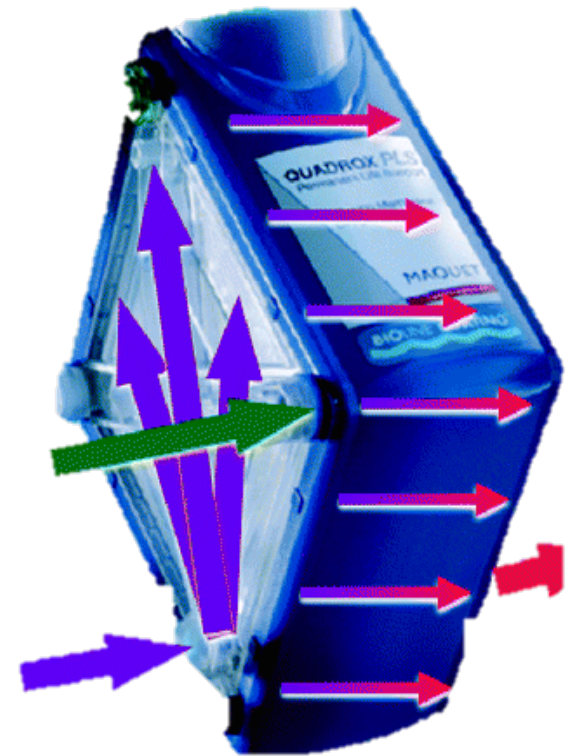


Oxygenator's Quantitative Evaluation

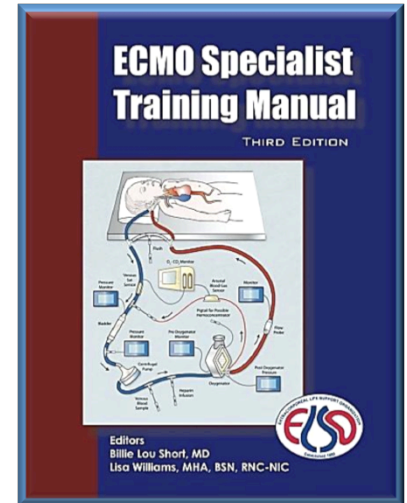


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Intra



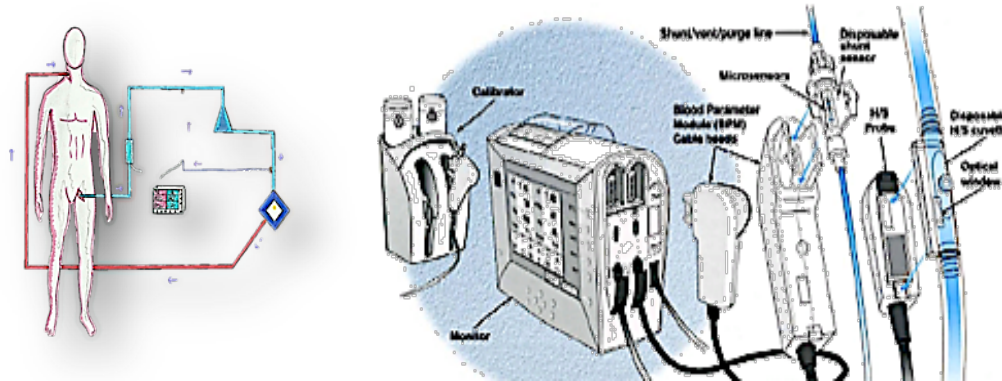
Oxygenator's Quantitative Evaluation



...Approximately 42 % of neonatal ECMO programs will monitor in-line measurements (pH, pO₂, pCO₂, BE.....) using a CDI 500 device....

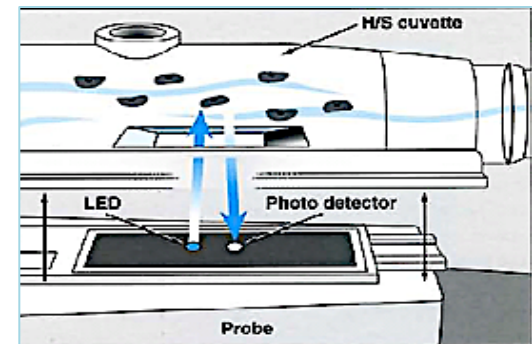
Oxygenator's Quantitative Evaluation

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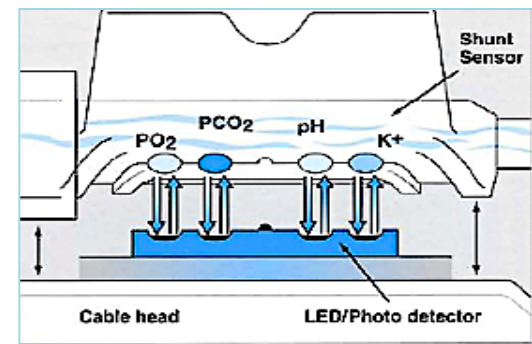
• CUVETTE H/S

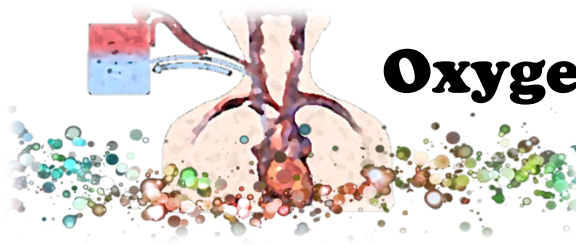
- 3/8 Inc. or 1/4 Inc.
- Optical Reflectance → SO_2 -Htc-Hgb



• SHUNT SENSOR

- Blood temperature
- Optical Fluorescence measurement → K^+ - PO_2 - PCO_2 -pH
- Minimal Flow 35 ml/min





