ECMO

Extra Corporeal Membrane Oxygenation

QUE ES EL ECMO

HISTORIA – EVOLUCION – SITUACION MUNDIAL

Dr. Alberto Díaz Seminario

Médico Intensivista

Sociedad Peruana de Medicina Intensiva

Extracorporeal Life Support Organization

40´ - 50´

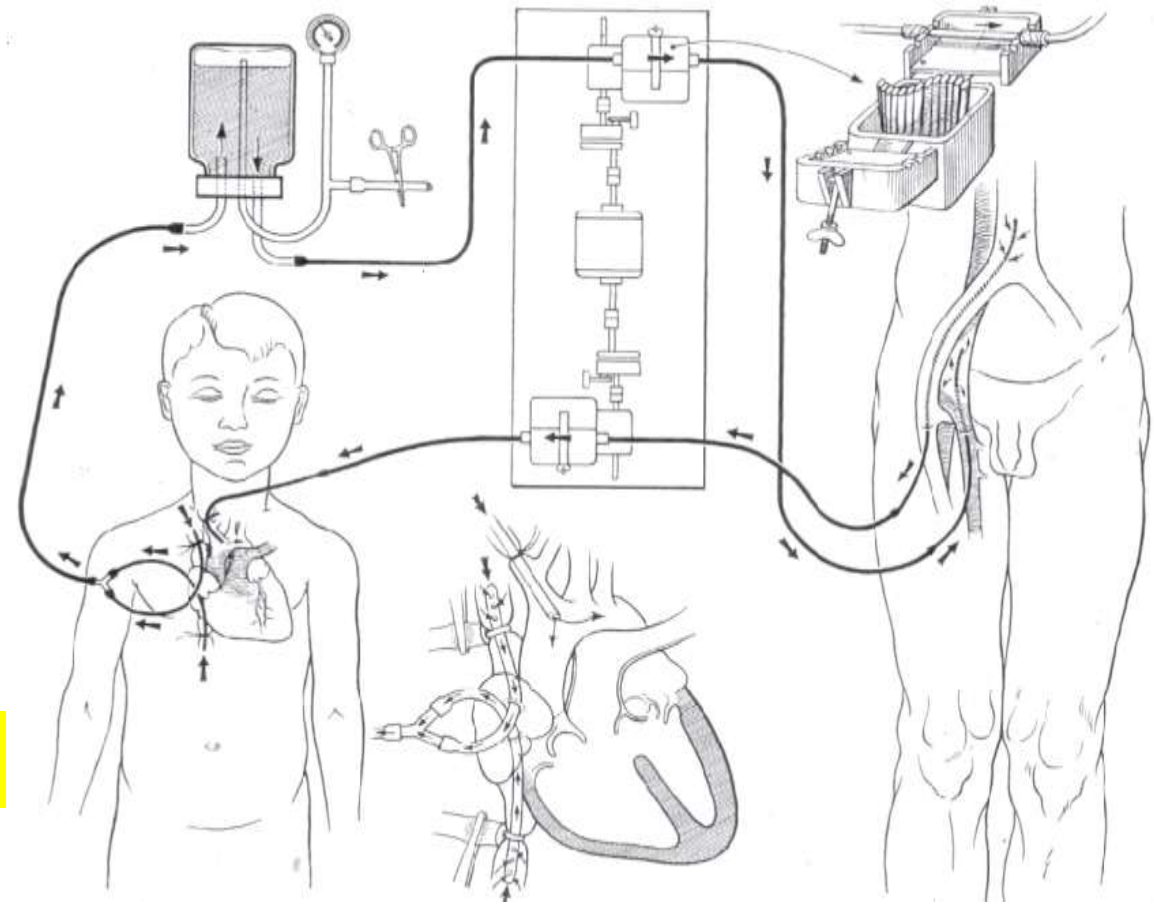
Sistema de circulación cruzada
1954 - C. W. Lillehei.

32 pacientes

Cirugía a corazón abierto

Circulación cruzada controlada

Circulación extracorporea



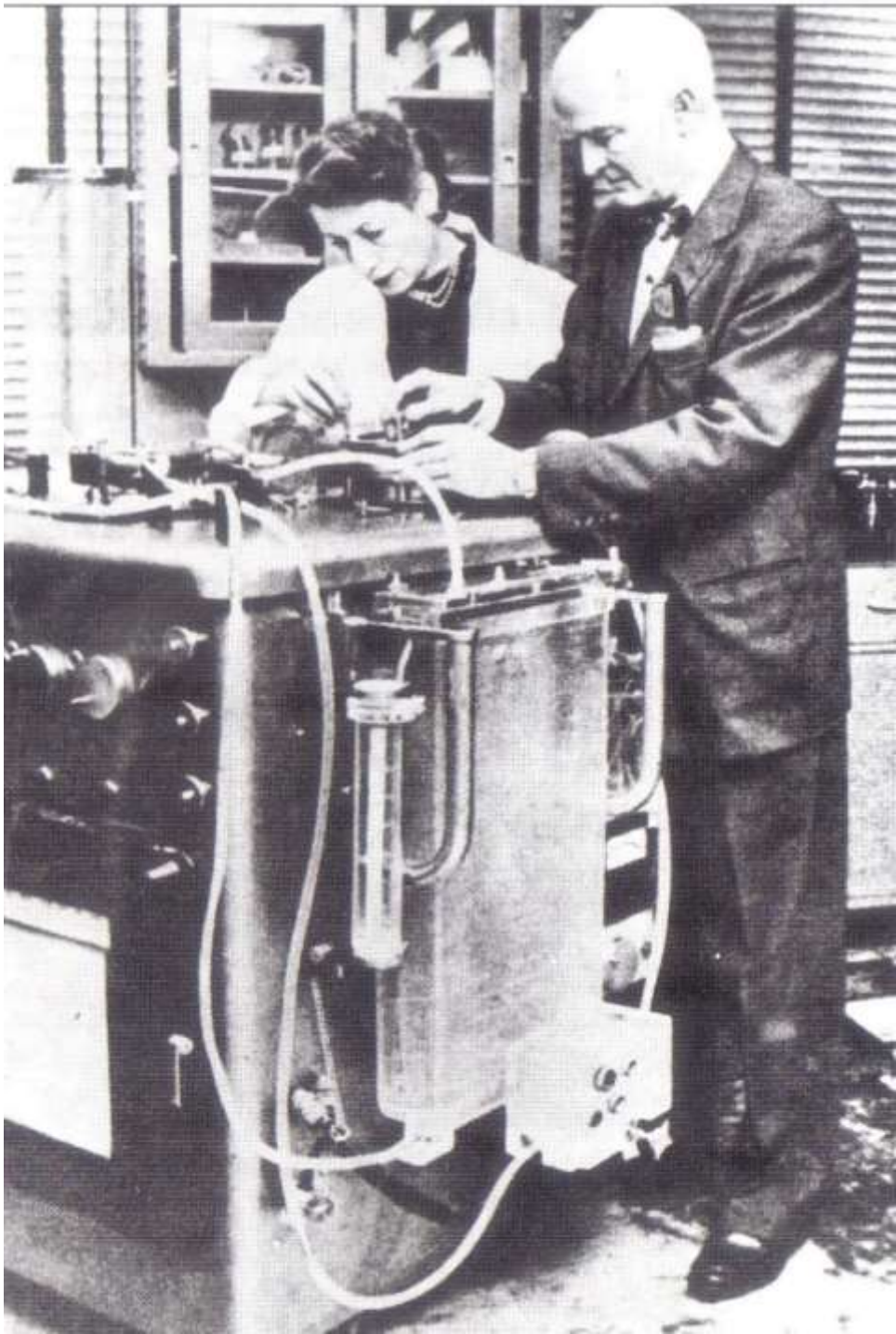
Esquema de circulación cruzada controlada, en la que un "donante", habitualmente el padre o la madre de un niño, servía como bomba y oxigenador para efectuar la cirugía a corazón abierto.

1

6 de Mayo de 1953

Dr. John H. Gibbon

Hospital Jefferson en Filadelfia



1

6 de Mayo de 1953
Dr. John H. Gibbon
Hospital Jefferson en Filadelfia

Cecilia Bavolek , 18 años

Comunicación interauricular (CIA)

26 minutos de circulación extracorpórea

1936
Charles Best

Síntesis de heparina

1939 ATS
Dr. Gibbon

Supervivencia de 4 animales de laboratorio sometidos a extracorpórea

1944 Thomas Watson
IBM

1

6 de Mayo de 1953
Dr. John H. Gibbon
Hospital Jefferson en Filadelfia

Cecilia Bavolek , 18 años

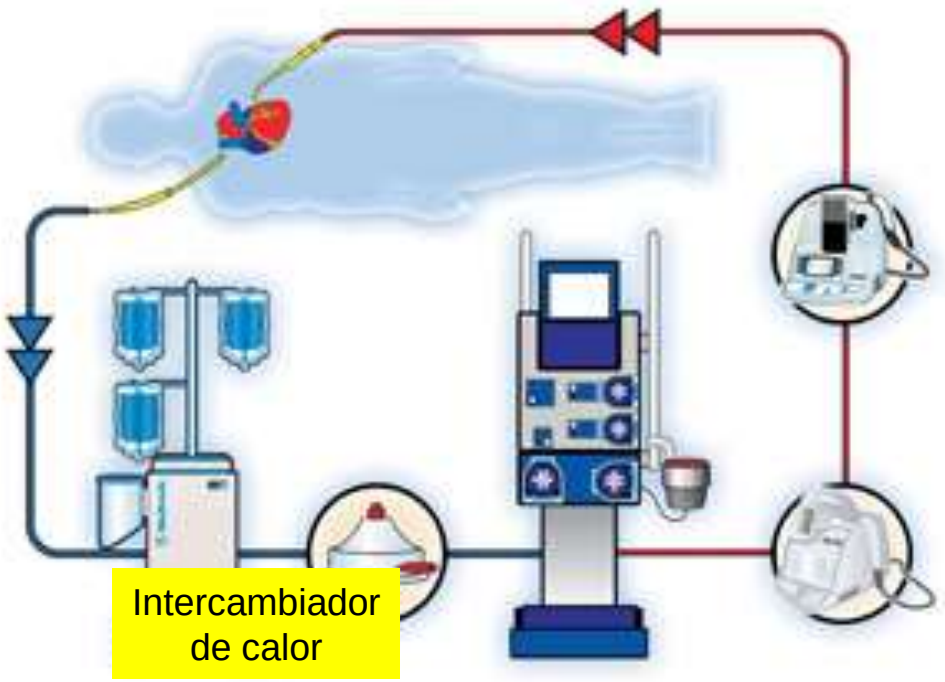
Comunicación interauricular (CIA)

26 minutos de circulación extracorpórea

Avances en cirugía cardiopulmonar
Transplante cardiaco

Cirugía con corazón parado

Maquina circulación extracorpórea
o
Máquina de bypass cardiopulmonar



Oxigenador + Bomba

PERFUSIÓN

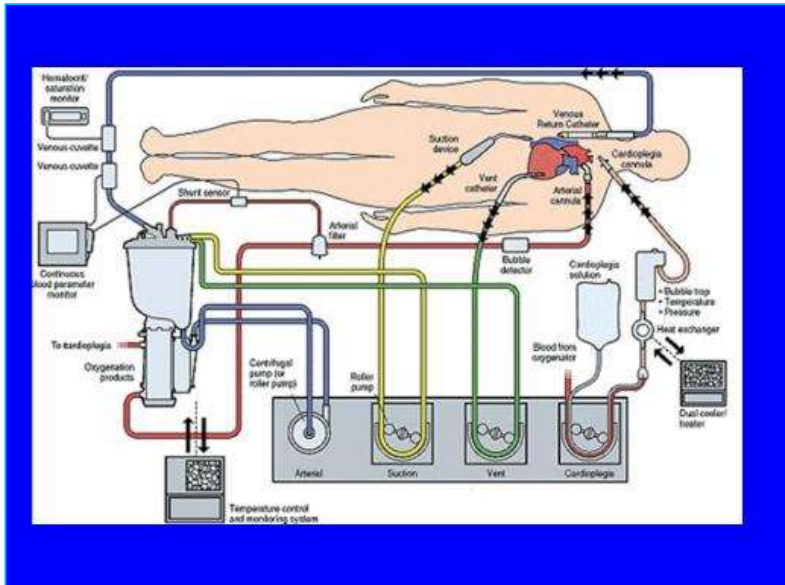
Problemas:
sistemas de circulación extracorpórea

Sangre en contacto con superficies no biológicas: induce respuesta inflamatoria sistémica

Hemodilución

Politransfusión

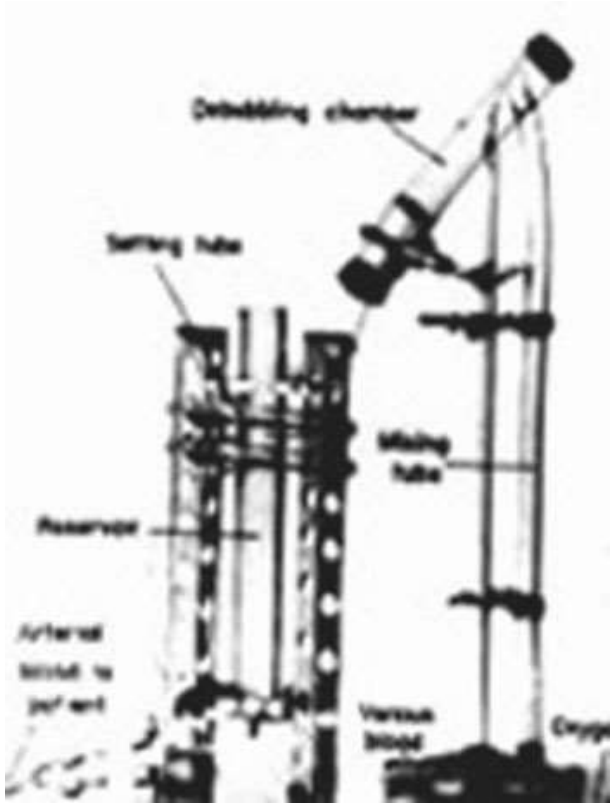
Hipotermia

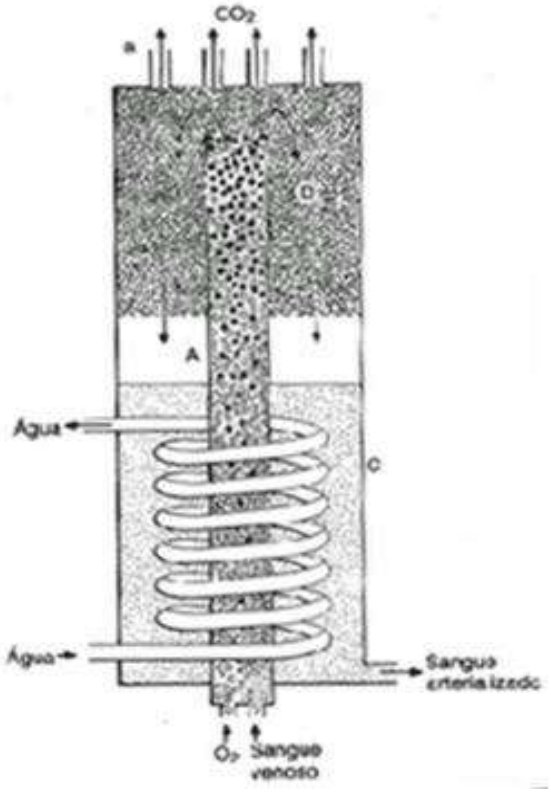


Anticoagulación - uso de heparina

Bomba externa para impulsar el flujo sanguíneo : lo somete a diferentes tensiones físicas y deformaciones

Evolución
sistema de circulación extracorpórea





Oxigenador de burbujas

1° prototipo del oxigenador de burbujas(Wall-Lillehei). Compuesto del tubo intercambiador de oxígeno (a la derecha), el recipiente para desburbujear (sobre éste) y el reservorio de hélice (a la izquierda).

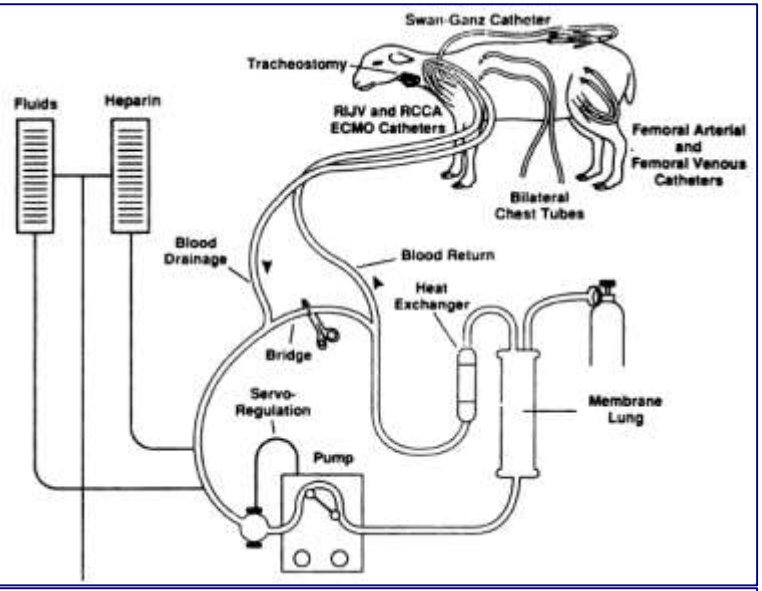
Oxigenador de burbujas

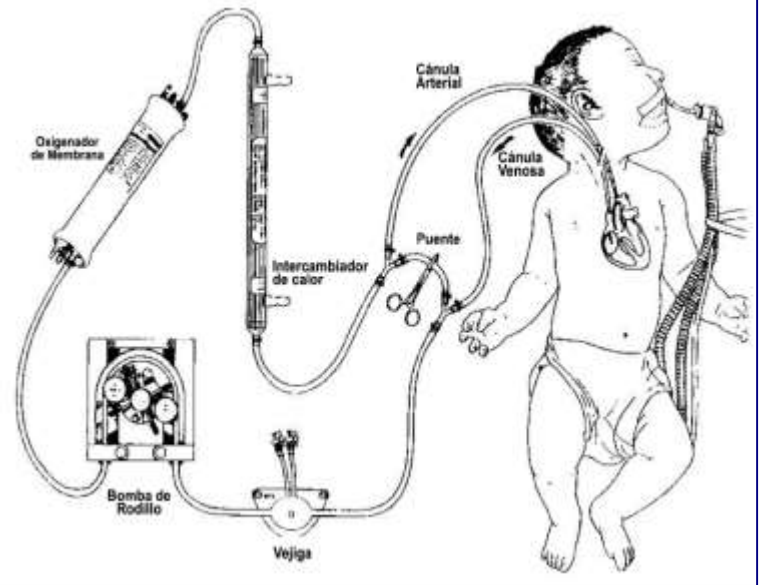
contacto directo entre la sangre y la fase gaseosa