Oxygenator's Quantitative Evaluation

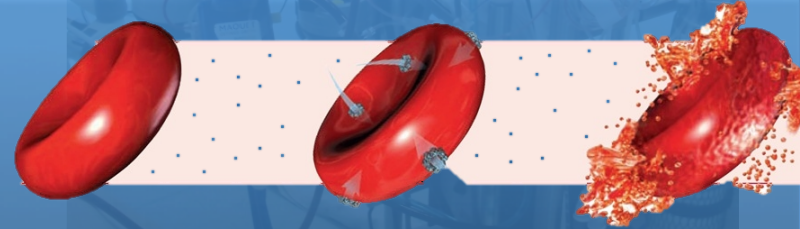


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Reliability of data



CDI → Hemolys

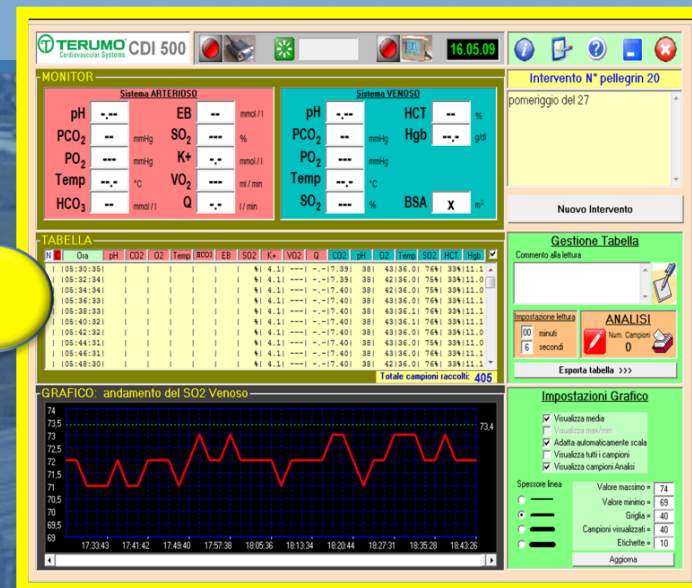


Oxygenator's Quantitative Evaluation



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2009



Recording Interval : 5 min.

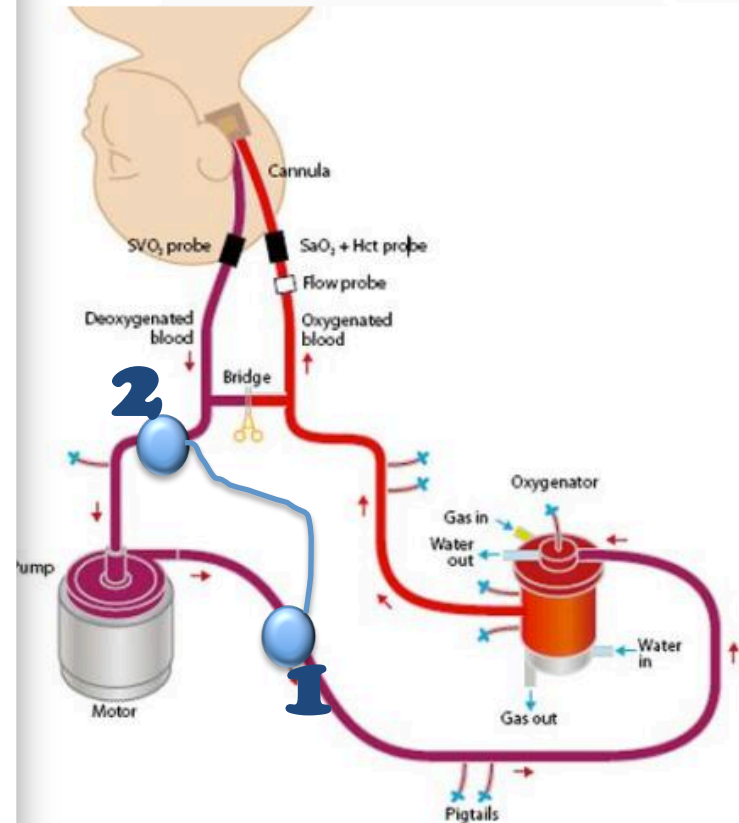
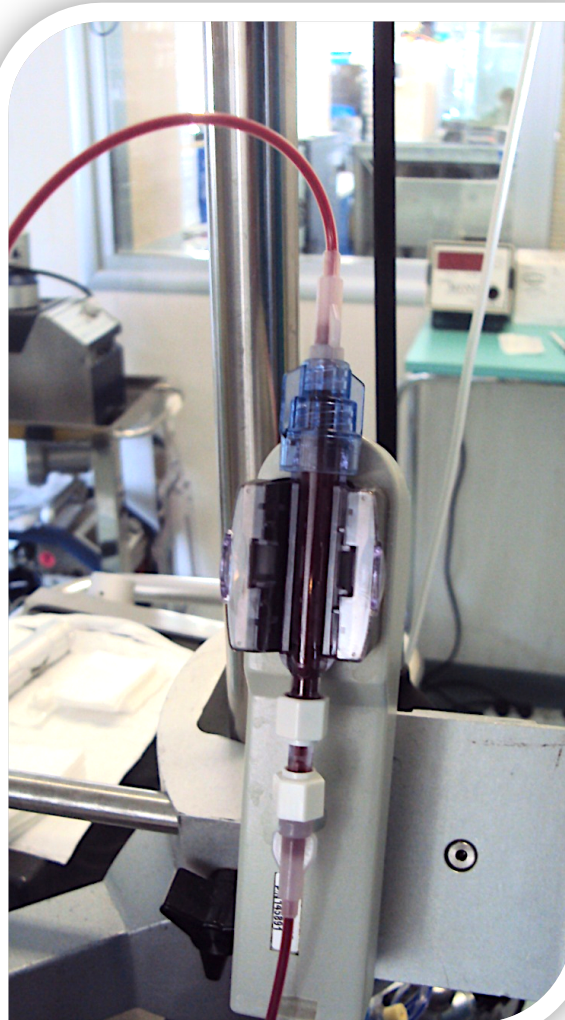
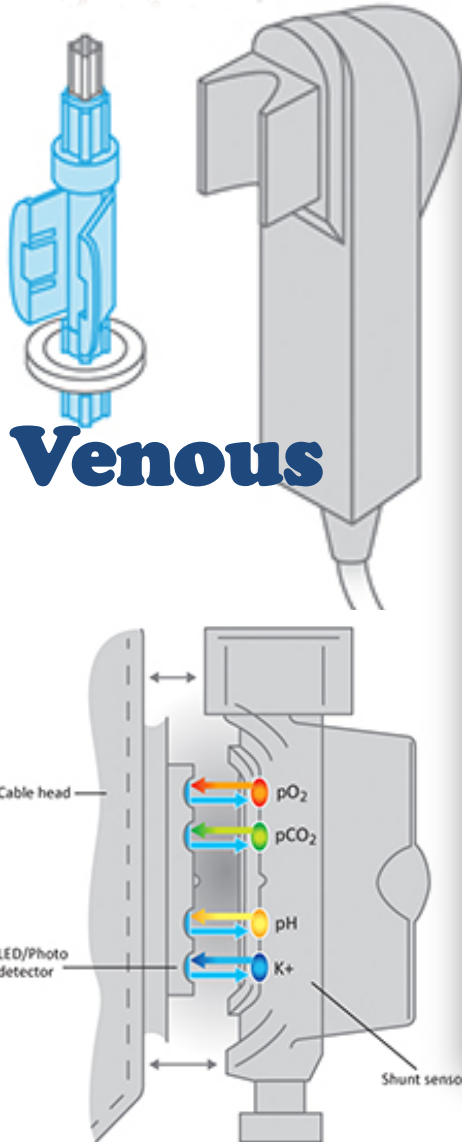
Numbers of BGA per 24 hrs : 12×24 (hr) = 288 BGA