↓

HEMÓLISIS

60 s





Desarrollo de varios OXIGENADORES DE MEMBRANA

mejor interface en términos de intercambio gaseoso y biocompatibilidad

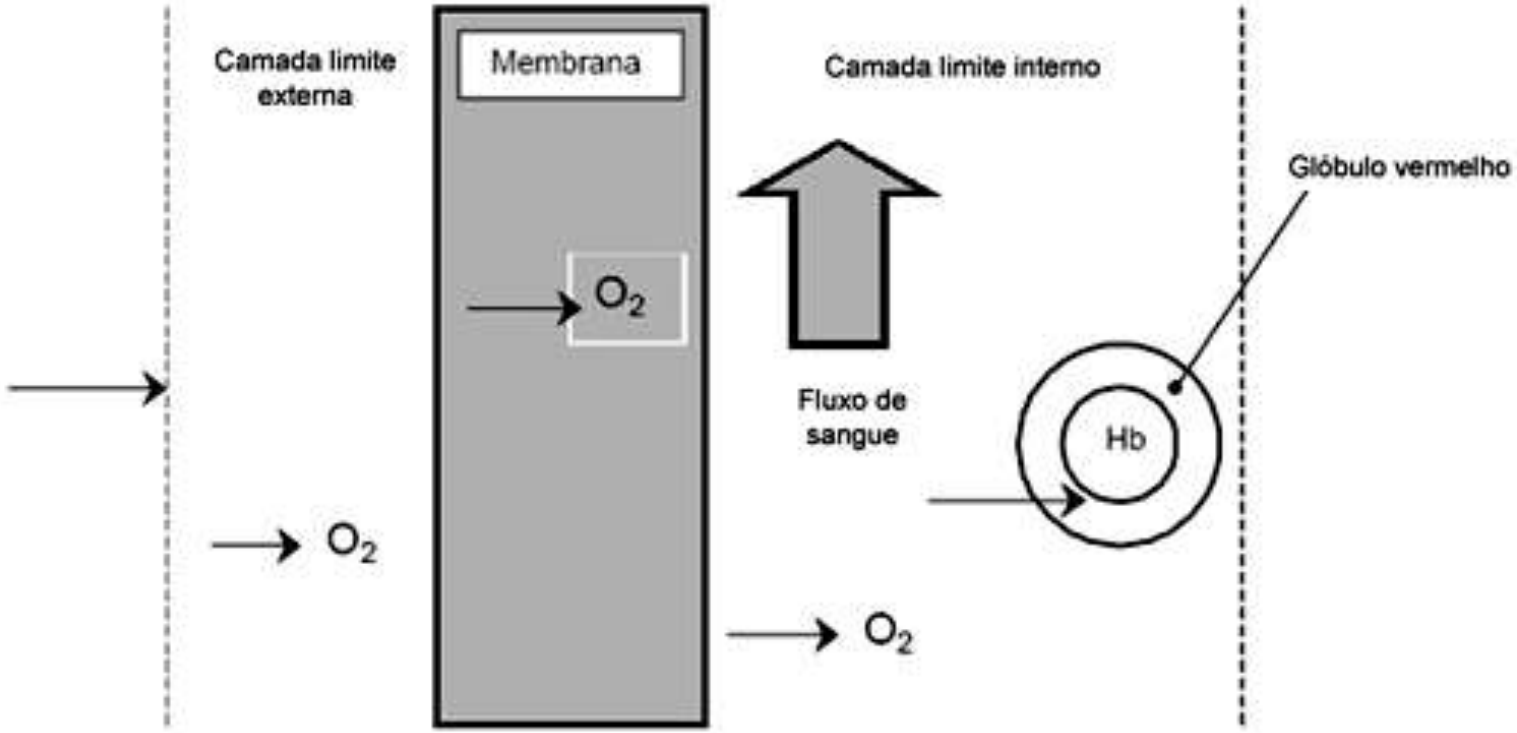
Separación de las faces hemática y gaseosa por un

oxigenador de membrana

- Disminuye el daño de los componentes de la sangre
- Permite un tiempo más prolongado de perfusión

Separación de las fases gaseosa y acuosa

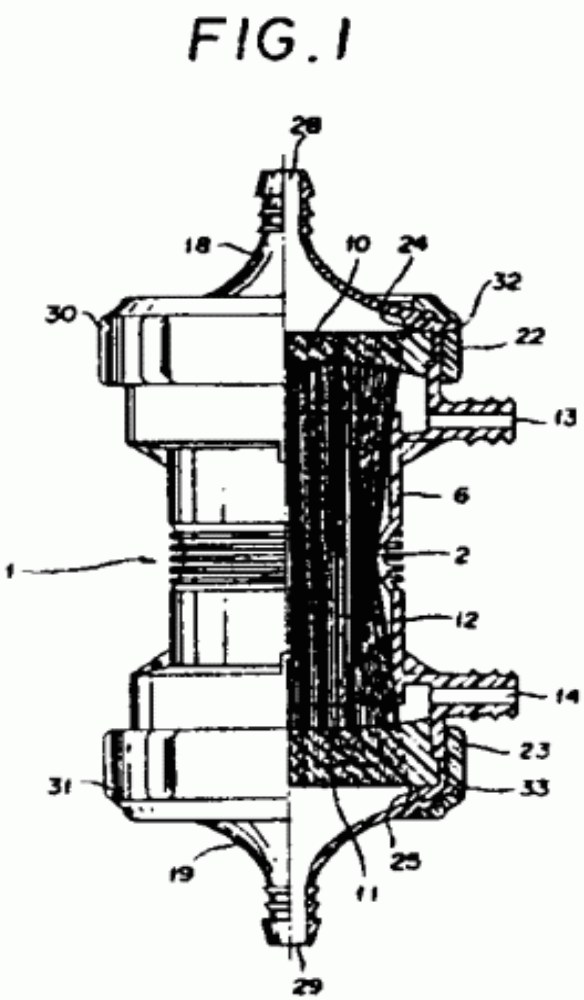
Difusión
Menor hemolisis
Permite tiempos prolongados de uso

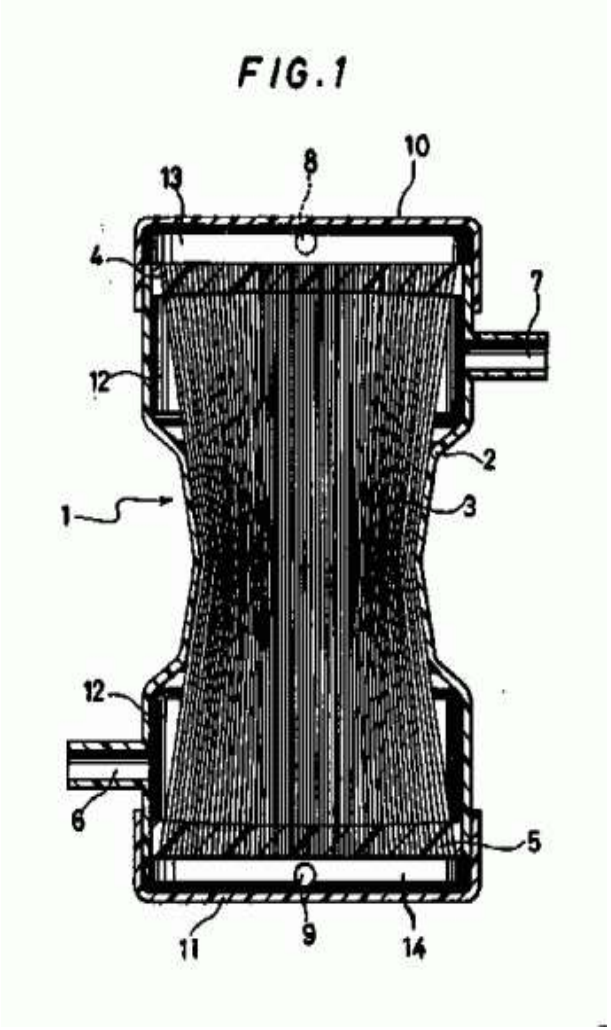


Oxigenador de membrana

Membrana de caucho reforzada en silicona, envuelta en plástico con una separación en su interior.

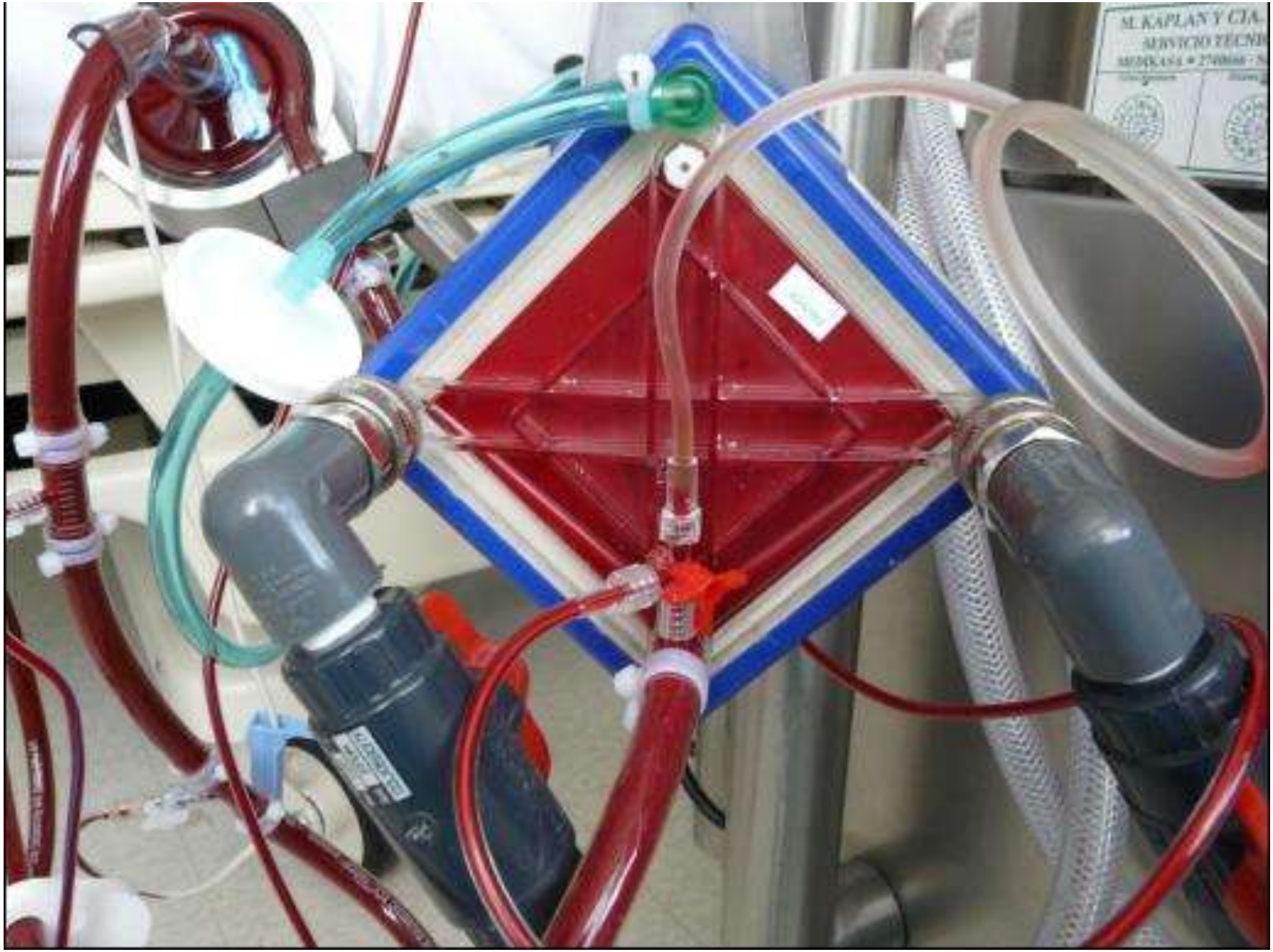
En su exterior hay tubos de caucho y silicona plegados que transportan al interior el flujo de gas que circula de arriba hacia abajo



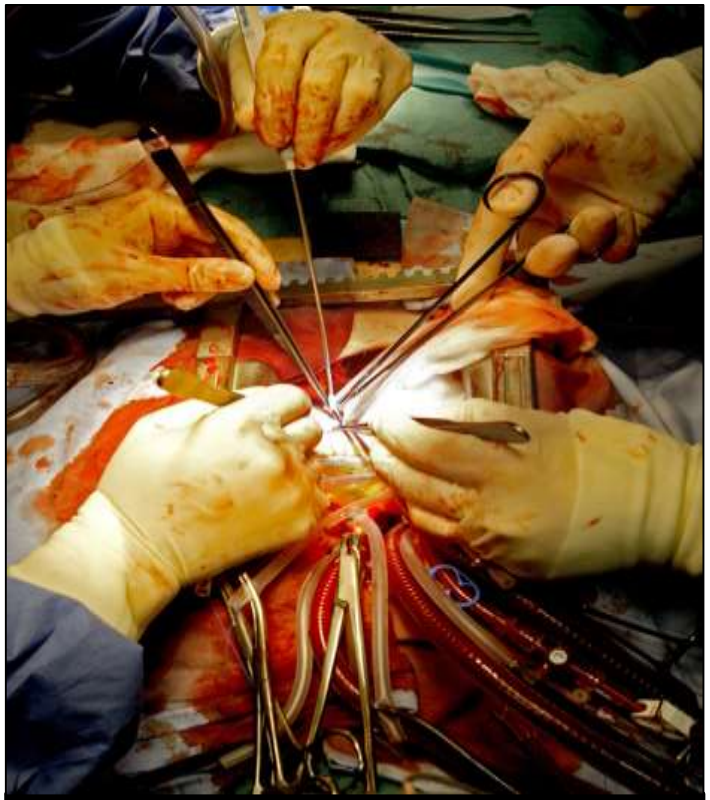



ECMO
ECMO


ECMO


M. KAPLAN Y CIA.

Separación de las faces hemática y gaseosa por un oxigenador de membrana



CEC
SOP

ECMO -ECLS
UCI

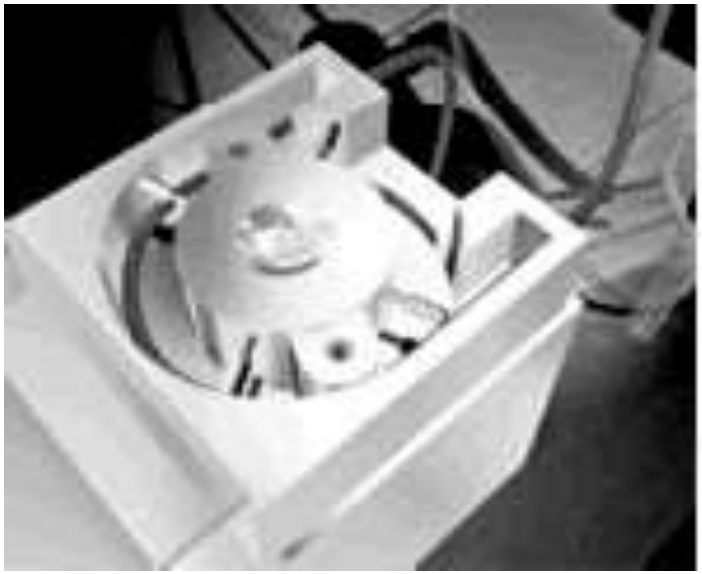
La aplicación del soporte extracorpóreo se extendió a la asistencia prolongada de pacientes con insuficiencia respiratoria y cardíaca aguda con cada vez mayor éxito

Continúa

BUSQUEDA DE MEJORES SISTEMAS DE BOMBA + OXIGENADORES DE MEMBRANA

Bombas

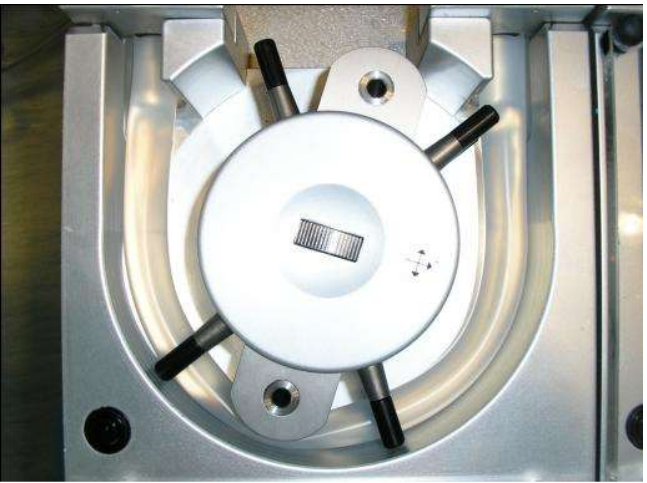
BOMBAS PERISTALTICAS DE RODILLO



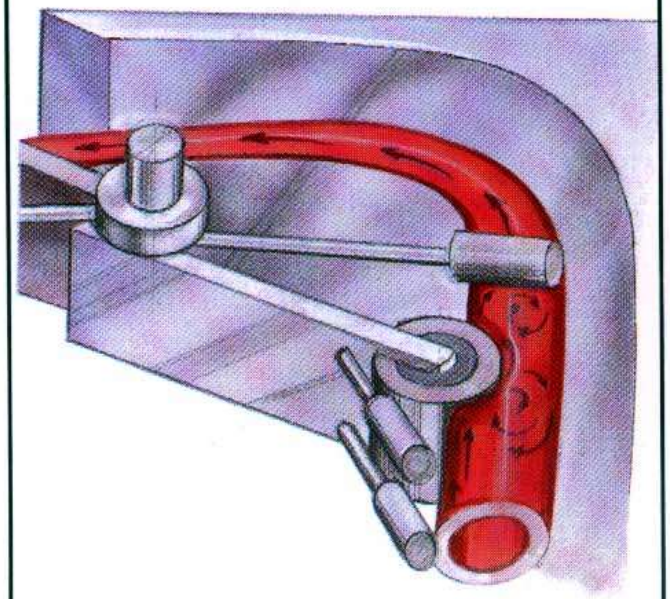
Bombas

Bombas pulsatiles
Bombas no pulsatiles

De rodillo
Impeledor
Centrífuga
Levitación magnética

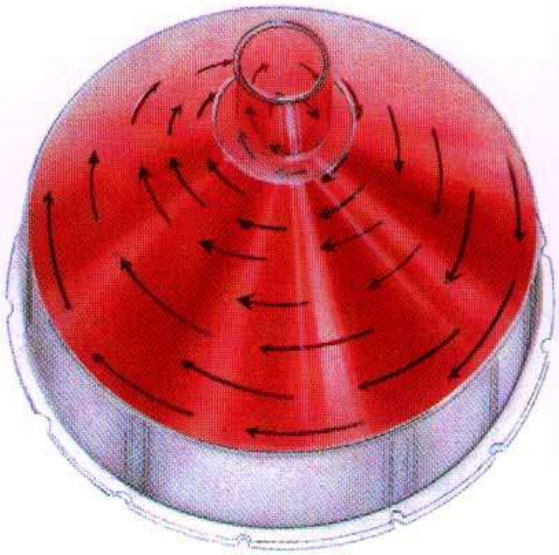


PERFUSION PUMP TECHNOLOGIES



Roller Pump
(Positive Displacement)
Rollers push the blood along. Leading and trailing edges of rollers create **turbulence** in the blood.

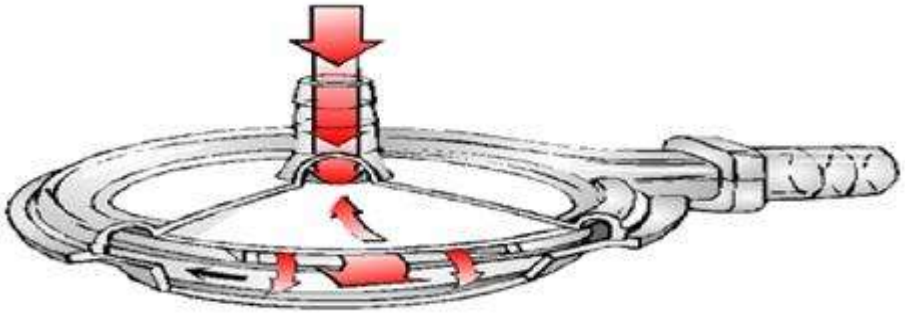
Impeller Pump
(Centrifugal)
Impeller blades push through the blood, creating **turbulence** in areas of positive pressure (leading edge) and negative pressure (trailing edge).

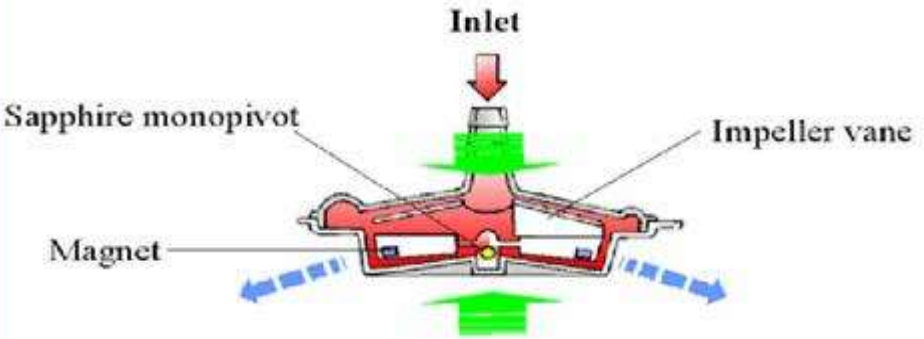


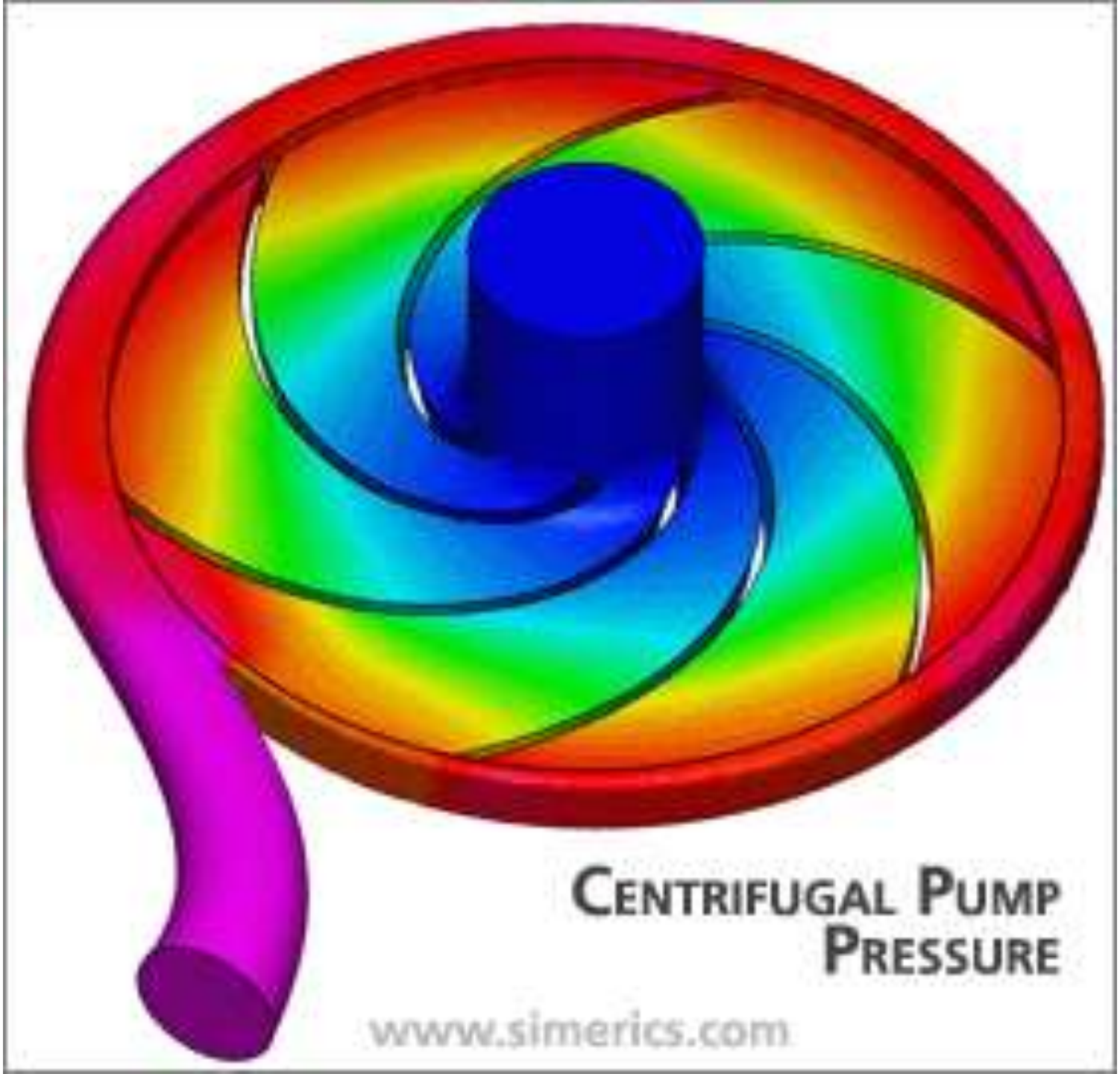
Bio-Medicus Pump
(Centrifugal)
Smooth, rotating cones use viscous drag. Pumping action is smooth and gentle. The blood does its own pumping.

BOMBAS CENTRIFUGAS

cono

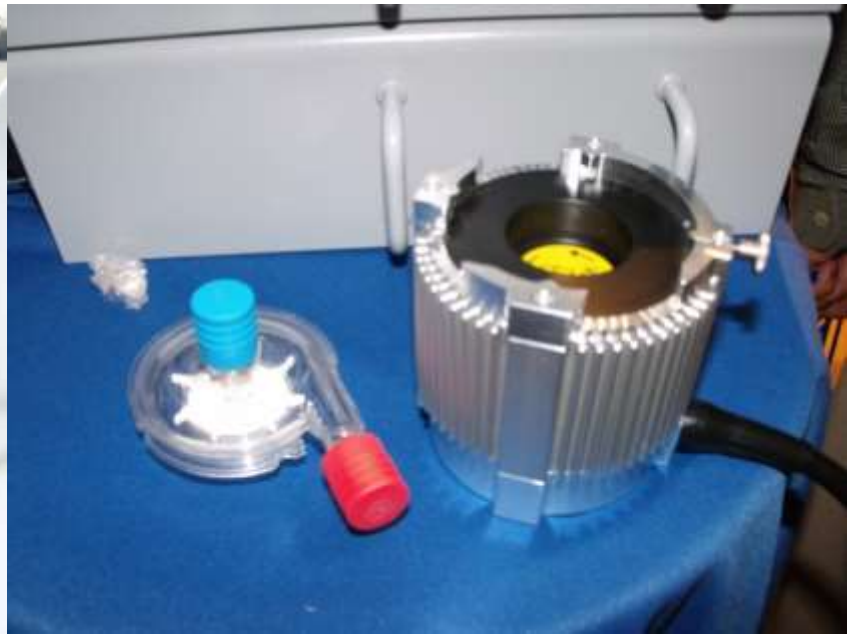





CENTRIFUGAL PUMP
PRESSURE
www.simerics.com


SN

BOMBA CENTRIFUGA DE LEVITACION MAGNETICA



INTERACCION SANGRE – BIOMATERIALES ECMO

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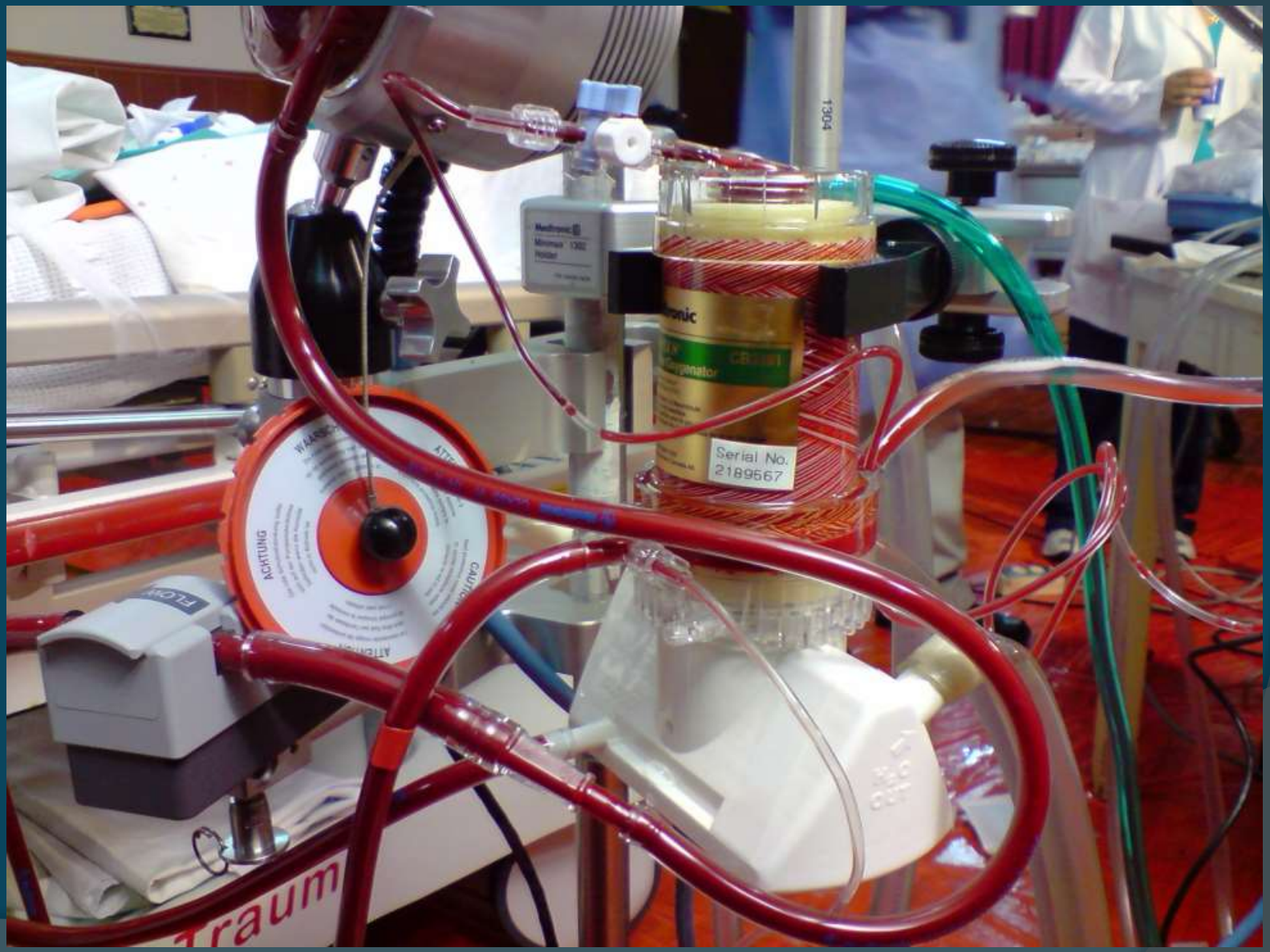

INTERACCION SANGRE – BIOMATERIALES ECMO

ECMO requiere la exposición constante del volumen sanguíneo a una extensa superficie artificial

INTERACCION SANGRE – BIOMATERIALES ECMO

BIOQUIMICA

- ACTIVACION CASCADAS COAGULACION - COMPLEMENTO
- ACTIVACION DE PLAQUETAS
- ACTIVACION ENDOTELIAL
- ACTIVACION – INVASION NEUTROFILOS

SIRS

INTERACCION SANGRE – BIOMATERIALES ECMO

BIOQUIMICA

- ACTIVACION CASCADAS COAGULACION - COMPLEMENTO
- ACTIVACION DE PLAQUETAS
- ACTIVACION ENDOTELIAL
- ACTIVACION – INVASION NEUTROFILOS

SIRS

MECANICA

Altas fuerzas mecánicas - fluidos

HEMOLISIS

Catéteres

Bombas

oxigenador

Interpreting Blood-Biomaterial Interactions from Surface Free Energy and Work of Adhesion

Trends Biomater. Artif. Organs, Vol 18 (2), January 2005

Axial dependence of platelet-collagen interactions in flowing blood. Upstream thrombus growth impairs downstream platelet adhesion

KS Sakariassen and HR Baumgartner

Arterioscler Thromb Vasc Biol 1989, 9:33-42

Blood-Surface Interactions During Cardiopulmonary Bypass

L. Henry Edmunds Jr

Journal of Cardiac Surgery

Volume 8, Issue 3, 404–410, May 1993

CELL-SURFACE ADHESIVE INTERACTIONS IN MICROCHANNELS AND MICROVESSELS

First International Conference on Microchannels and Minichannels

April 24-25, 2003, Rochester, New York, USA

THE INTERACTION OF POLYMER SURFACES WITH BLOOD

T. BEUGELING

Department of Chemical Technology, Biomaterials Section, Twente University of Technology, ENSCHEDE, The Netherlands

Interpreting Blood-Biomaterial Interactions from Surface Free Energy and Work of Adhesion

Trends Biomater. Artif. Organs, Vol 18 (2), Januar

Axial dependence of platelet-collagen interactions i… thrombus growth impairs downstr…

KS Sakariassen and…

Arte… …23-42

Blood-Su…

J…

Vo… …4–410

CEL… …RACTIONS

I… …MICROVESSELS

First International Conference on

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April 24-25, 2003, Rochester, New York, USA

THE INTERACTION OF POLYMER SURFACES WITH BLOOD

T. BEUGELING

Department of Chemical Technology, Biomaterials Section, Twente University of Technology, ENSCHEDE, The Netherlands

Synthetic surfaces exposed to biological fluids adsorb proteins

… how does this mediate the body's ultimate response to a biomaterial?

ECMO

Segundos después . . .

ECMO

Segundos después . . .

MOLECULAR LAYER OF PROTEIN

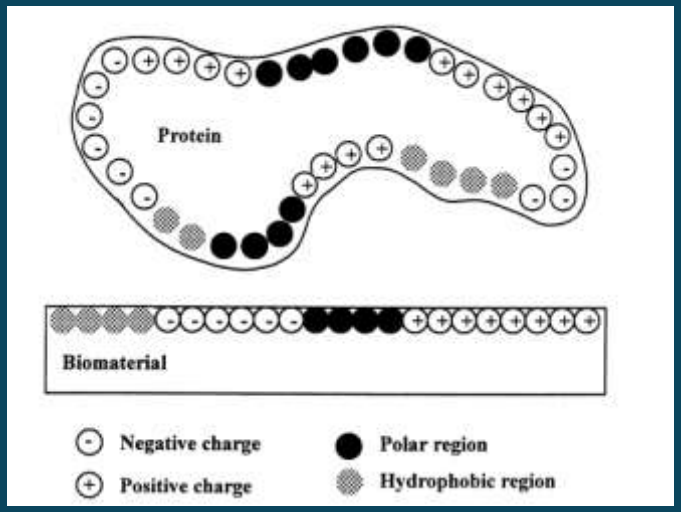
FIBRINOGENO
ALBUMINA
ALFA GLOBULINA
GAMA GLOBULINA
HAGEMAN FACTOR - XII
OTRAS PROTEINAS

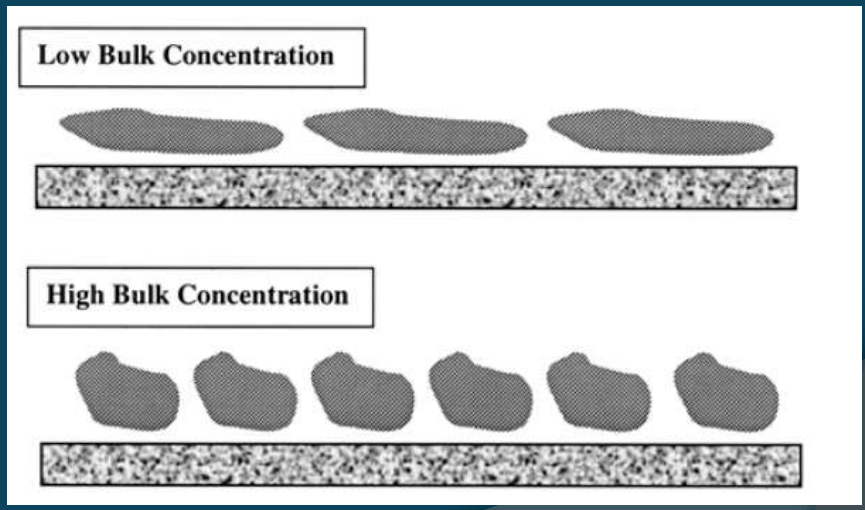
ECMO

Segundos después . . .

MOLECULAR LAYER OF PROTEIN

La naturaleza de las proteínas adsorbidas a la superficie afectan a los otros componentes sanguíneos





Protein-Surface Interactions

ECMO

Segundos después . . .

MOLECULAR LAYER OF PROTEIN

FIBRINOGENO
ALBUMINA
ALFA GLOBULINA
GAMA GLOBULINA
HAGEMAN FACTOR - XII
OTRAS PROTEINAS

Sin Heparina circulante

Activa la cascada de la coagulación

ECMO

Segundos después . . .

MOLECULAR LAYER OF PROTEIN

FIBRINOGENO
ALBUMINA
ALFA GLOBULINA
GAMA GLOBULINA
HAGEMAN FACTOR - XII
OTRAS PROTEINAS

Sin Heparina circulante

Se convierte a fibrina + plaquetas = trombos blancos

Adhesión fuerte a tubos-conectores
Zonas de alteración de flujo
Turbulencia
Distorsión y agregación de plaquetas

MOLECULAR LAYER OF PROTEIN

FIBRINOGENO
ALBUMINA
ALFA GLOBULINA
GAMA GLOBULINA
HAGEMAN FACTOR - XII
OTRAS PROTEINAS

Pre-tratado de circuitos con albúmina

Disminuye unión de otras proteínas al circuito

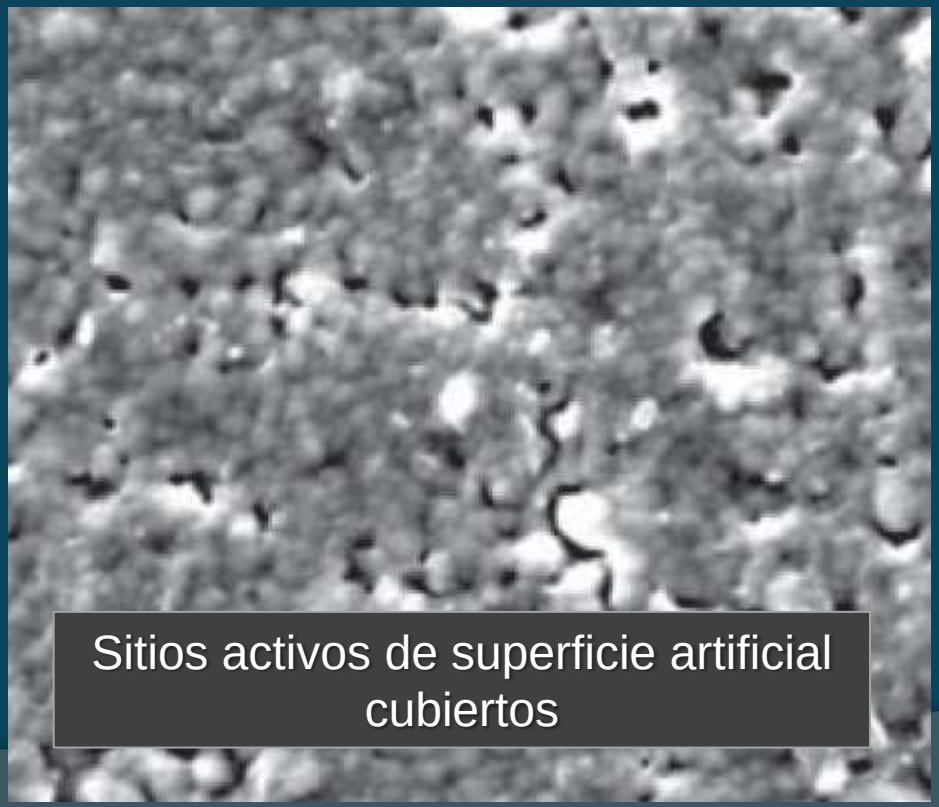
Monocapa de PROTEINAS (albumina)

“protein - water – electrolyte layer”

Evita la adherencia posterior de proteínas

Evita el incremento en tamaño de la capa

Mantenimiento patrones de flujo y resistencia del circuito



Sitios activos de superficie artificial cubiertos

ECMO

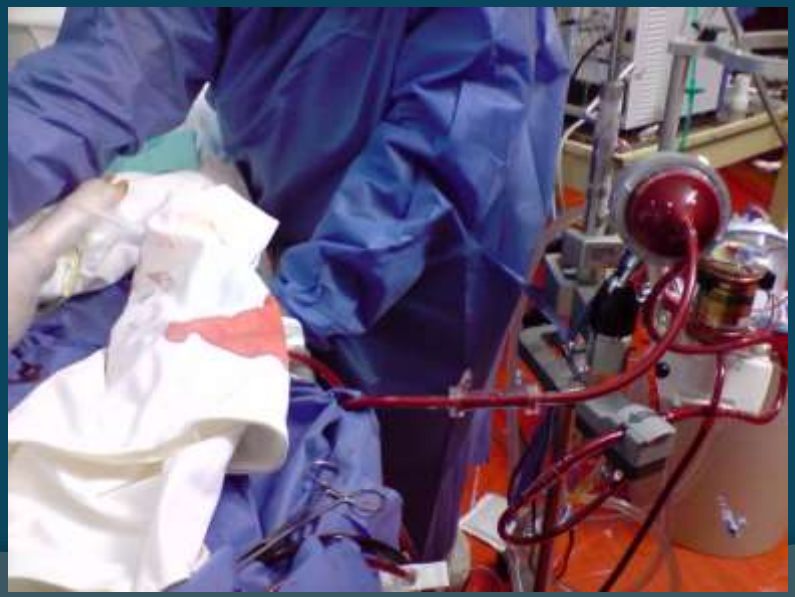
CYTOKINAS CIRCULANTES

~ 1 HORA

- FNTα
- IL 6
- IL 1β

* Más rápido

No es sintetizada de novo



ACTIVACION DEL ENDOTELIO

- FNTα
- IL 6
- IL 1β

Moléculas de superficie

expresadas en membrana celular

favorecen

- fenómenos de rodamiento
- adhesión a la pared endotelial
- penetración de la pared vascular
- migración trans endotelial