Reconstruction every 12 hrs = $12 \times 12 = 144$ BGA

ECMO modality	Pediatric vs Adult	Indication	Mean ECMO Time (h)	Mean CDI Measure (n)	Recording Intervall (min)
VV (6)	Pediatric	RDS (4)	225	3413	5
		MPACAS (1)			
		CDH (1)			
VV (11)	Adult	Bridge to LTx (8)	213	2515	5
		ARDS (3)			
VA (8)	Pediatric	Post – Cardiotomic (6)	199	2865	5
		ECPR (2)			
VA (13)	Adult	Cardiogenic Shock (5)	226	3387	5
		Post – Cardiotomic (4)			
		LTx (1)			
		ECPR (4)			

Oxygenator's Quantitative Evaluation

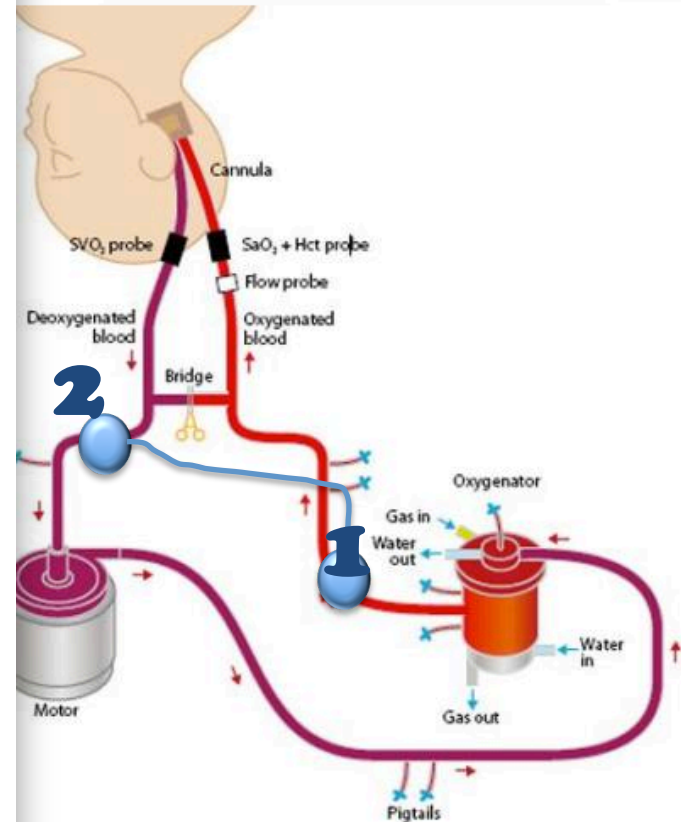
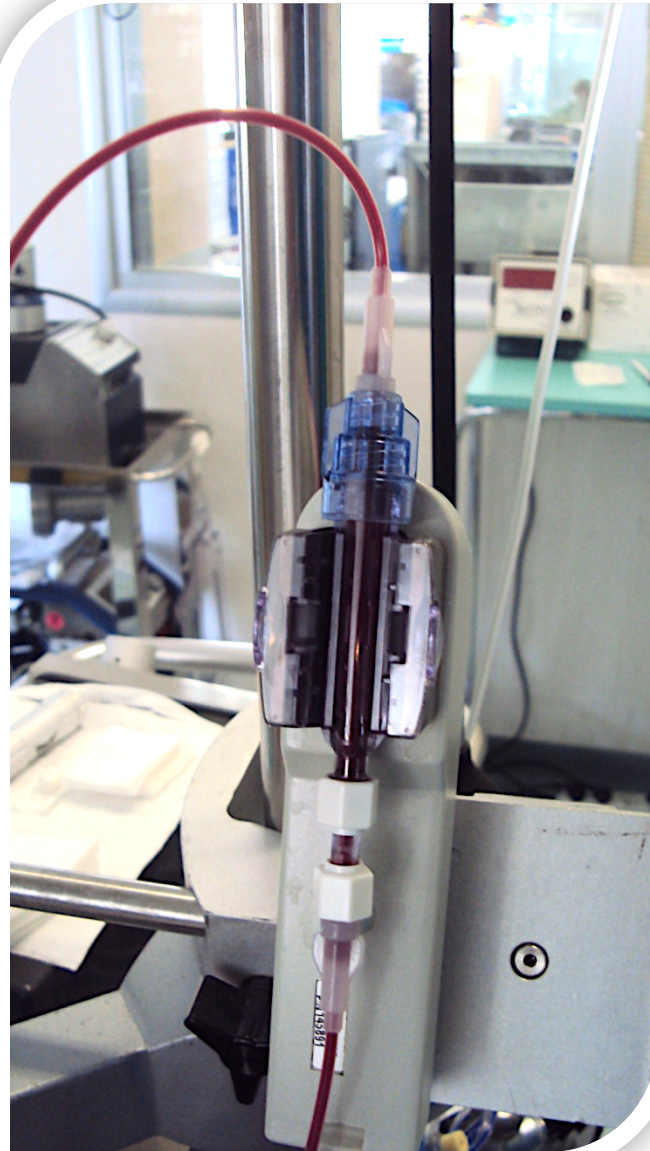
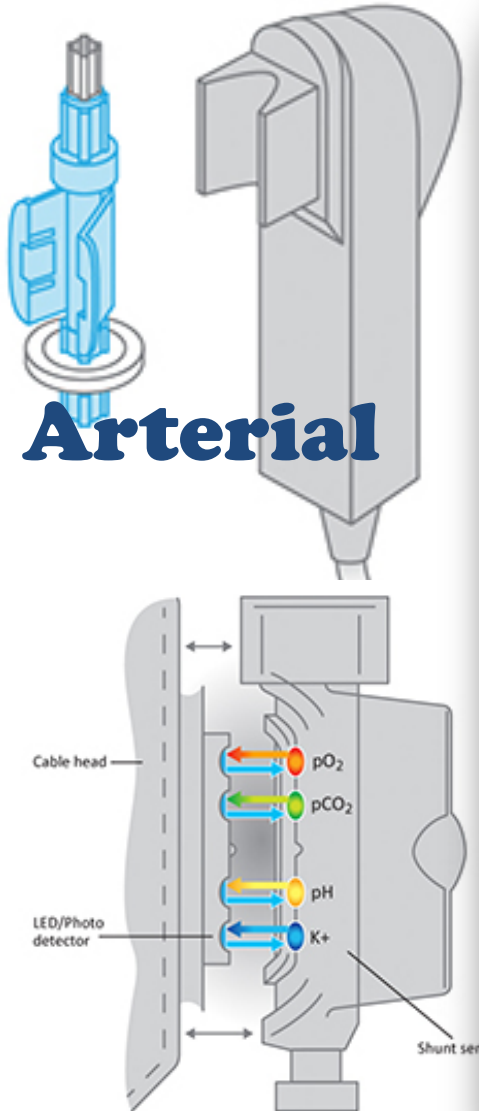
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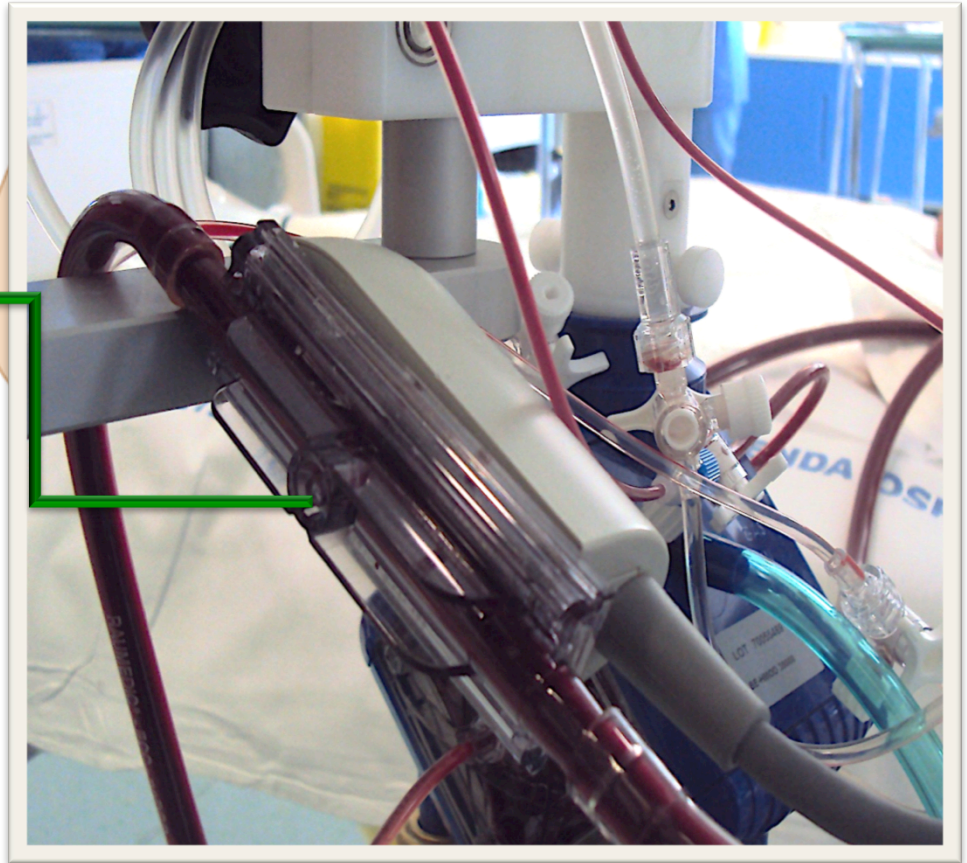
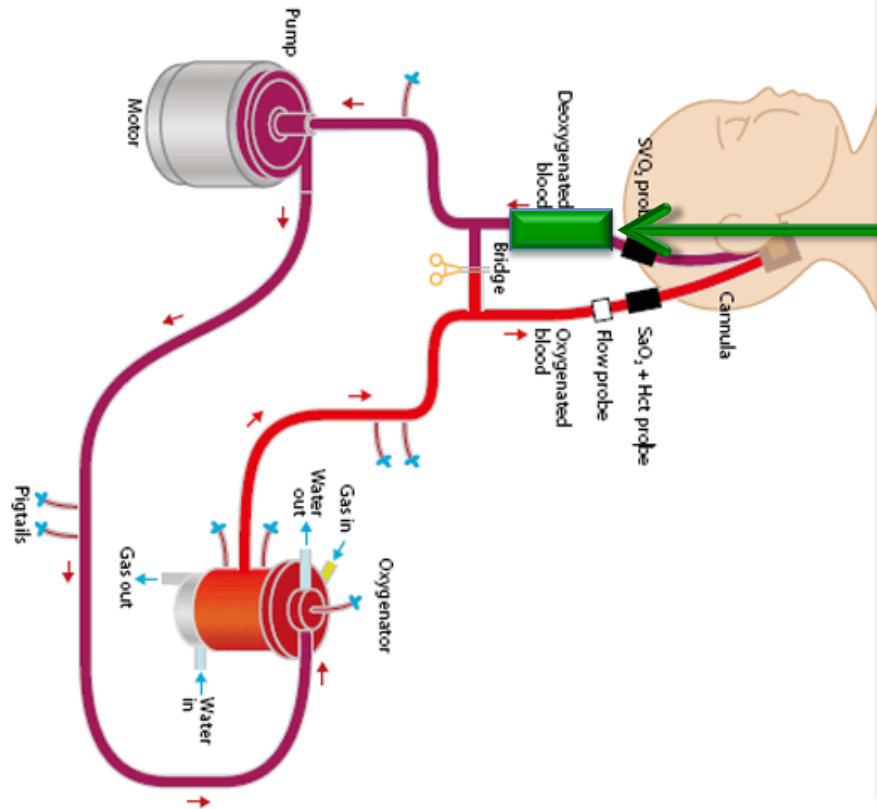