ACTIVACION DEL ENDOTELIO

- FNTα
- IL 6
- IL 1β

Moléculas de superficie

expresadas en membrana celular

Moléculas de adhesión

FAMILIA DE LAS SELECTINAS:

selectina E (ELAM 1) selectina L (L ECAM) selectina P (GMP-140

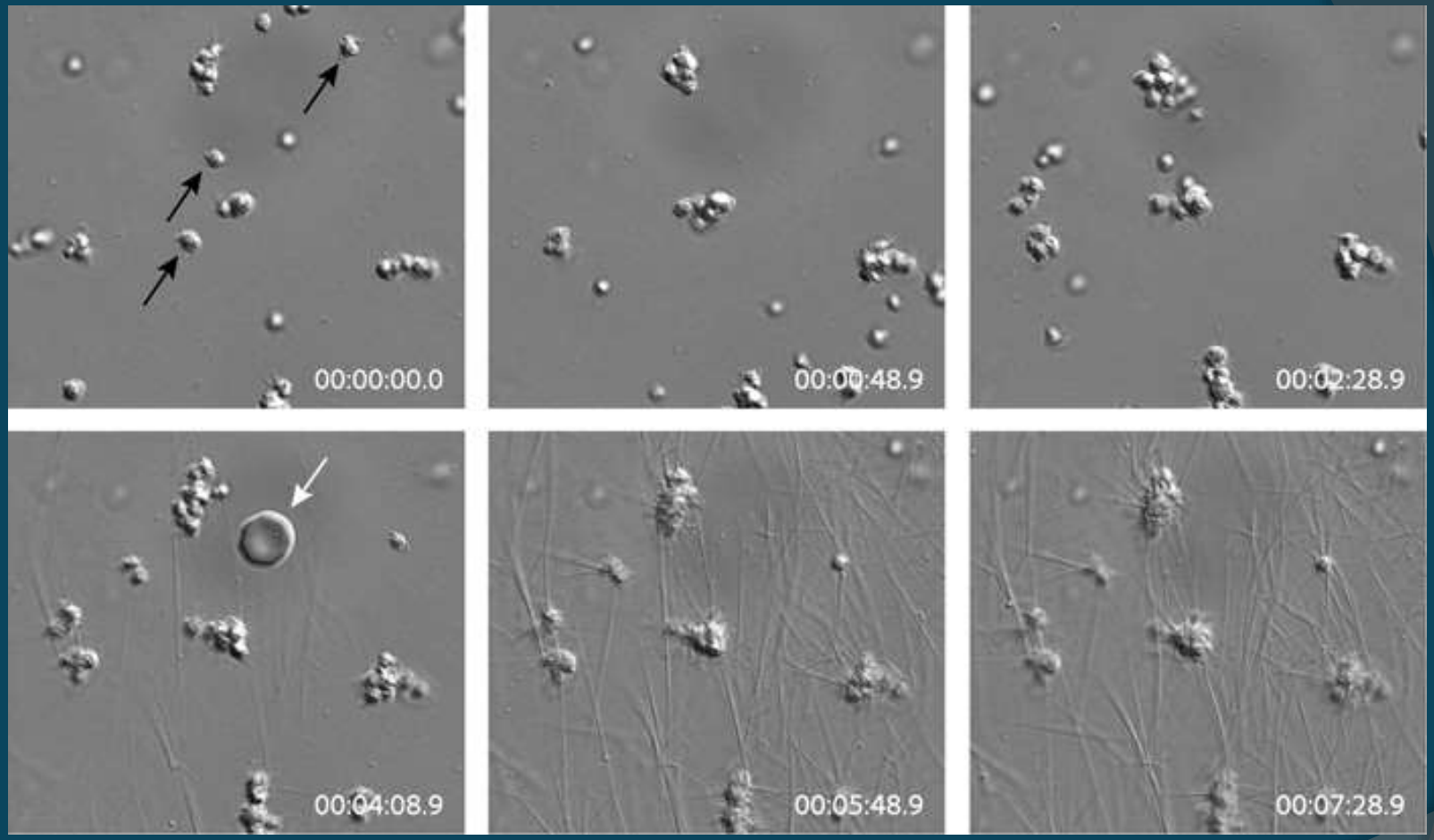
SUPERFAMILIA DE LAS INMUNOGLOBULINAS (IGSF)

VCAM-1 (molécula de adhesión intercelular)

FAMILIA DE LAS INTEGRINAS

CD11 y CD18

ACTIVACION PLAQUETARIA



Time-lapse images visualizing the adhesion of platelets, platelet aggregation and ultimately fibrin network formation on a hydrophilic glass surface.

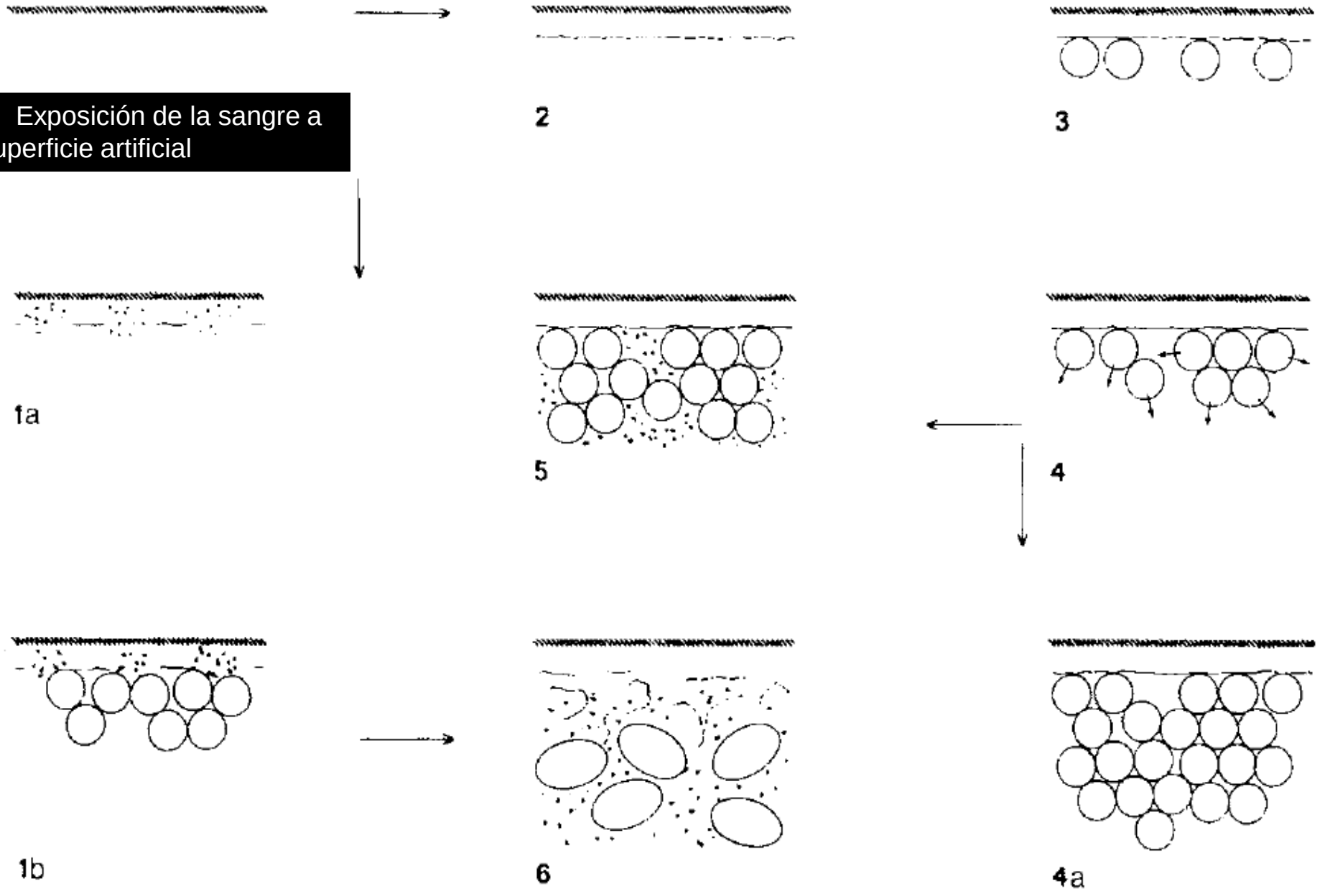
Black arrows: single platelets. White arrow: red blood cell.

The duration of the experiment was 8 minutes.

Images by differential interference contrast (DIC) microscopy

Interaction of a foreign material with blood

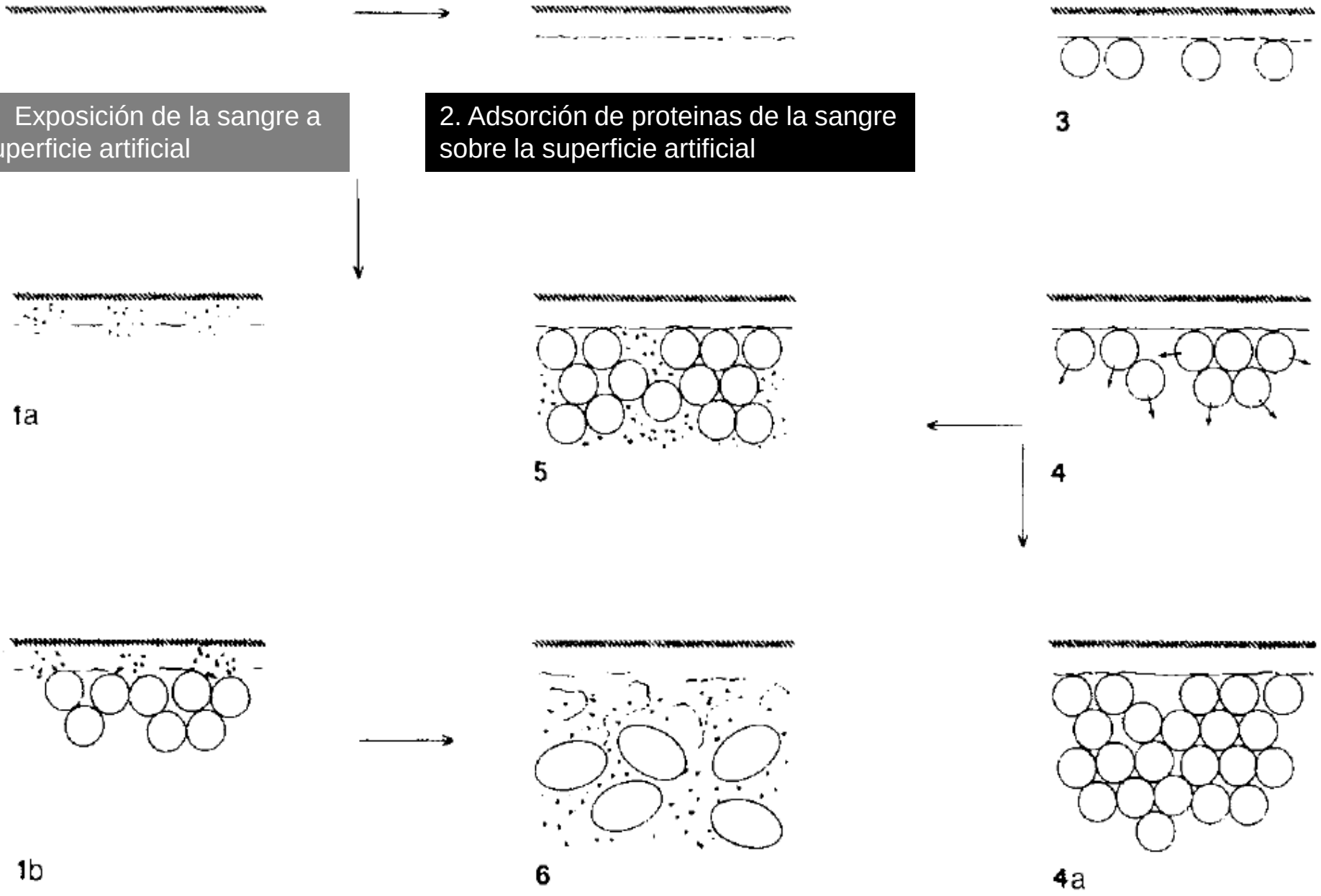
1. Exposición de la sangre a superficie artificial



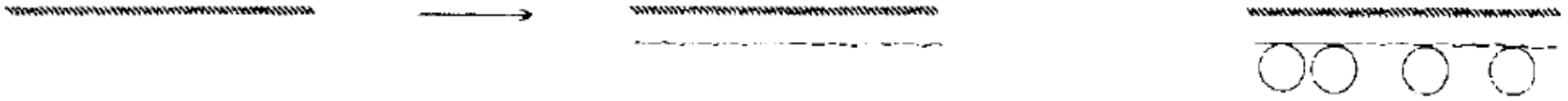
Como interactua la sangre con una superficie artificial

1. Exposición de la sangre a superficie artificial

2. Adsorción de proteinas de la sangre sobre la superficie artificial



Interaction of a foreign material with blood

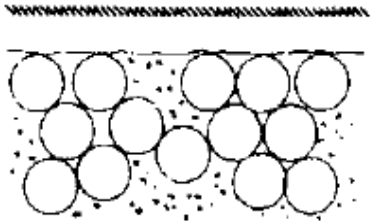


1. Exposición de la sangre a superficie artificial

2. Adsorción de proteinas de la sangre sobre la superficie artificial

3. Adhesión de plaquetas a la capa de proteinas adsorbidas

1a



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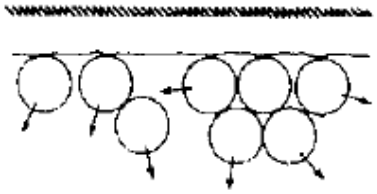

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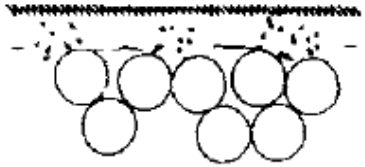
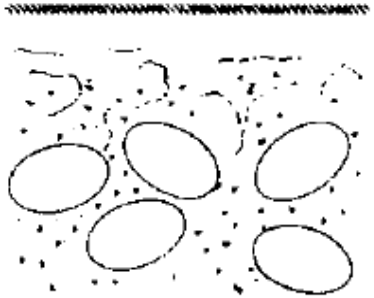


1b



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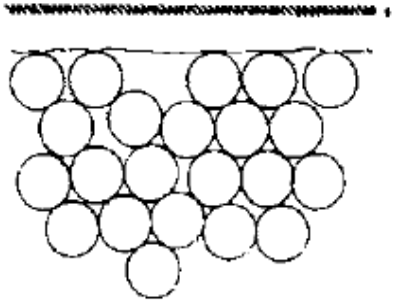
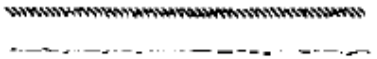


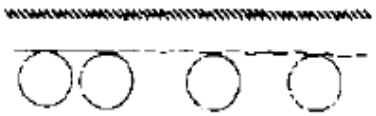
4a

Interaction of a foreign material with blood

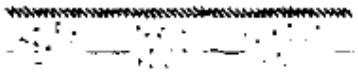
1. Exposición de la sangre a superficie artificial



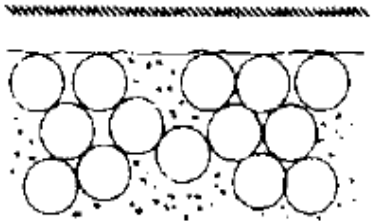
2. Adsorción de proteinas de la sangre sobre la superficie artificial



3. Adhesión de plaquetas a la capa de proteinas adsorbidas



1a



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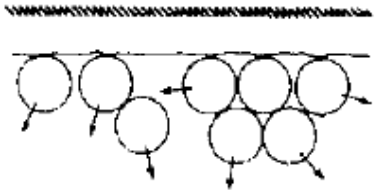
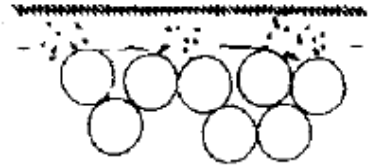


4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario



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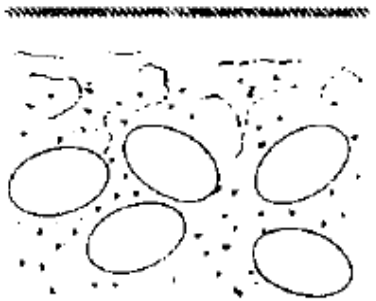

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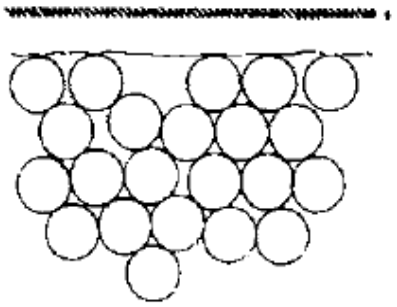
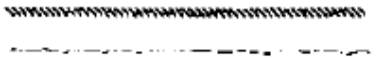


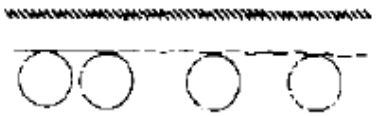
4a

Interaction of a foreign material with blood

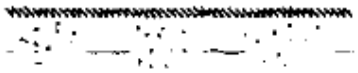
1. Exposición de la sangre a superficie artificial



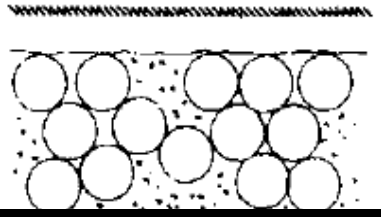
2. Adsorción de proteinas de la sangre sobre la superficie artificial



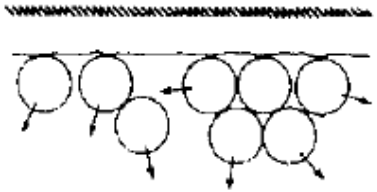
3. Adhesión de plaquetas a la capa de proteinas adsorbidas



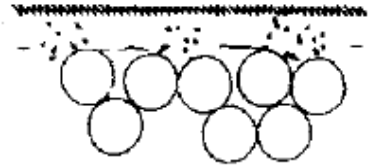
1a



5. la coagulación inicia sobre la superficie de las plaquetas agregadas. Formación de una red insoluble de fibrina



4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario



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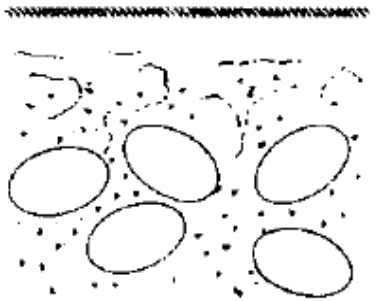

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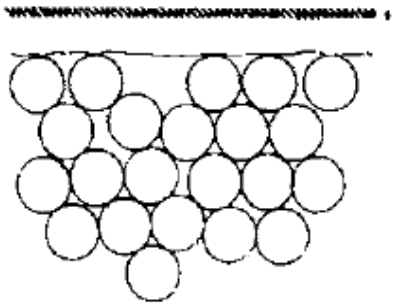
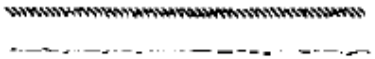


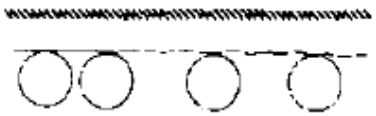
4a

Interaction of a foreign material with blood

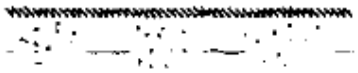
1. Exposición de la sangre a superficie artificial



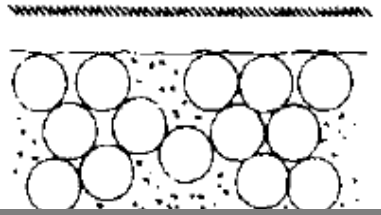
2. Adsorción de proteinas de la sangre sobre la superficie artificial



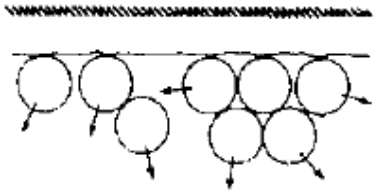
3. Adhesión de plaquetas a la capa de proteinas adsorbidas



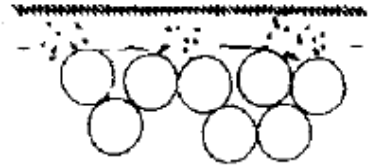
1a



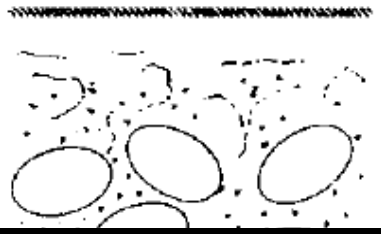
5. la coagulación inicia sobre la superficie de las plaquetas agregadas. Formación de una red insoluble de fibrina



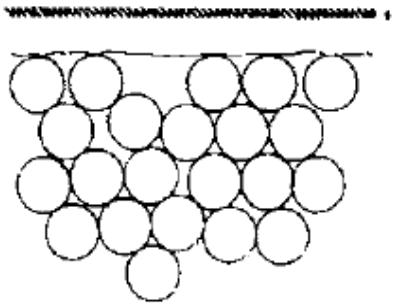
4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario



1b



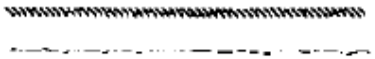
6. Plaquetas individuales pierden su integridad y se fusionan con otras. Fibrina atrapa otras células y se forma un trombo rojo



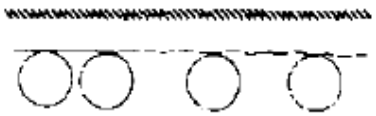
4a

Interaction of a foreign material with blood

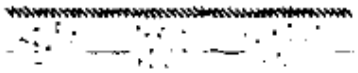
1. Exposición de la sangre a superficie artificial



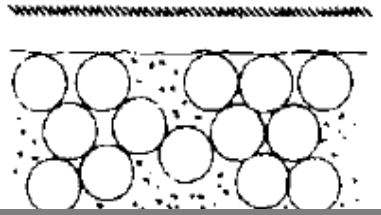
2. Adsorción de proteinas de la sangre sobre la superficie artificial



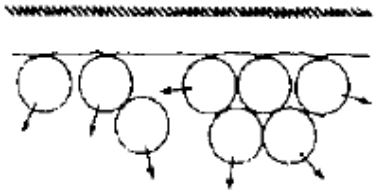
3. Adhesión de plaquetas a la capa de proteinas adsorbidas



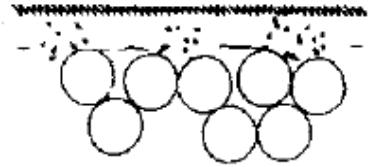
1a



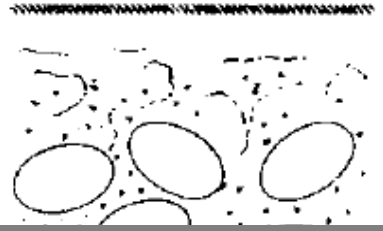
5. la coagulación inicia sobre la superficie de las plaquetas agregadas. Formación de una red insoluble de fibrina



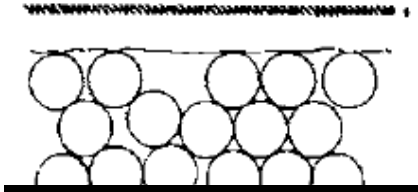
4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario



1b

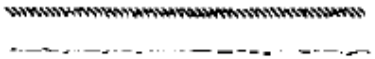


6. Plaquetas individuales pierden su integridad y se fusionan con otras. Fibrina atrapa otras células y se forma un trombo rojo



4a. Formación de un trombo blanco por agregación de plaquetas

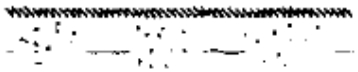
Interaction of a foreign material with blood



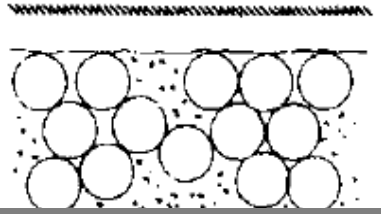
1. Exposición de la sangre a superficie artificial

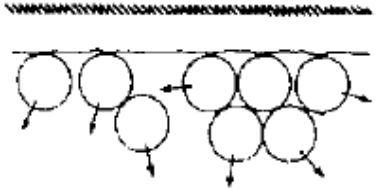
2. Adsorción de proteinas de la sangre sobre la superficie artificial

3. Adhesión de plaquetas a la capa de proteinas adsorbidas



1a

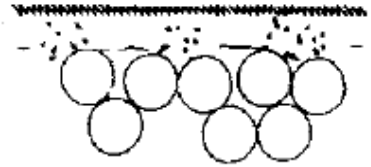


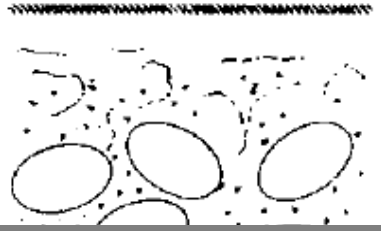


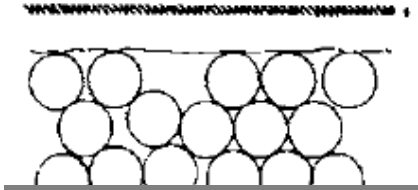
1a se inicia la coagulación por la activación del factor XII sobre la superficie artificial

5. la coagulación inicia sobre la superficie de las plaquetas agregadas. Formación de una red insoluble de fibrina

4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario





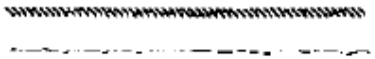


1b

6. Plaquetas individuales pierden su integridad y se fusionan con otras. Fibrina atrapa otras células y se forma un trombo rojo

4a. Formación de un trombo blanco por agregación de plaquetas

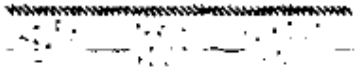
Interaction of a foreign material with blood

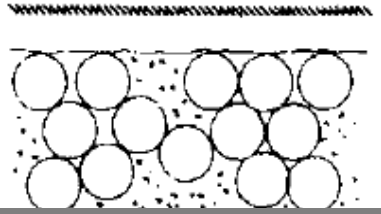


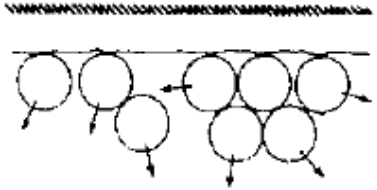
1. Exposición de la sangre a superficie artificial

2. Adsorción de proteinas de la sangre sobre la superficie artificial

3. Adhesión de plaquetas a la capa de proteinas adsorbidas



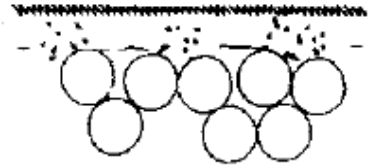


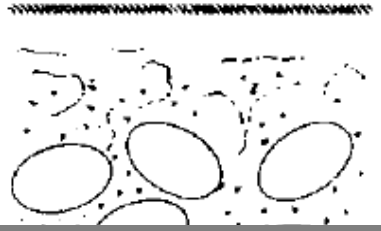


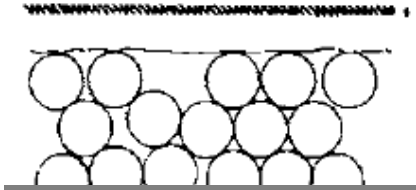
1a se inicia la coagulación por la activación del factor XII sobre la superficie artificial

5. la coagulación inicia sobre la superficie de las plaquetas agregadas. Formación de una red insoluble de fibrina

4. Liberación de ADP y otros constituyentes plaquetarios. Formación de un agregado plaquetario





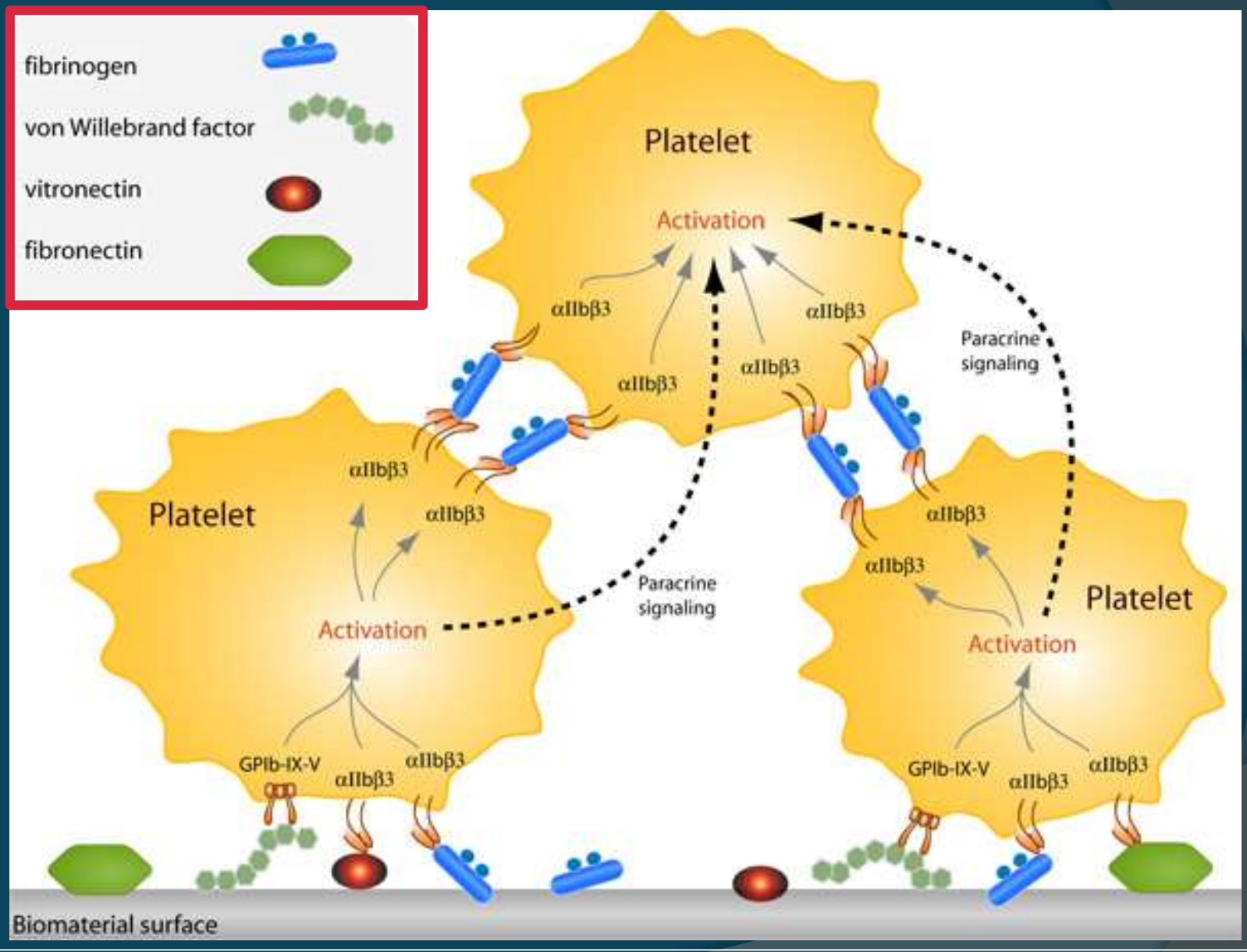


1b: se forma trombina durante el proceso de la coagulación resultando en agragación plaquetaria

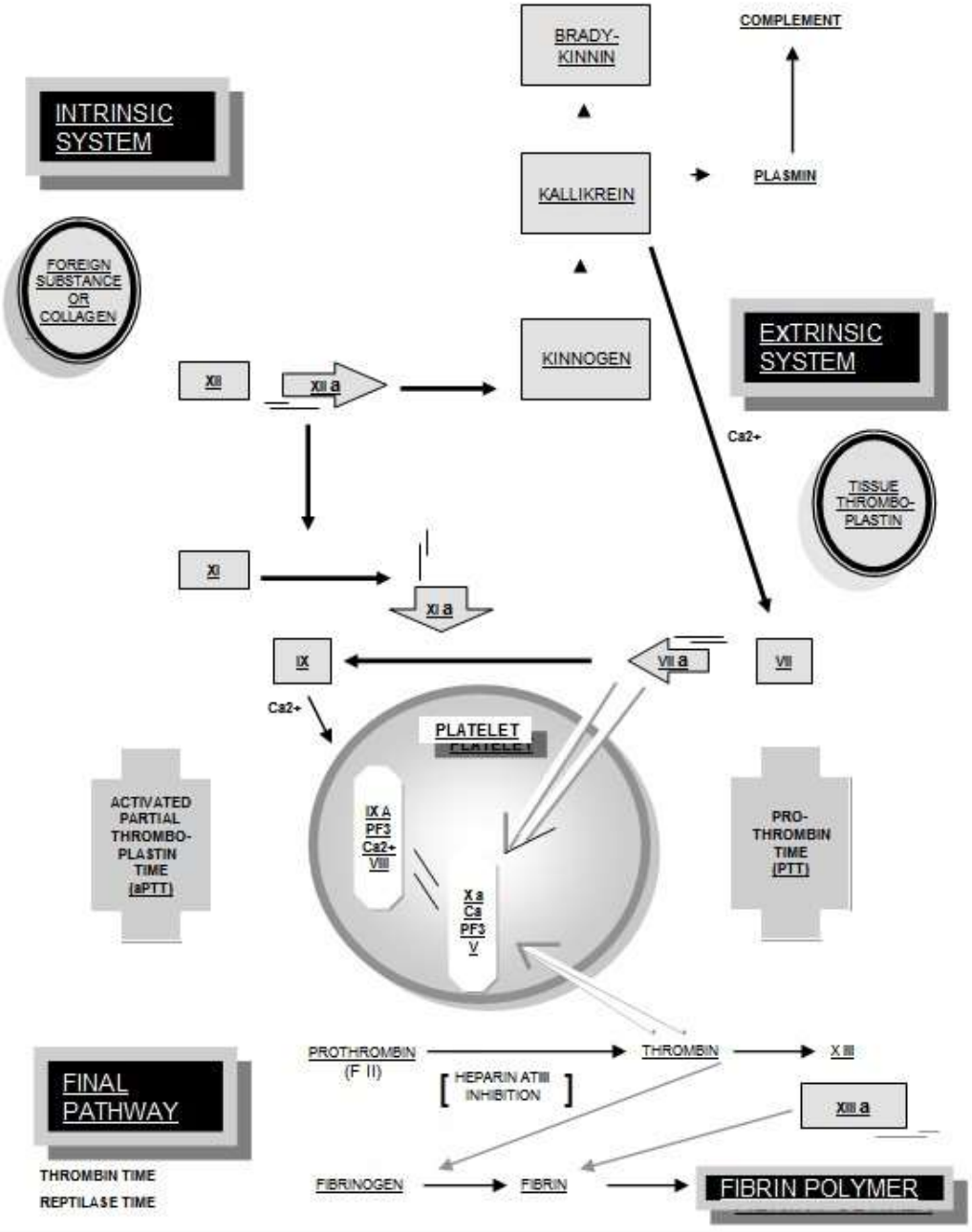
6. Plaquetas individuales pierden su integridad y se fusionan con otras. Fibrina atrapa otras células y se forma un trombo rojo

4a. Formación de un trombo blanco por agregación de plaquetas

ADHESION PLAQUETARIA A SUPERFICIES ARTIFICIALES



Platelets adhere to artificial surface through interaction with surface adsorbed adhesion molecules like fibrinogen, von Willebrand factor, vitronectin and fibronectin

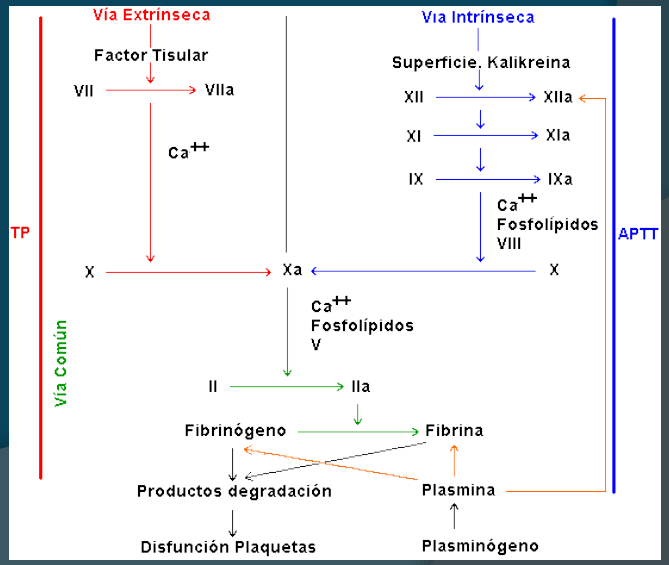


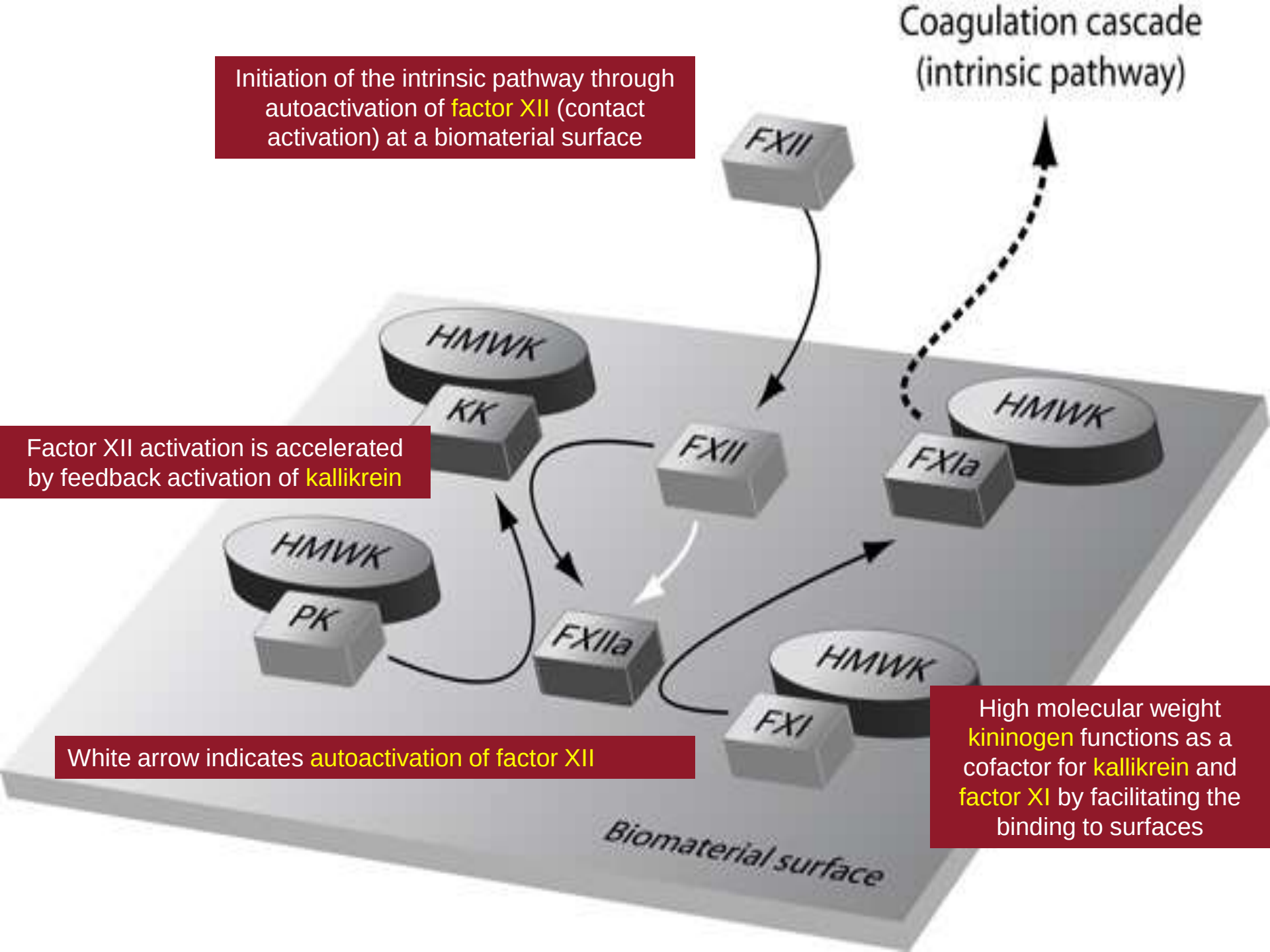
The protein coagulation cascade: Note the very central role of the platelet. Interactions between serum enzyme proteins probably occur on the surface matrix of the platelet. (Speiss, 1993)

Exposicion a superficies artificiales

1. **Coagulation Cascade**
   ~12 proteins

2. **Complement Alternative Pathway**
   >20 proteins



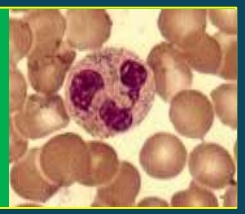

Coagulation cascade
(intrinsic pathway)
Initiation of the intrinsic pathway through autoactivation of factor XII (contact activation) at a biomaterial surface
FXII
HMWK
KK
FXII
FXIa
HMWK
HMWK
PK
FXIIa
HMWK
FXI
Factor XII activation is accelerated by feedback activation of kallikrein
White arrow indicates autoactivation of factor XII
High molecular weight kininogen functions as a cofactor for kallikrein and factor XI by facilitating the binding to surfaces
Biomaterial surface

sangre

contacto

Elementos artificiales

Activación Neutrófilos -PMN



Daño endotelial

Injúria Pulmonar Pós Circulacão Extracorpórea. Stephen C. ClarkPerfusión 21: 225-228,2006

sangre

contacto

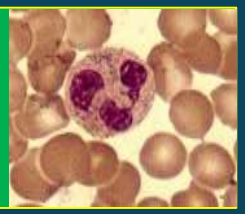
Elementos artificiales

Mediadores proinflamatorios

IL-1, -2, -6, -8 TNFa

Factor de activación plaquetaria

Activación Neutrófilos -PMN



complemento

C3 – C5a

Moléculas de adhesión a superficies

Daño endotelial

Injúria Pulmonar Pós Circulacão Extracorpórea. Stephen C. ClarkPerfusión 21: 225-228,2006

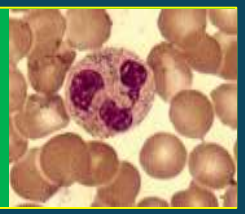
sangre ⟷ contacto ⟷ Elementos artificiales

Mediadores proinflamatorios

IL-1, -2, -6, -8 TNFa

Factor de activación plaquetaria

Activación Neutrófilos -PMN



complemento

C3 – C5a

Moléculas de adhesión a superficies

selectina E
selectina P

moléculas de adhesión celular 1 y 2 (ICAM-1, ICAM-2)
molécula de adhesión celular del endotelio vascular 1 (VICAM-1).