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Oxygenator's Quantitative Evaluation

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Oxygenator's Quantitative Evaluation

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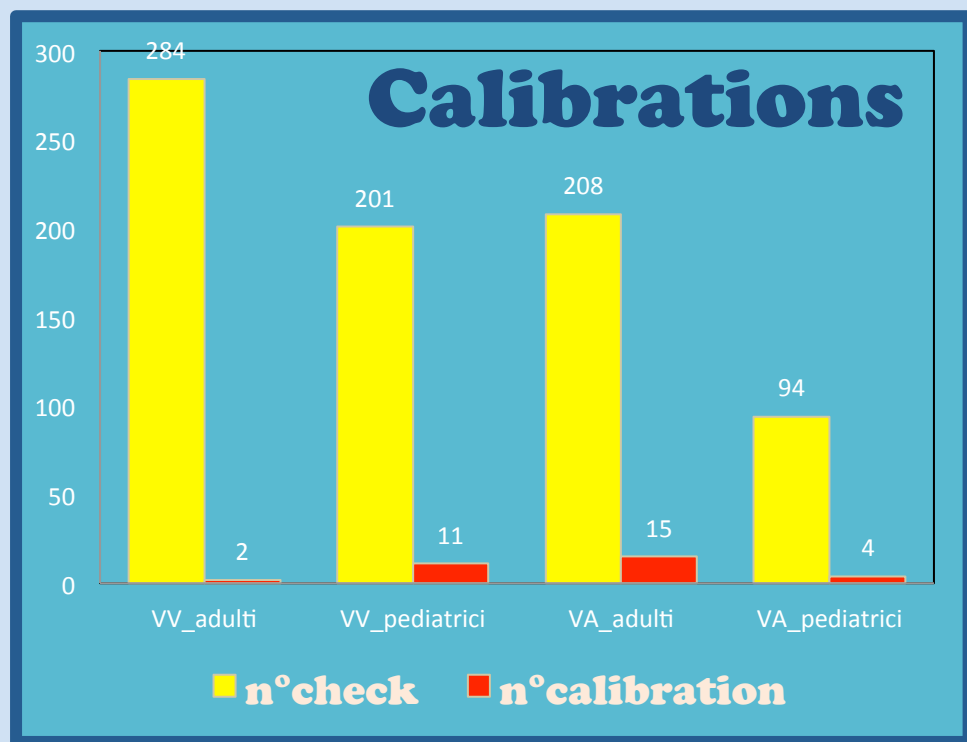
Data: / /

Perfusionista 08 - 15	
Perfusionista 15 - 20	
Perfusionista 20 - 08	

Paziente	08 - 15	15 - 20	20 - 08
Colore			
Temperature			
Temperature arto sup. dx			
Temperature arto sup. sn			

Etichetta RI

552



Scanco dati registrati	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Materiali emergenza	08 - 15	15 - 20	20 - 08
Circuito	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Ossigenatore	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Testata di pompa	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Tubi	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Flussimetro	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>
Consolle libera	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>	SI <input type="checkbox"/> NO <input type="checkbox"/>



Oxygenator's Quantitative Evaluation

Riepilogo test dell'ipotesi

ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>pHvBGA</u> e <u>pHvCDI</u> è uguale a <u>0</u>	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.087	Mantieni l'ipotesi nulla
Il livello di significatività è 0.05.			

Riepilogo test dell'ipotesi

ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>PCO2vBGA</u> e <u>PCO2vCDI</u> è uguale a <u>0</u>	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.565	Mantieni l'ipotesi nulla
Il livello di significatività è 0.05.			