Injúria Pulmonar Pós Circulacão Extracorpórea.
Stephen C. ClarkPerfusión 21: 225-228,2006

sangre

contacto

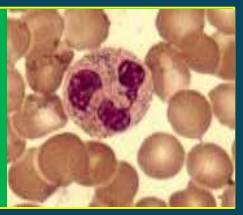
Elementos artificiales

Mediadores proinflamatorios

IL-1, -2, -6, -8 TNFa

Factor de activación plaquetaria

Activación Neutrófilos -PMN



complemento

C3 – C5a

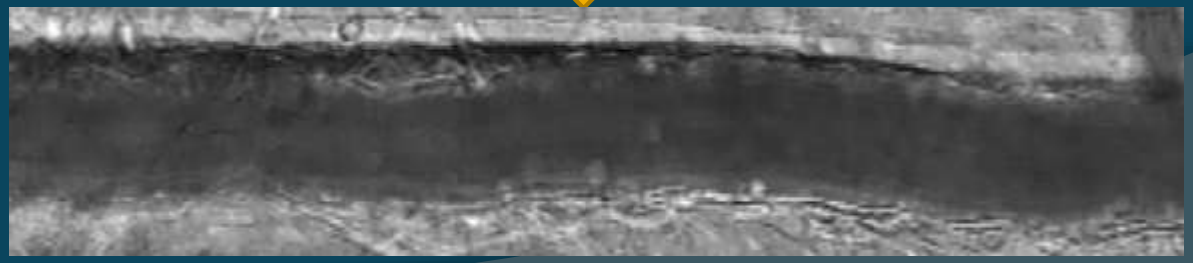
Moléculas de adhesión a superficies

AUMENTAN SU EXPRESIÓN

selectina E
selectina P

ENDOTELIO

moléculas de adhesión celular 1 y 2 (ICAM-1, ICAM-2)
molécula de adhesión celular del endotelio vascular 1 (VICAM-1).



In vivo microcirculatory flow experiments.
Several white blood cells interacting with the vessel wall are evident

sangre

contacto

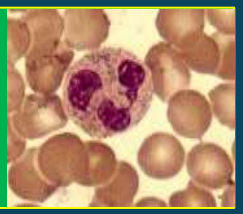
Elementos artificiales

Mediadores proinflamatorios

IL-1, -2, -6, -8 TNFa

Factor de activación plaquetaria

Activación Neutrófilos -PMN



complemento

C3 – C5a

Moléculas de adhesión a superficies

selectina E
selectina P

moléculas de adhesión celular 1 y 2 (ICAM-1, ICAM-2)
molécula de adhesión celular del endotelio vascular 1 (VICAM-1).

PMN ADHERIDOS → MIGRACIÓN

Daño endotelial

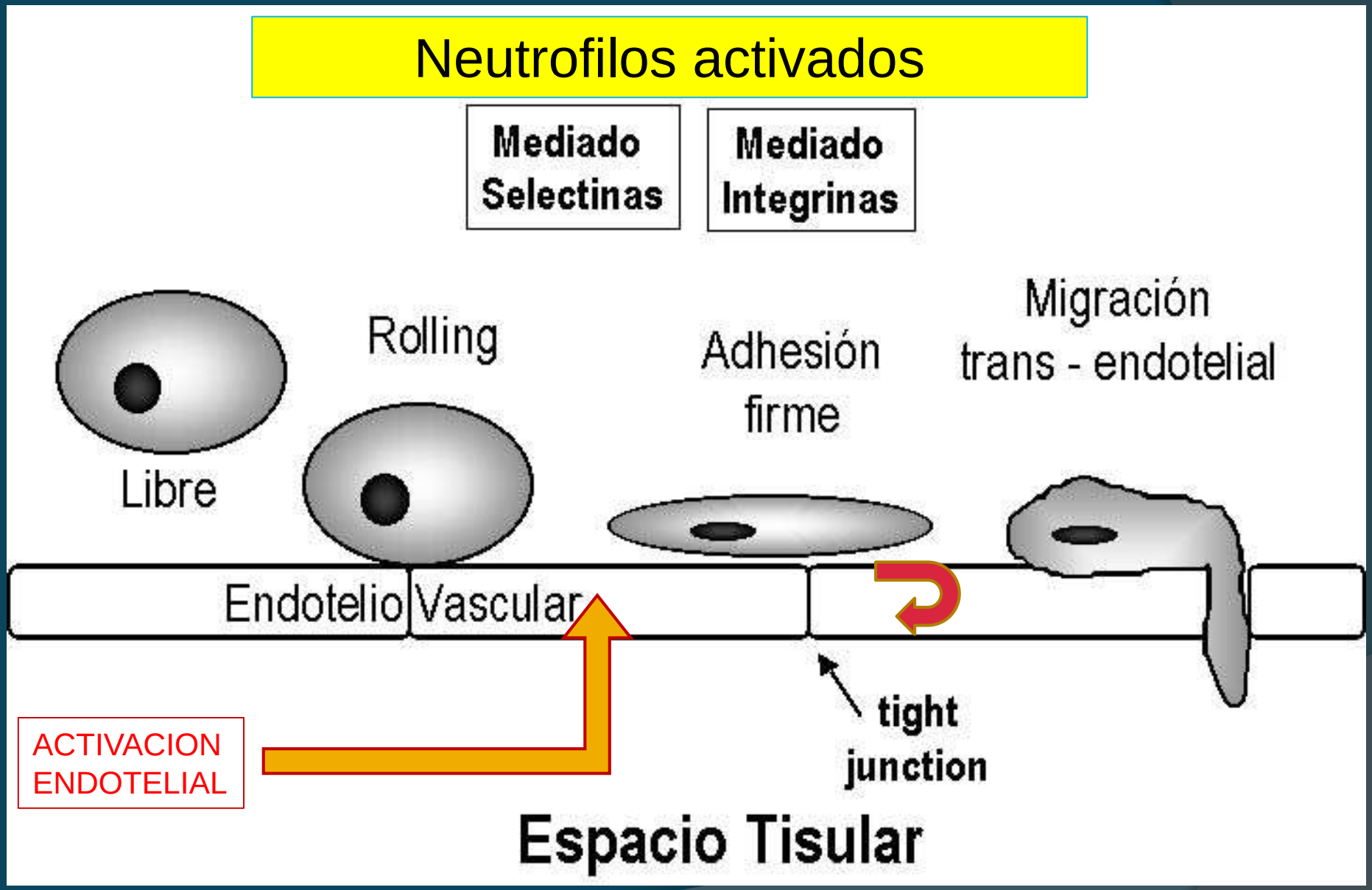
Parenquima pulmonar

IL-8

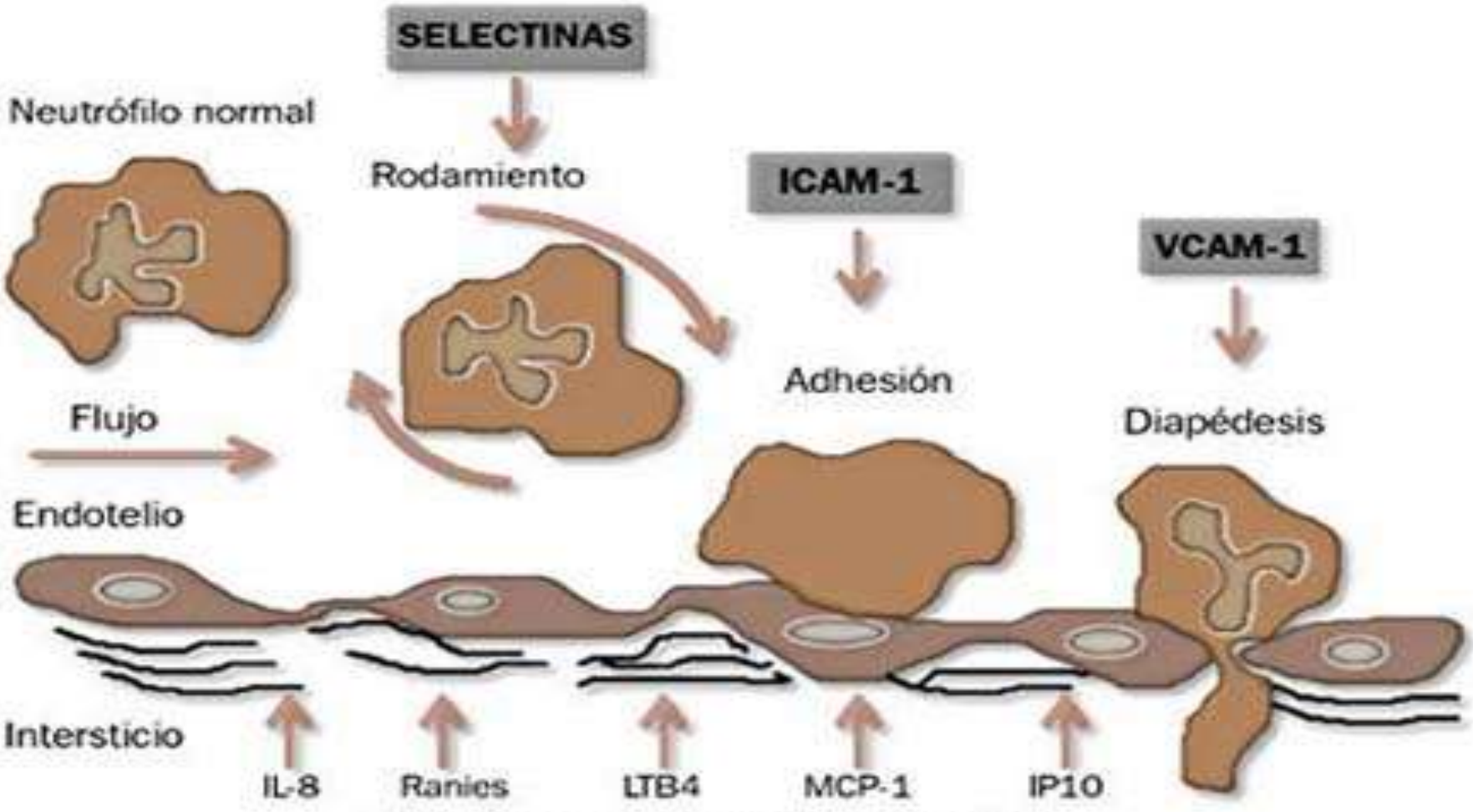
ENDOTELIO PULMONAR

Injúria Pulmonar Pós Circulacão Extracorpórea.
Stephen C. ClarkPerfusión 21: 225-228,2006

Neutrofilos activados



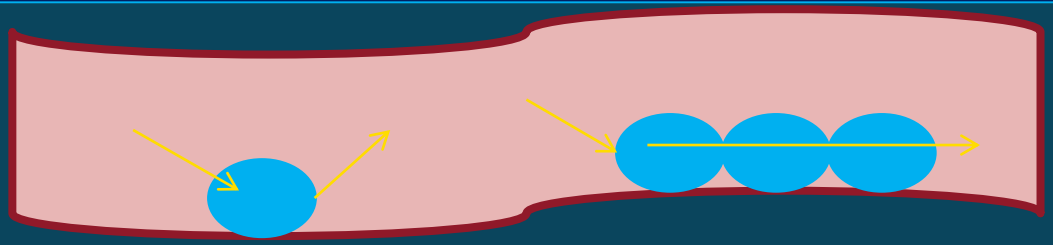
MOLECULAS DE ADHESION CELULAR A SUPERFICIES



CITOQUINAS QUE ATRAEN PMN

Estado de adhesividad endotelial

Encuentro aleatorio de cualquier leucocito con una célula endotelial

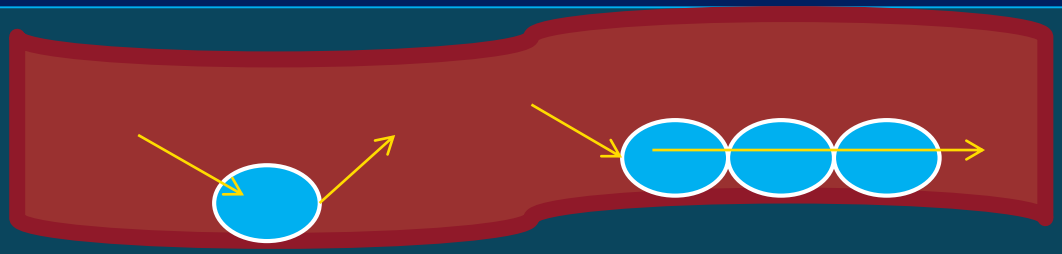


Aumento del tiempo de estancia de los leucocitos con el endotelio

ADHESION SECUENCIAL:
NEUTROFILOS → LINFOCITOS → MONOCITOS

Estado de adhesividad endotelial

Encuentro aleatorio de cualquier leucocito con una célula endotelial

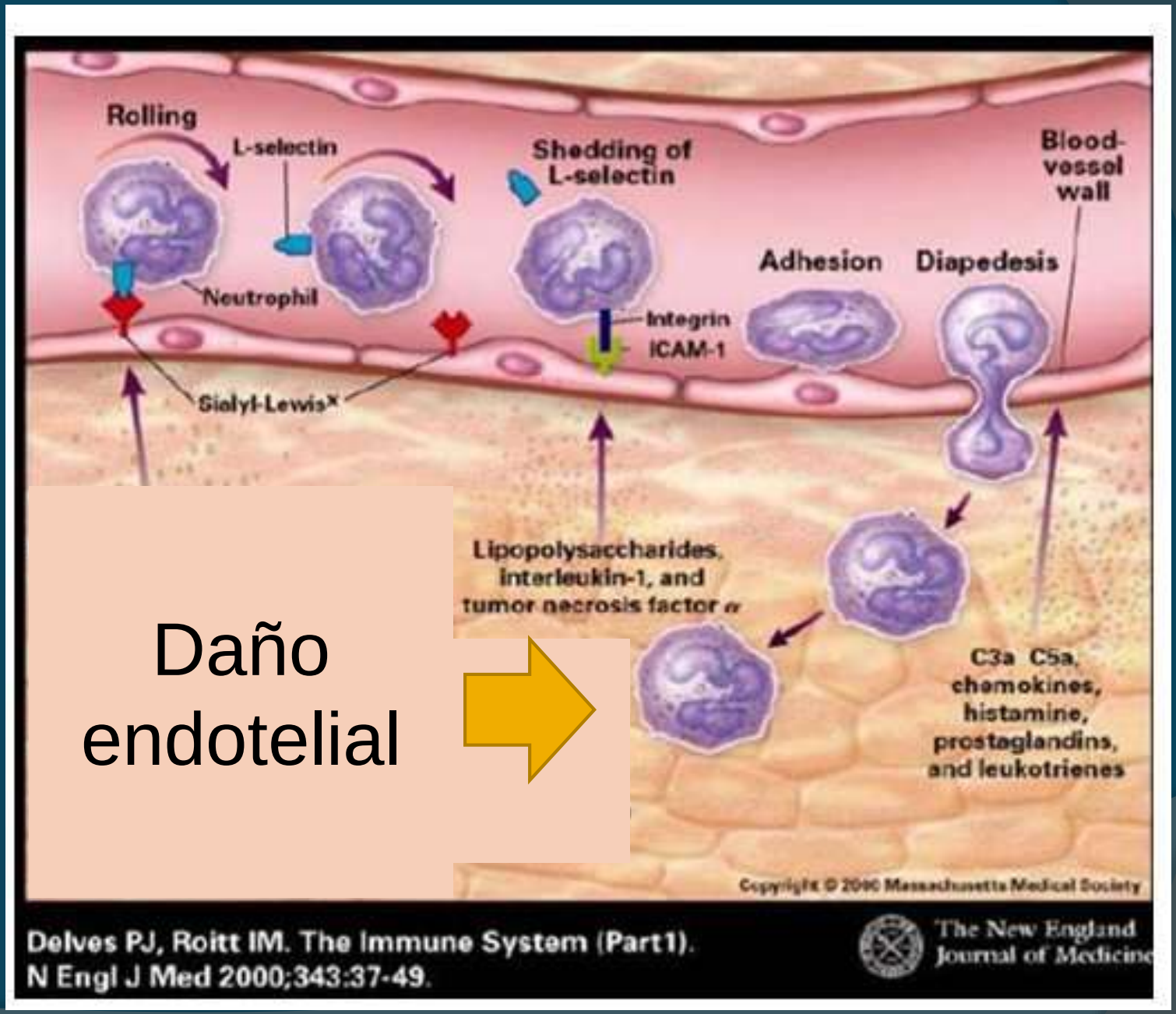


Aumento del tiempo de estancia de los leucocitos con el endotelio

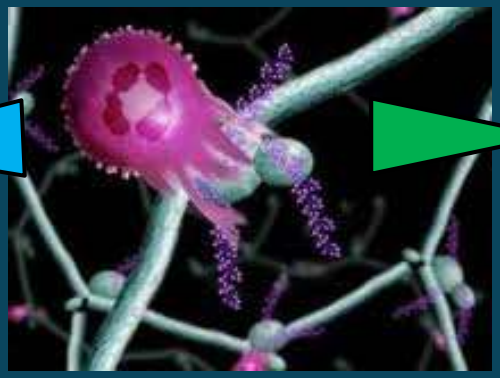
ADHESION SECUENCIAL:
NEUTROFILOS → LINFOCITOS → MONOCITOS

HAPTOTAXIS

Movimiento a favor de un gradiente de moléculas de adhesión


Rolling
L-selectin
Shedding of L-selectin
Blood-vessel wall
Adhesion
Diapedesis
Neutrophil
Integrin
ICAM-1
Sialyl-Lewis^x
Lipopolysaccharides, interleukin-1, and tumor necrosis factor α
C3a C5a, chemokines, histamine, prostaglandins, and leukotrienes
Daño endotelial
Copyright © 2000 Massachusetts Medical Society
Delves PJ, Roitt IM. The Immune System (Part1). N Engl J Med 2000;343:37-49.
The New England Journal of Medicine

Neutrofilos activados



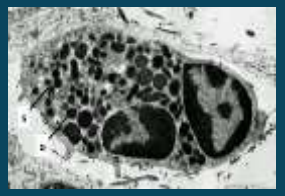
Liberación de radicales libres de oxígeno

Peroxidación lipídica de membrana

Lisis de células endoteliales

permeabilidad y reactividad vascular

Liberación enzimas proteolíticas específicas



elastasa

colagenasa

daño vascular

Permeabilidad endotelial -alveolar

ELASTASA NEUTROFILICA

Marcador útil
-Injuria pulmonar
- Activación de PMN

Injúria Pulmonar Pós Circulacão Extracorpórea.
Stephen C. ClarkPerfusión 21: 225-228,2006

HEMOLISIS EN ECMO

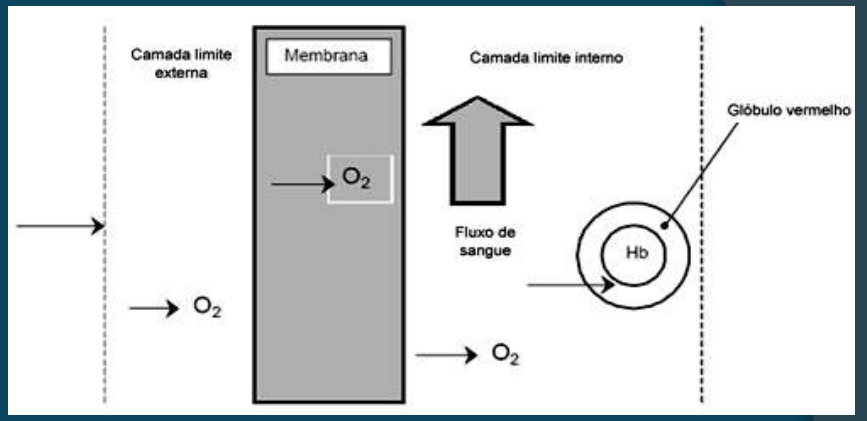
oxigenador

bomba

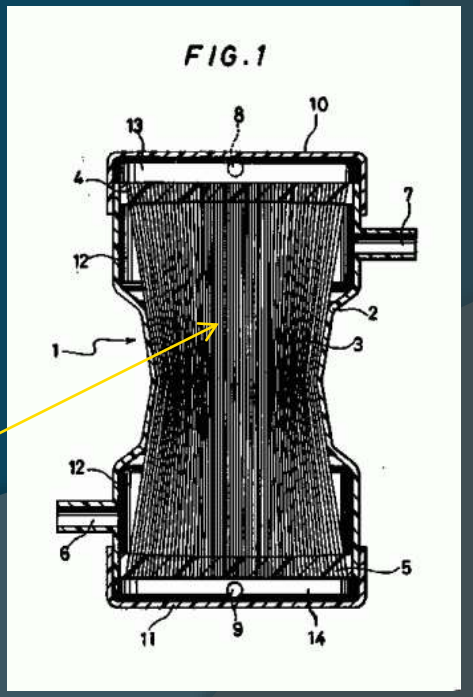
cánulas

Oxigenador de burbujas

Separación de fases gaseosa y acuosa



Oxigenadores de membrana



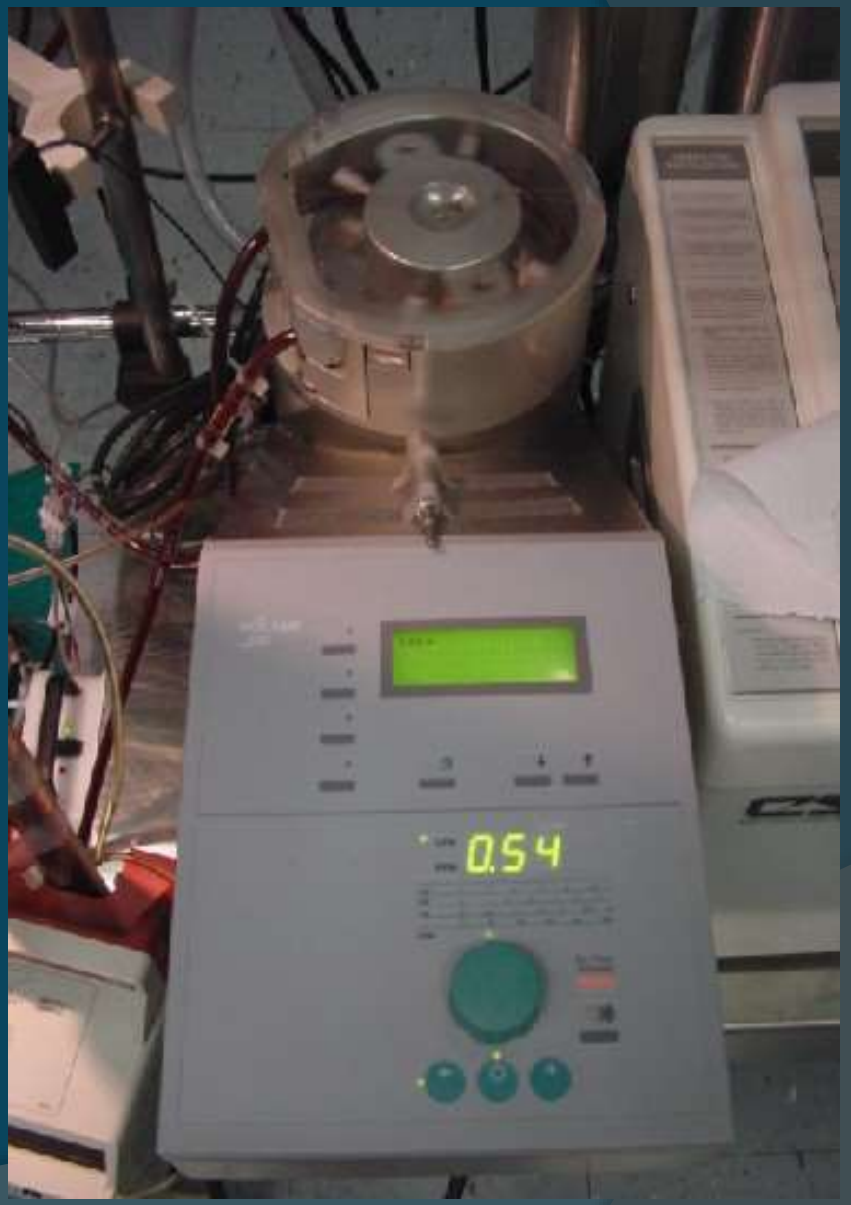
obstrucción

BOMBAS PERISTALTICAS DE RODILLO

compresión progresiva de un tubo elástico contra una carcasa rígida

Generan flujo pulsátil

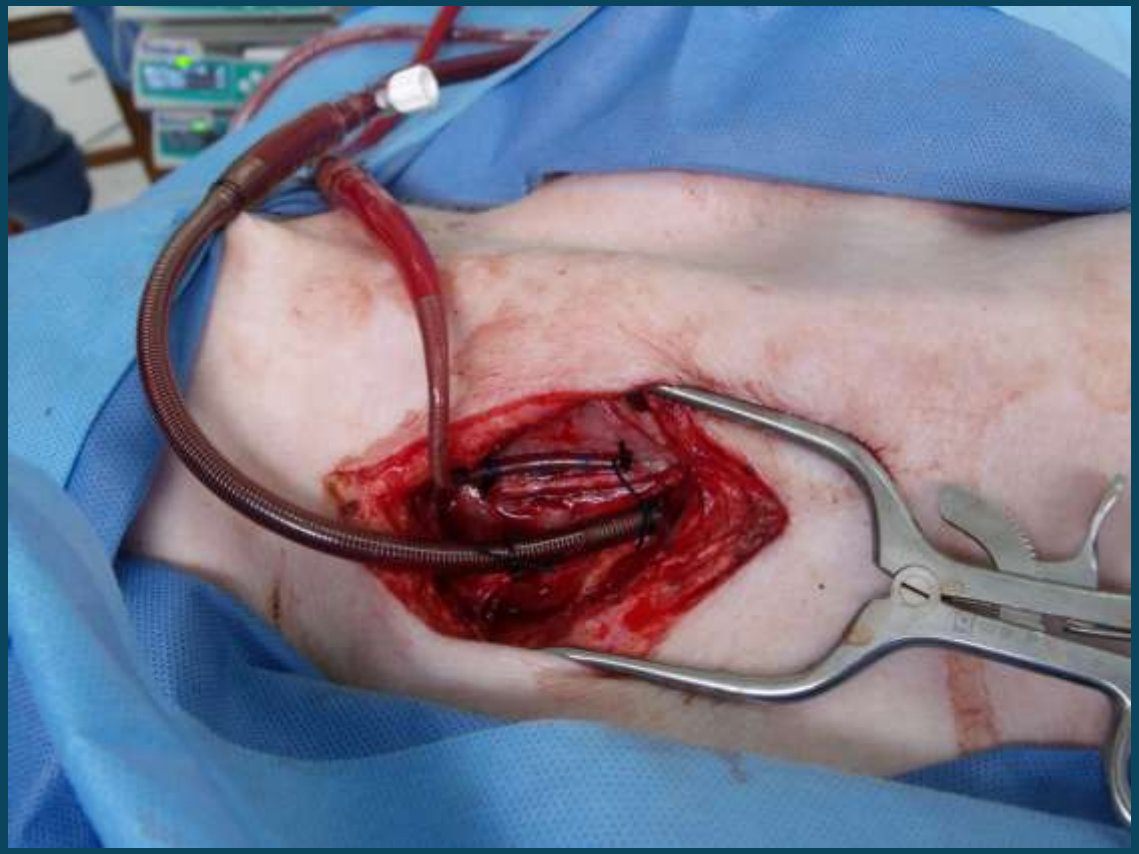
> hemolisis



BOMBAS CENTRIFUGAS

no manejan oclusividad, generando presión negativa

CANULAS



Selección de cánula adecuada

Tamaños pequeños generan flujos altos, mayor resistencia y mayor riesgo de hemolisis

Flujo a una RPM determinada esta en función de la resistencia en la cánula venosa

SHEAR STRESS < 132 dyn/cm2
ΔP < 100 mmHg
ΔP = R (Q, IDL, L)
VENOSO < 50 mmhg
ARTERIAL < 80 mmHg

Hemolisis

Picos de caida de Hb y elevación de DHL

Presentación ususal:

- hemoglobinuria
- caida lenta de Hb

Relación con días en ECMO

Adición de hemofiltro incrementa hemolisis

MINIMIZAR ACTIVACION DE LA SANGRE

CORTICOIDES

APROTININA

NAFAMOSTAT

Controlar mediadores
- Citoquinas
- coagulación
- complemento

LEUCODEPLECION

ANTIOXIDANTES

Controlar efectores

MOLECULAR COATING TECHNOLOGIES

Mejorar biocompatibilidad

MOLECULAR COATING TECHNOLOGIES

Albumina Coating

Heparin Coating

NO Release of Surfaces

CARMEDA

TRILLIUM

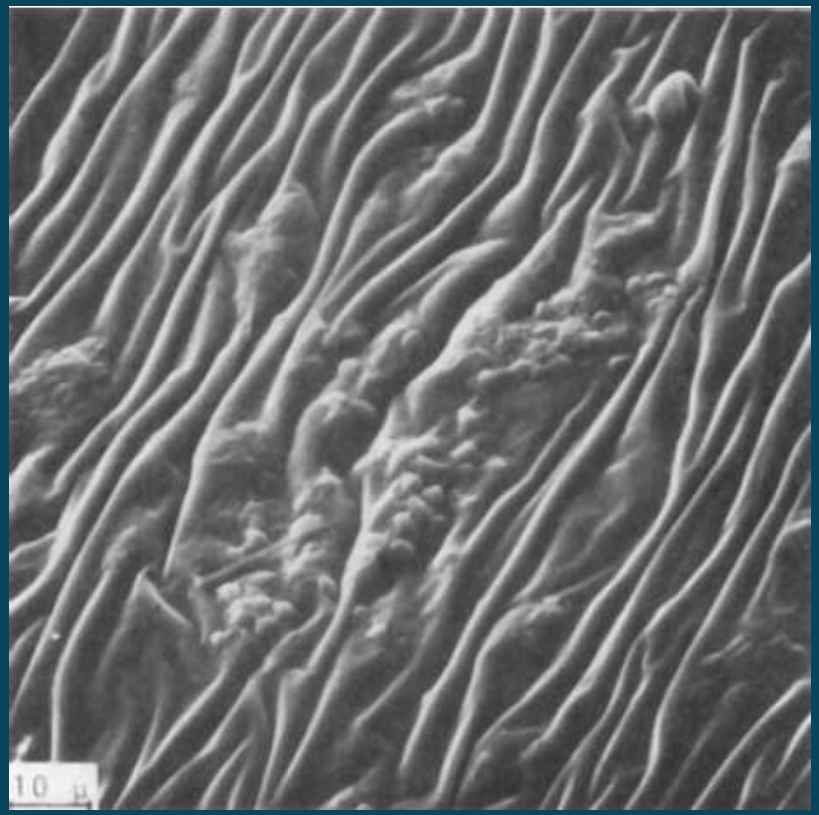
MOLECULAR COATING TECHNOLOGIES

Effect of Preadsorption of Albumin onto Different Surfaces on the Coagulation Time of Plasma

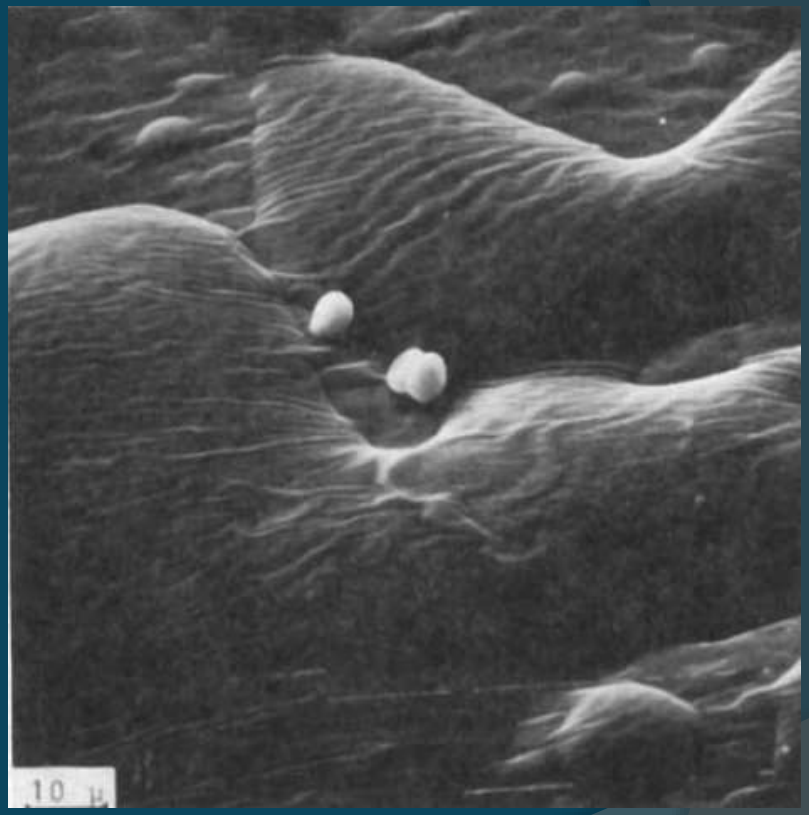
Material	Relative coagulation time in %	Number of experiments
cuprophane	100	10
albumin	115 - 119	3
polystyrene	105	10
albumin	119 - 126	9
glass	53	10
albumin	64 - 69	3

Unión ionica a la superficie de un polímero por medio de un agente de acoplamiento adsorbente

MOLECULAR COATING TECHNOLOGIES



PVC exposed to blood in the flow cell for 5 min (flow rate 1 ml/min). Many aggregated platelets with pseudopods adhere to the irregular surface



PVC coated with a complex of P and TDMAC. The surface has been exposed to blood in the flow cell for 5 min (flow rate 1 ml/min). Three erythrocytes adhere to the surface; no platelets are present upon this surface area

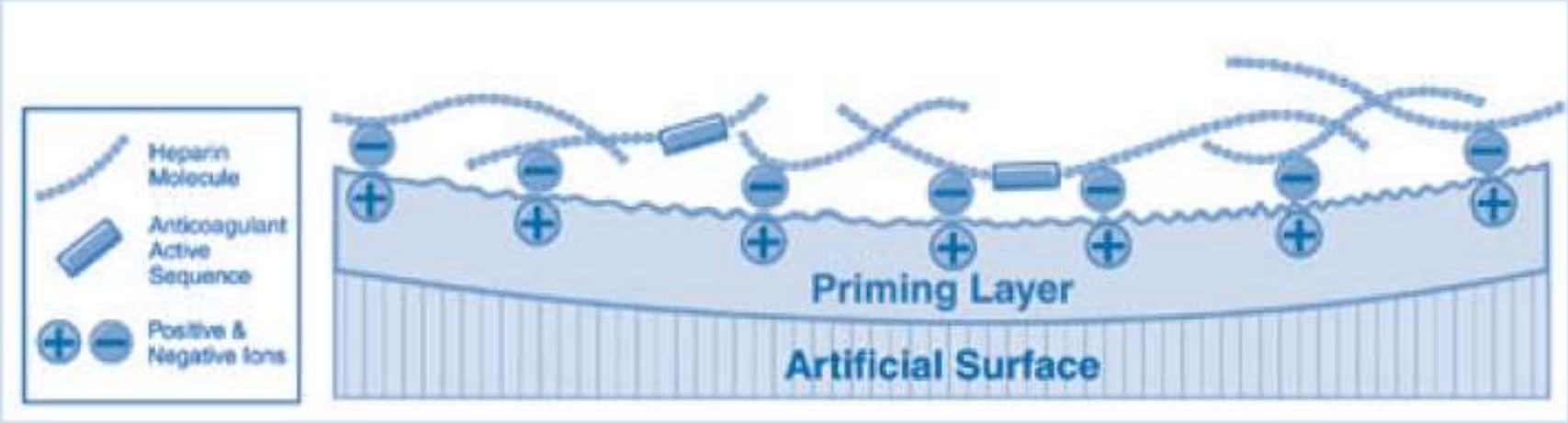
MOLECULAR COATING TECHNOLOGIES

Adhesion of Platelets and Activation of Intrinsic Coagulation

Material	Adhering platelets on 0.01 mm^2	PTT - value (polystyrene = 100%)
glass	34 (20 - 59)	66
polystyrene	14 (8 - 21)	100
PVC, uncoated	16 (13 - 18)	100
PVC/P-TDMAC	3 (0 - 5)	105

MOLECULAR COATING TECHNOLOGIES

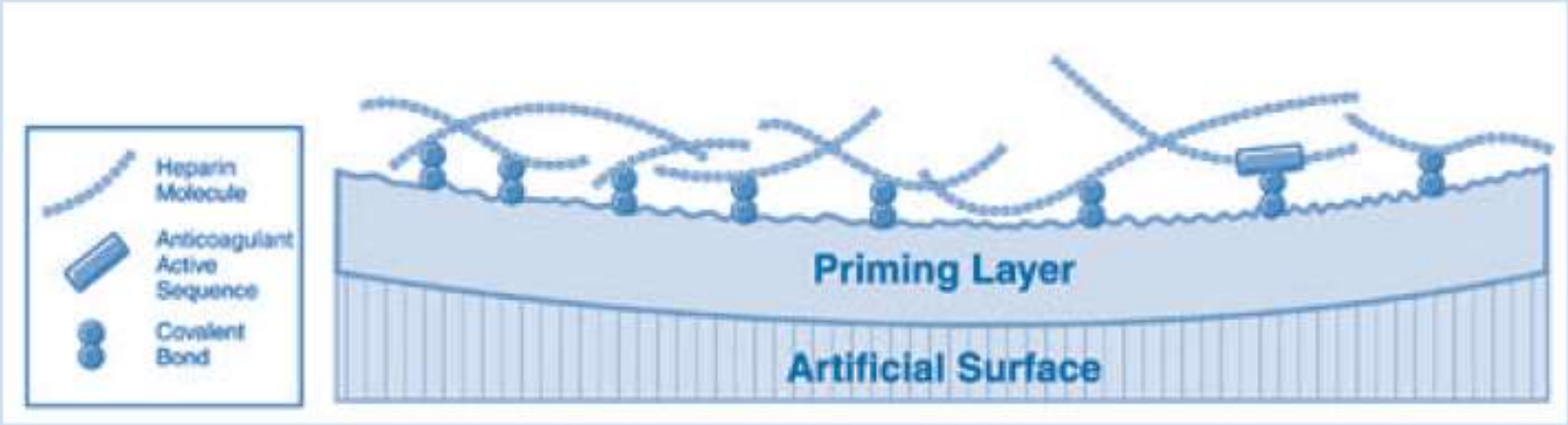
HEPARINA UNIDA IONICAMENTE



Ionically bonded heparin is less stable and tends to wash off when blood flows through the CPB Circuit.