Riepilogo test dell'ipotesi

ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>PO2vBGA</u> e <u>PO2vCDI</u> è uguale a <u>0</u>	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.685	Mantieni l'ipotesi nulla
Il livello di significatività è 0.05.			

Riepilogo test dell'ipotesi

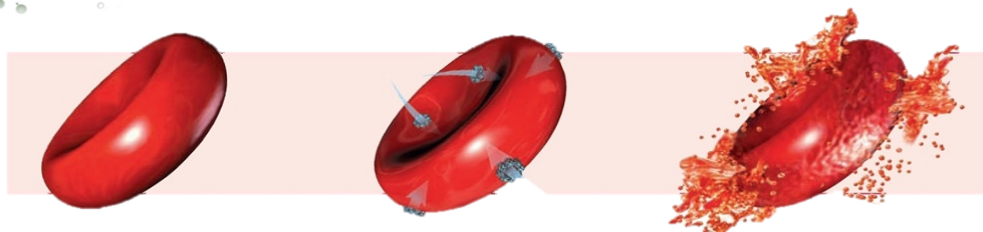
ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>KvBGA</u> e <u>KvCDI</u> è uguale a 0	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.055	Mantieni l'ipotesi nulla
Il livello di significatività è 0.05.			

Riepilogo test dell'ipotesi

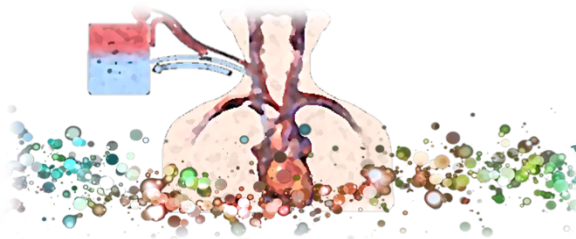
ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>HCO3vBGA</u> e <u>HCO3vCDI</u> è uguale a 0	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.001	Rifiuta l'ipotesi nulla
Il livello di significatività è 0.05.			

Riepilogo test dell'ipotesi

ipotesi nulla	test	significatività	decisione
La mediana delle differenze tra <u>BEvBGA</u> e <u>BEvCDI</u> è uguale a 0	Test dei segni per ranghi di <u>Wilcoxon</u> a campioni correlati	0.03	Rifiuta l'ipotesi nulla
Il livello di significatività è 0.05.			



Pazienti	Valore medio di PFH
Circuito ECMO adulti senza CDI 500	24.35
Circuito ECMO adulti con CDI 500	24.26
Circuito ECMO pediatrico senza CDI 500	24.48
Circuito ECMO pediatrico con CDI 500	20.65



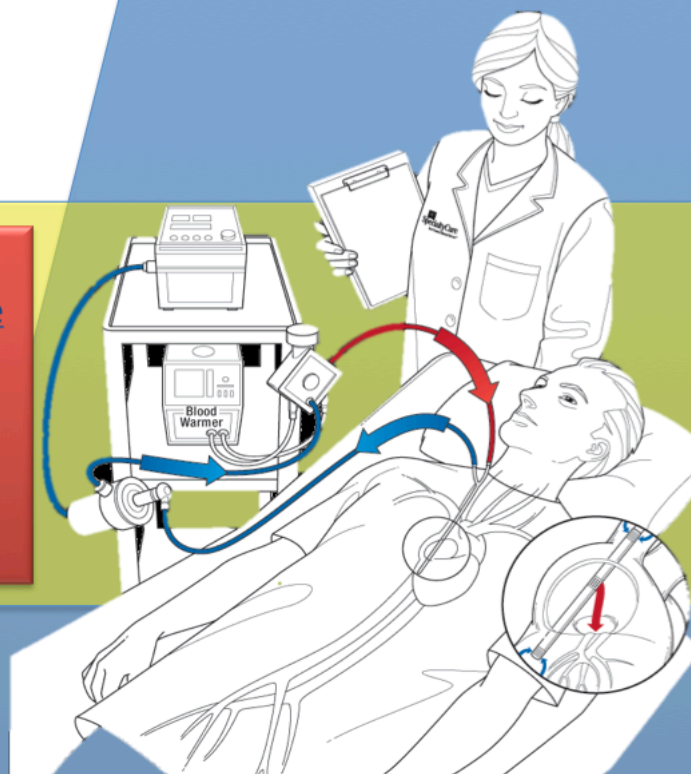
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D.M. 27 luglio 1998, n. 316

Art. 4

Il tecnico della fisiopatologia cardiocircolatoria e perfusione cardiovascolare contribuisce alla formazione del personale di supporto e **concorre direttamente** all'aggiornamento relativo al profilo professionale e **alla ricerca nelle materie di sua competenza.**



Analysis of Thrombotic Deposits in Extracorporeal Membrane Oxygenators by Multidetector Computed Tomography

CHRISTIAN DORNIA,* ALOIS PHILIPP,† STEFAN BAUER,* MATTHIAS LUBNOW,‡ THOMAS MÜLLER,‡ KARLA LEHLE,† CHRISTOF SCHMID,† RENÉ MÜLLER-WILLE,* PHILIPP WIGGERMANN,* CHRISTIAN STROSZCZYNSKI,* AND ANDREAS G. SCHREYER*

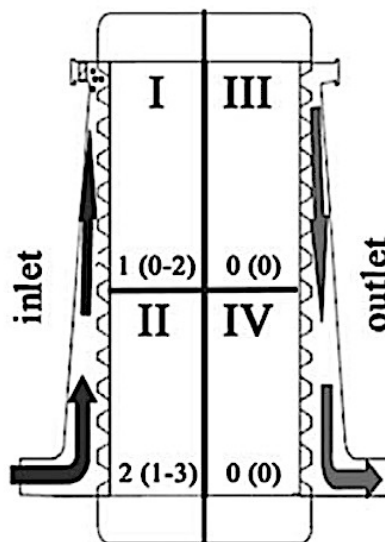
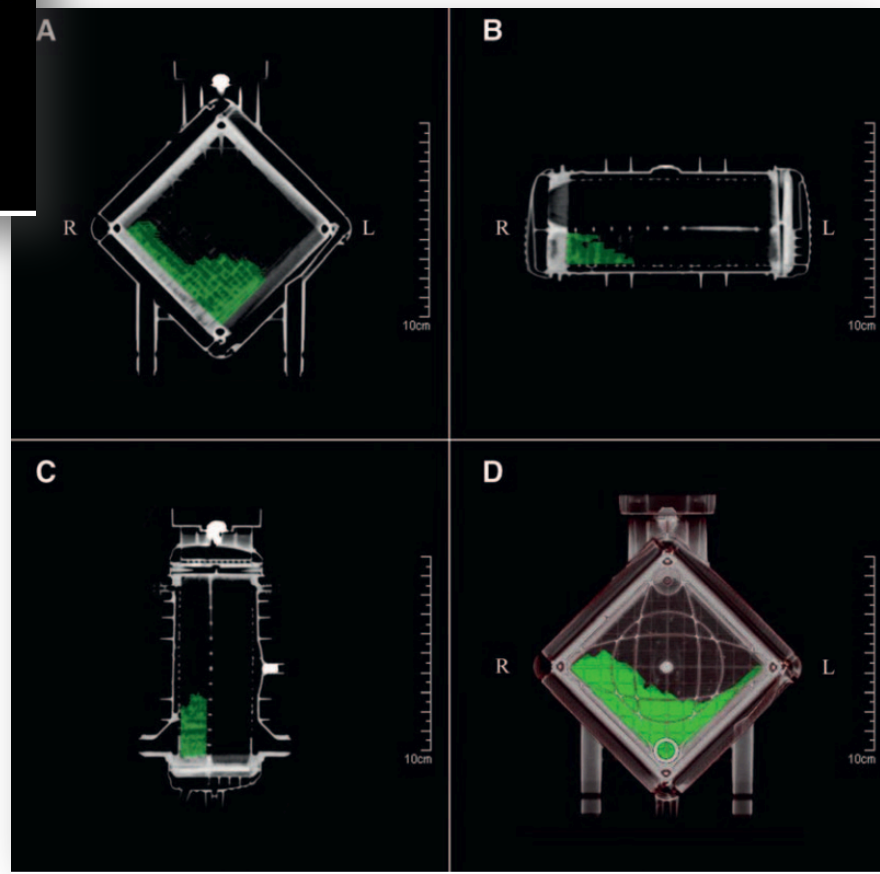
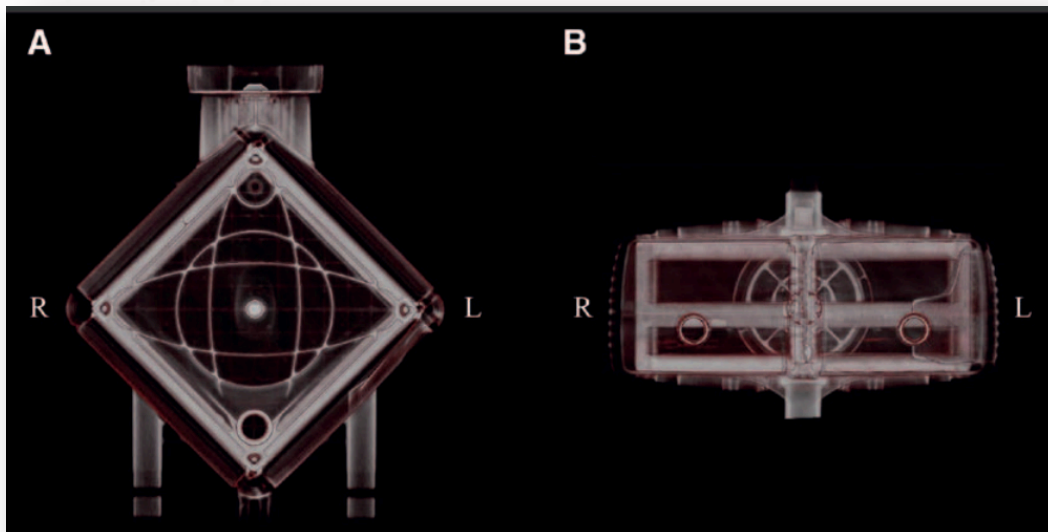


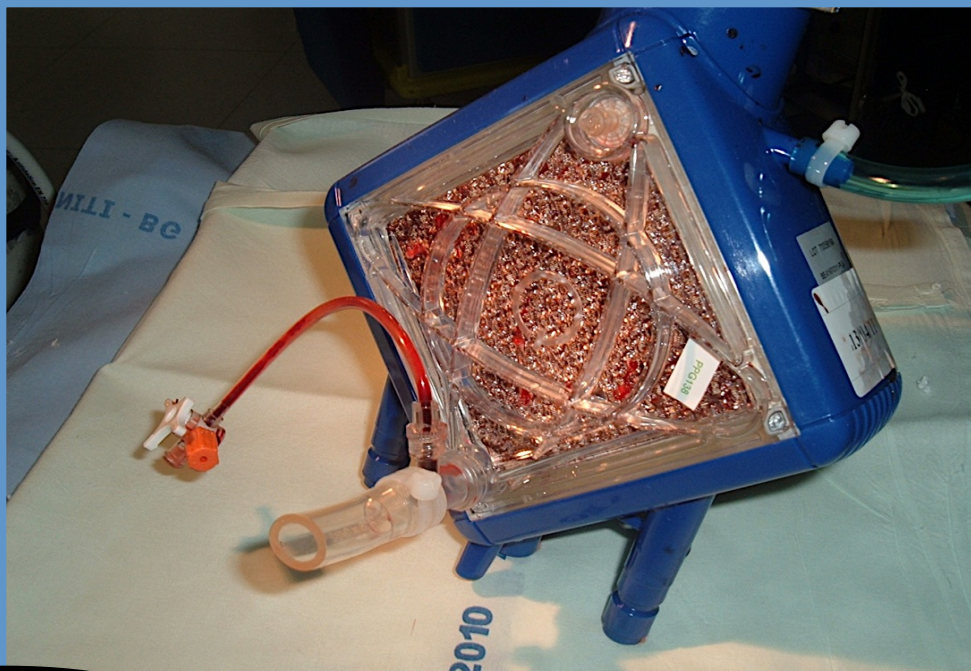
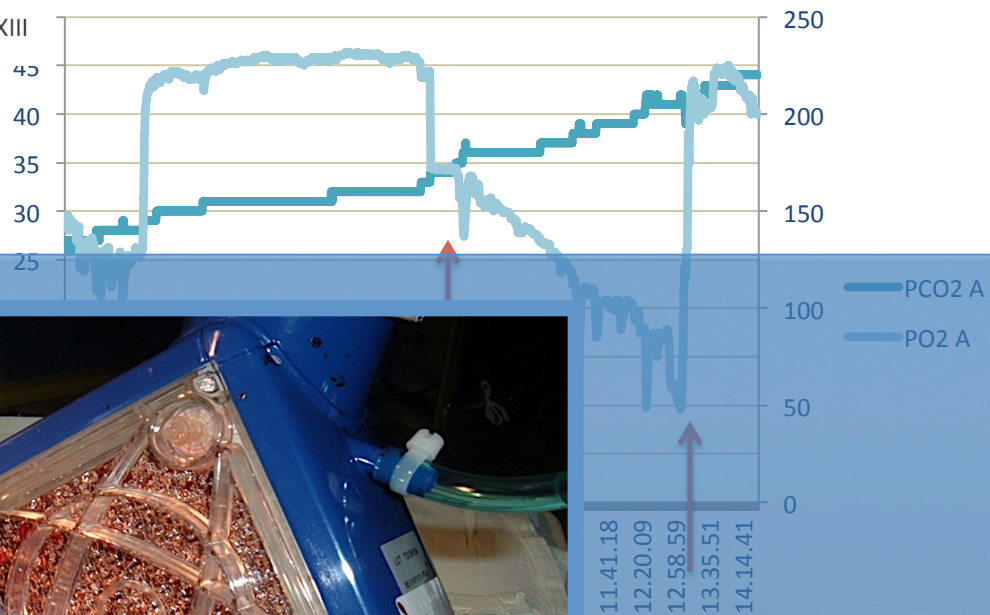
Figure 4. Schematic presentation of clot distribution showing the thrombus extent score per chamber on the four-point scale: (0) no thrombotic deposits, (1) low extent (2) moderate extent, and (3) high extent of thrombus formation. Data are presented as median and range.



Case Report



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PARAMETERS

- PinPump = -1
- Pump speed
- Flow= 5,700 l
- Pin Oxy = 260
- Pout Oxy = 23
- $\Delta P = 30$ mmHg

- R Oxy = 5,3 → 200

- PO₂ = 222 mmHg → 82,4 mmHg

- PCO₂ = 34,8 mmHg → 45,6 mmHg

ECLS

ROMBOSIS

-Change out of ECLS circuit

-23-04-2011 Weaning of ECLS

Conclusion 1

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- From Sweden to Ann Arbor
- Hope for ECMO Babies
- Saving Jake
- The Dick Sarns Innovation Fellowship
- The John R. Pfeifer Collegiate Professorship
- The Robert Bartlett Professorship in Pediatric Surgery
- Tovah's Story
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"Hope" for ECMO Babies

In 1974, a poor young woman in Baja, Mexico, was going into labor with her first pregnancy. Determined that her child would have a better life as a United States citizen she crossed the border to deliver her baby in California. When her water broke and she took the next exit off the freeway, finding herself at the Orange County Medical Center where her daughter was born. The little girl looked perfect, but her lungs were not working. Despite a ventilator turned to high settings the baby's lungs were unable to provide her with enough oxygen. It became increasingly apparent that the infant would not survive.



Give online

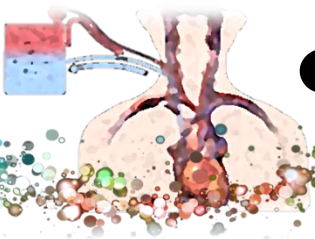


...use a specially modified heart-lung machine....©

The neonatologists called Robert Bartlett, a man who had been involved in developing the use of extracorporeal membrane oxygenation (ECMO) for the past four decades. The technique had never been used successfully in a newborn, but the baby would certainly die without it. The mother signed with an "X" and then took one long, last look at her daughter and disappeared, perhaps being equally scared of the baby's likely outcome and of her own arrest and deportation. After three months, the child was still alive.

Esperanza is now 34 years old, the oldest of the so-called "ECMO Babies" who survived against all odds with the help of Dr. Bartlett. ECMO (which stands for Extracorporeal Membrane Oxygenation) has saved thousands of lives over the past four decades. During an illustrious career at the University of Michigan, Dr. Bartlett worked unceasingly to perfect the ECMO equipment - devising new artificial organs and improved pumps to make the procedure ever safer for his tiny charges. The University's Pediatric Surgery Section is at the forefront of ECMO intervention nationwide, and owes this distinction to Dr. Bartlett. Now a Professor Emeritus of the Department of Surgery, he directs the University's Life Support Research Laboratory.

To learn more about Dr. Bartlett's work, or to make a gift to support the future of ECMO research, please contact Ann Boyd-Stewart in the Department of Surgery's Office of Development at 734.678.8466 or aboyd@med.umich.edu.



Conclusion 2



Azienda Ospedaliera
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Multidisciplinary approach





**KEEP
CALM
THE
ECMO Team
Is Coming**

**Thank you very much
for your kind attention**