MOLECULAR COATING TECHNOLOGIES

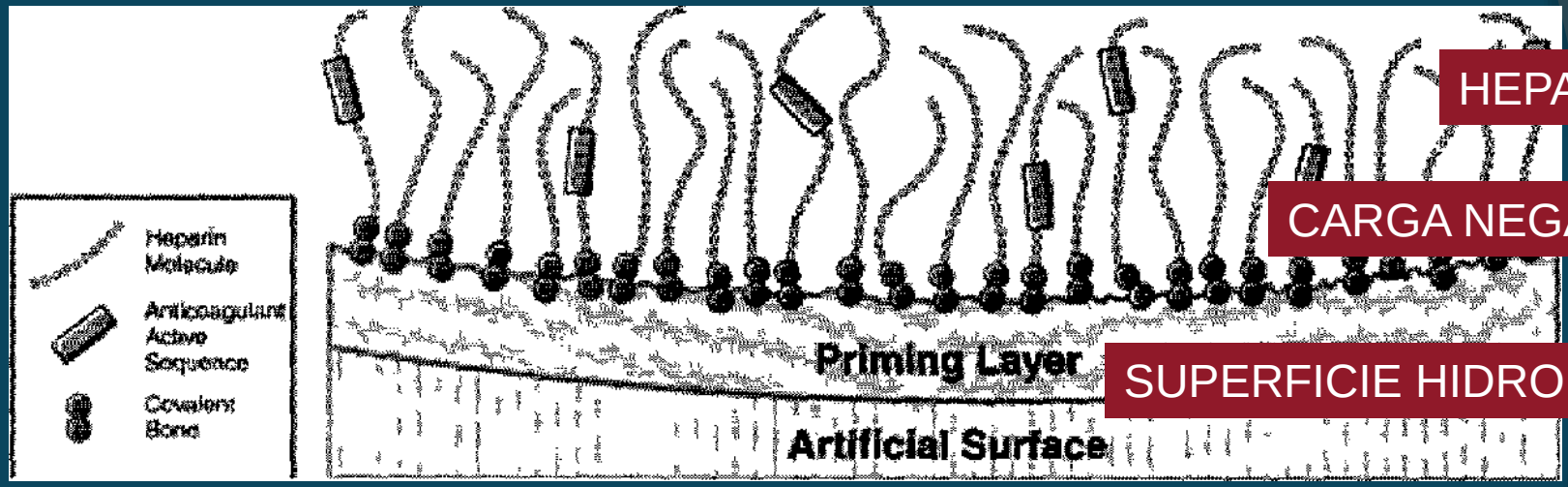
HEPARINA UNIDA COVALENTEMENTE



Covalent bonds are more stable but the heparin's anticoagulant active sequence may become involved in the bond and therefore unavailable to interact with blood.

MOLECULAR COATING TECHNOLOGIES

Carmeda® BioActive Surface



HEPARINA

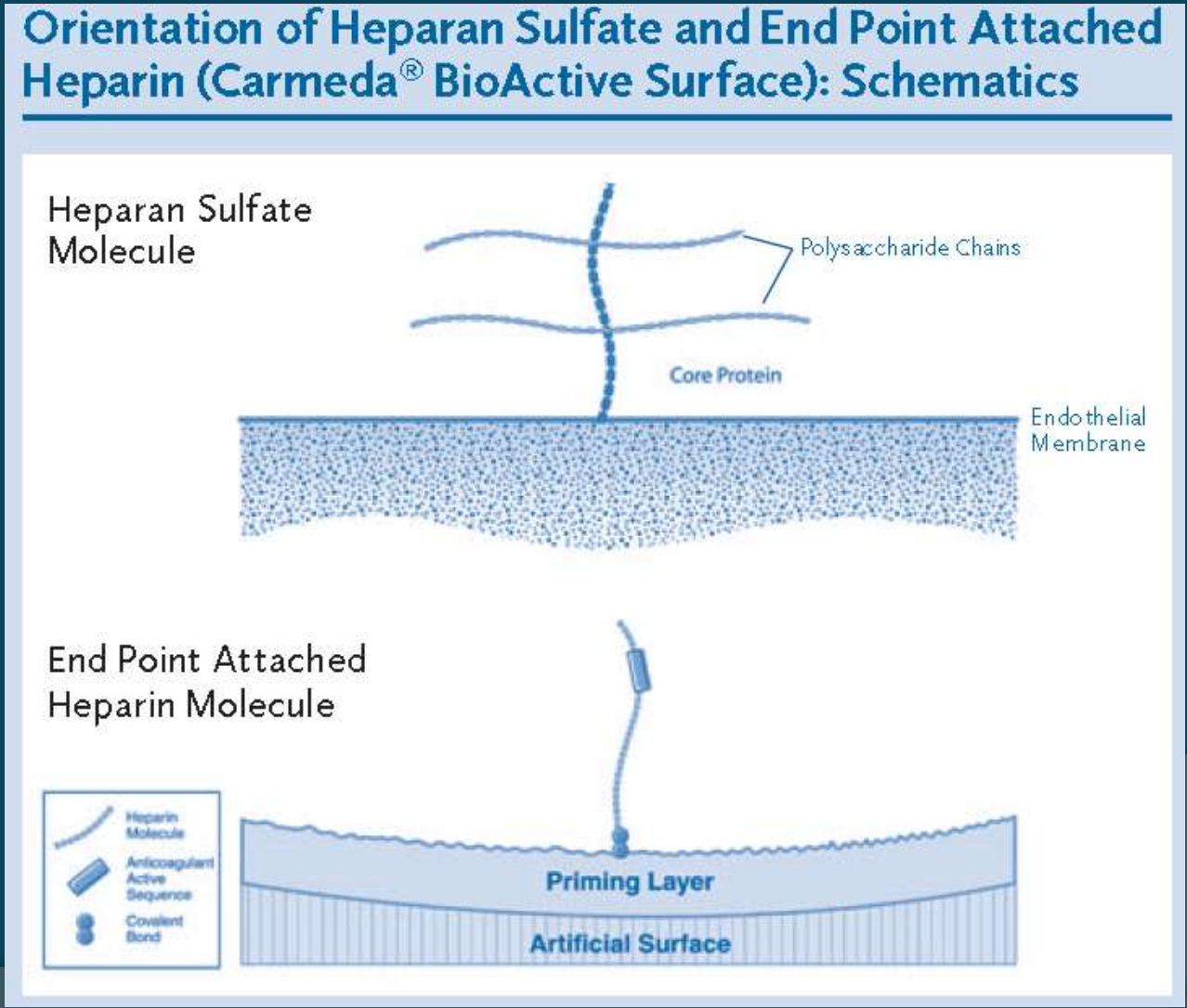
CARGA NEGATIVA

SUPERFICIE HIDROFILICA

Durable, non-leaching End Point Attached heparin biosurface that mimics heparan sulfate naturally found on the vascular endothelium lining the circulatory system to provide thromboresistance and biocompatibil

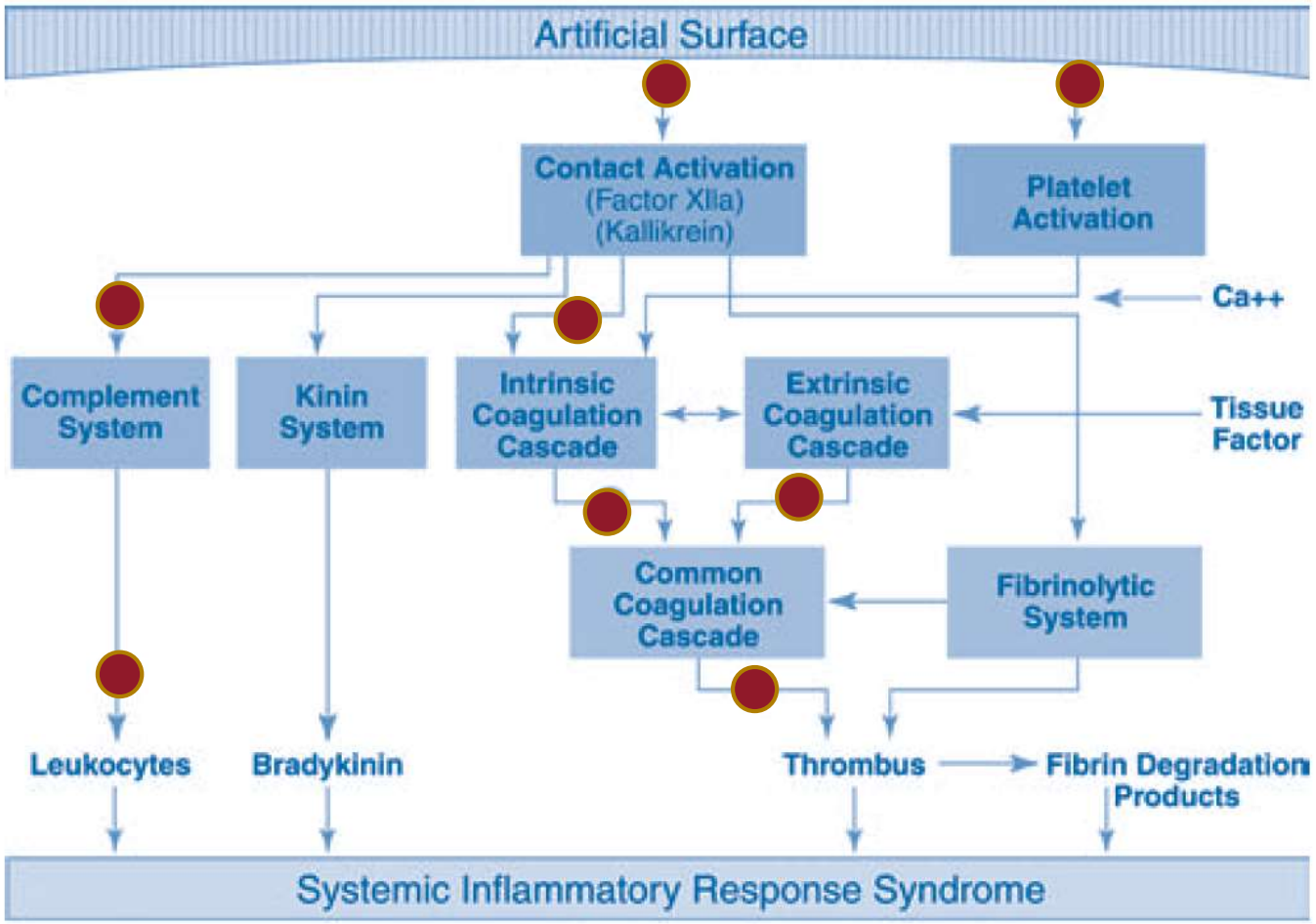
MOLECULAR COATING TECHNOLOGIES

Carmeda® BioActive Surface



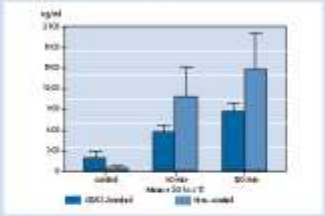
MOLECULAR COATING TECHNOLOGIES

Impact of Carmeda® BioActive Surface on the Human Body Defense Systems



Complement System

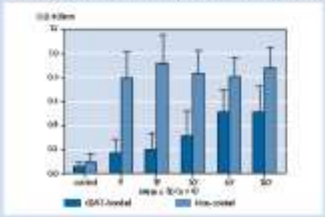
Terminal Complement Complex (soluble marker)



Significantly less terminal complement complex formation occurred with Carmeda® BioActive Surface bonding, indicating less complement activation.

($p < 0.05$)

C3-Complement (surface adsorbed marker)

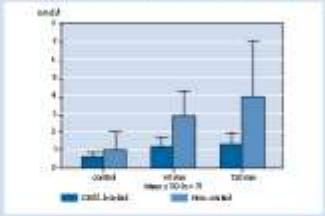


Significantly reduced complement activation occurred with End Point Attached heparin, suggested by reduced surface adsorption of complement protein C3 on the Carmeda® BioActive Surface bonded samples.

($p < 0.01$)

Coagulation System

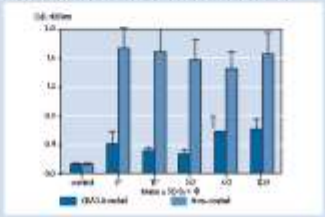
Prothrombin Fragment 1+2 (soluble marker)



Less coagulation activation occurred with Carmeda® BioActive Surface bonding, suggested by significantly lower prothrombin fragment F1+2 levels.

($p < 0.01$)

Fibrinogen (surface adsorbed marker)

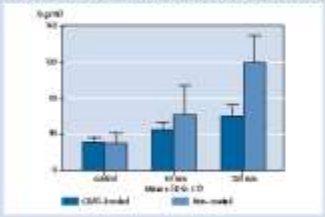


Significantly lower adsorption of fibrinogen on the Carmeda® BioActive Surface bonded surfaces occurred, compared to uncoated surfaces, also provided evidence of reduced thrombogenicity with End Point Attached heparin.

($p < 0.01$)

Neutrophils

PMN-elastase-alpha 1-PI (soluble marker)

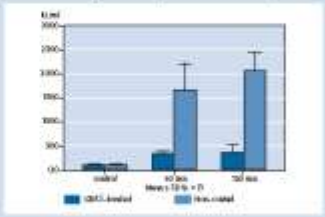


The Carmeda® BioActive Surface group had significantly lower PMN-elastase release, indicating less neutrophil activation.

($p < 0.05$)

Platelets

β-Thromboglobulin (soluble marker)

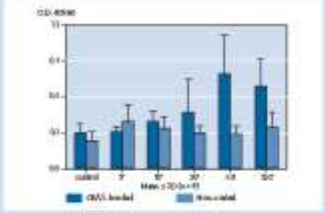


Levels of βTG were five times greater in the uncoated samples compared to the Carmeda® BioActive Surface bonded samples, suggesting less platelet activation with use of End Point Attached heparin surfaces.

($p < 0.01$)

Kallikrein System

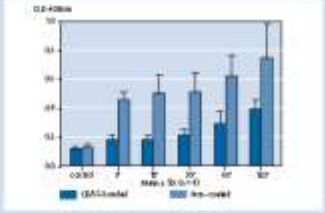
High-molecular-weight-kininogen (surface adsorbed marker)



Improved hemocompatibility, suggested by significantly greater surface adsorption of the contact factor high-molecular-weight Kininogen (HMWK), was found with Carmeda® BioActive Surface bonding.

($p < 0.05$)

Fibronectin (surface adsorbed marker)

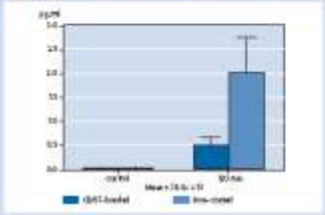


Reduced thrombogenicity on Carmeda® BioActive Surface bonded surfaces was suggested by significantly lower adsorption of the plasma protein fibronectin.

($p < 0.01$)

Cytokines

Interleukin 1-β (soluble marker)



Blood cell secretion of the pro-inflammatory cytokine IL-1β was significantly reduced in the Carmeda® BioActive Surface samples.

($p < 0.01$)

Comparison of soluble markers and surface adsorbed markers of blood activation measured in samples taken from Carmeda® BioActive Surface bonded and uncoated test loops through which heparinized human whole blood was circulated for up to 120 minutes. Carmeda® BioActive Surface (CBAS) was found to favorably alter the composition of surface adsorbed proteins and was also associated with a reduction in complement, coagulation, neutrophil and platelet activation (Weber N. Biomaterials 2002; 23:429-439).

Hemocompatibility of Carmeda® BioActive Surface: Comparison of Soluble and Surface Adsorbed Markers of Hemocompatibility

Weber N. Biomaterials 2002; 23:429-439

GOLD STANDAR

EVOLUCION DEL SOPORTE DE VIDA EXTRACORPOREO

Separación de faces hemática y gaseosa

Niveles más bajos de anticoagulación

Membranas con mayor eficiencia oxigenatoria

Mejoras en la interface

Biocompatibilidad

oxigenador de membrana

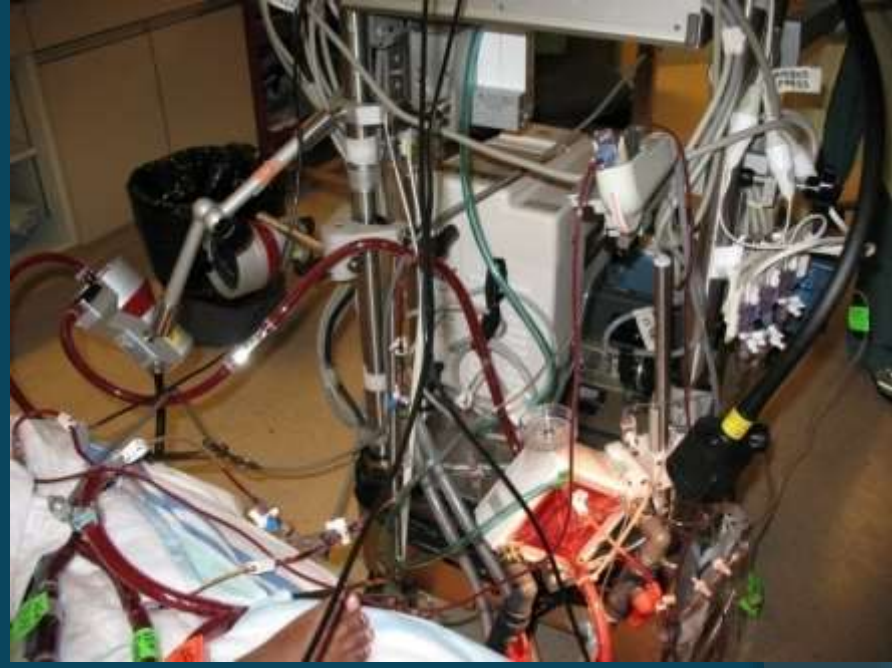
Bombas centrífugas

Disminución del daño de los componentes de la Sangre

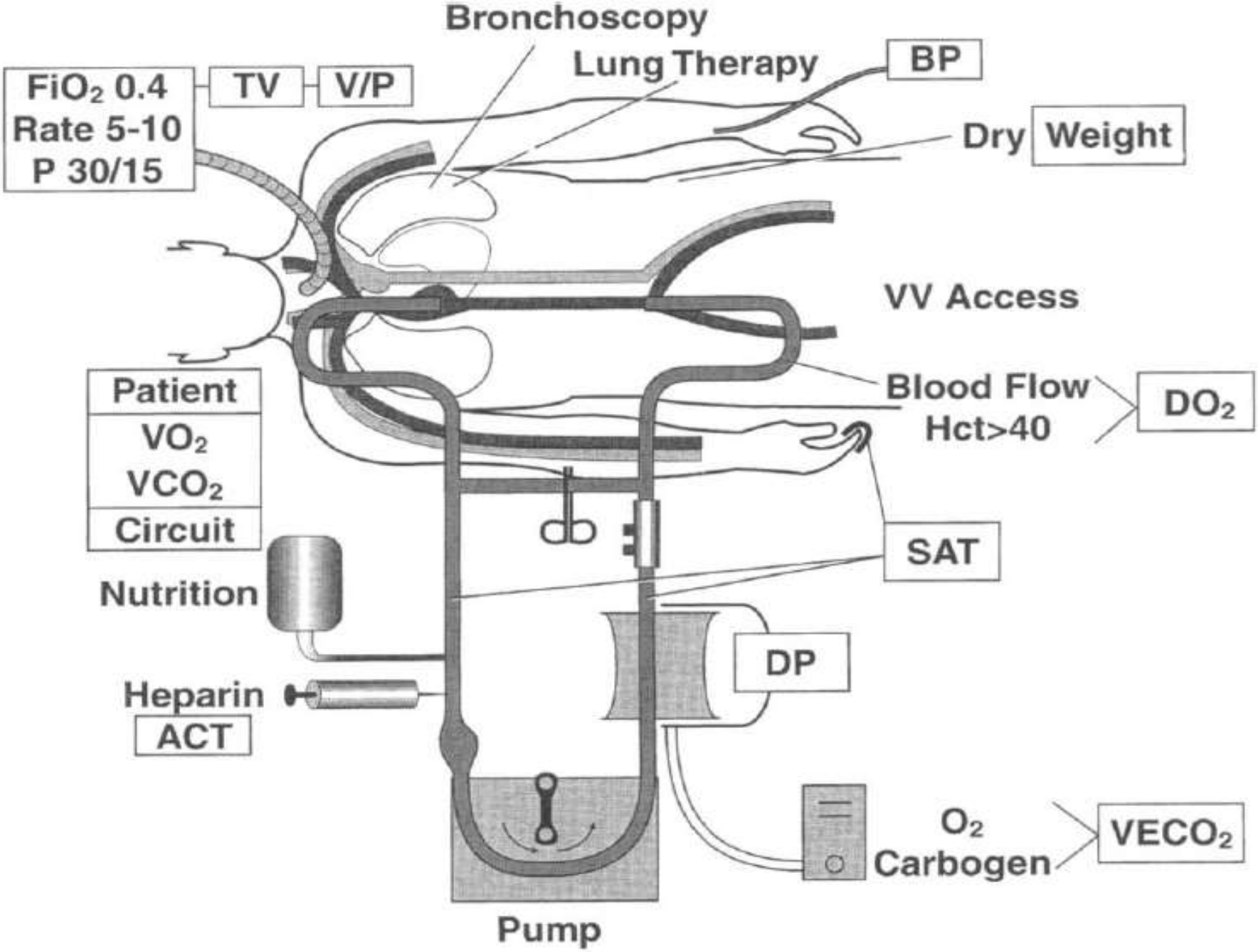
Tiempo más prolongado de perfusión

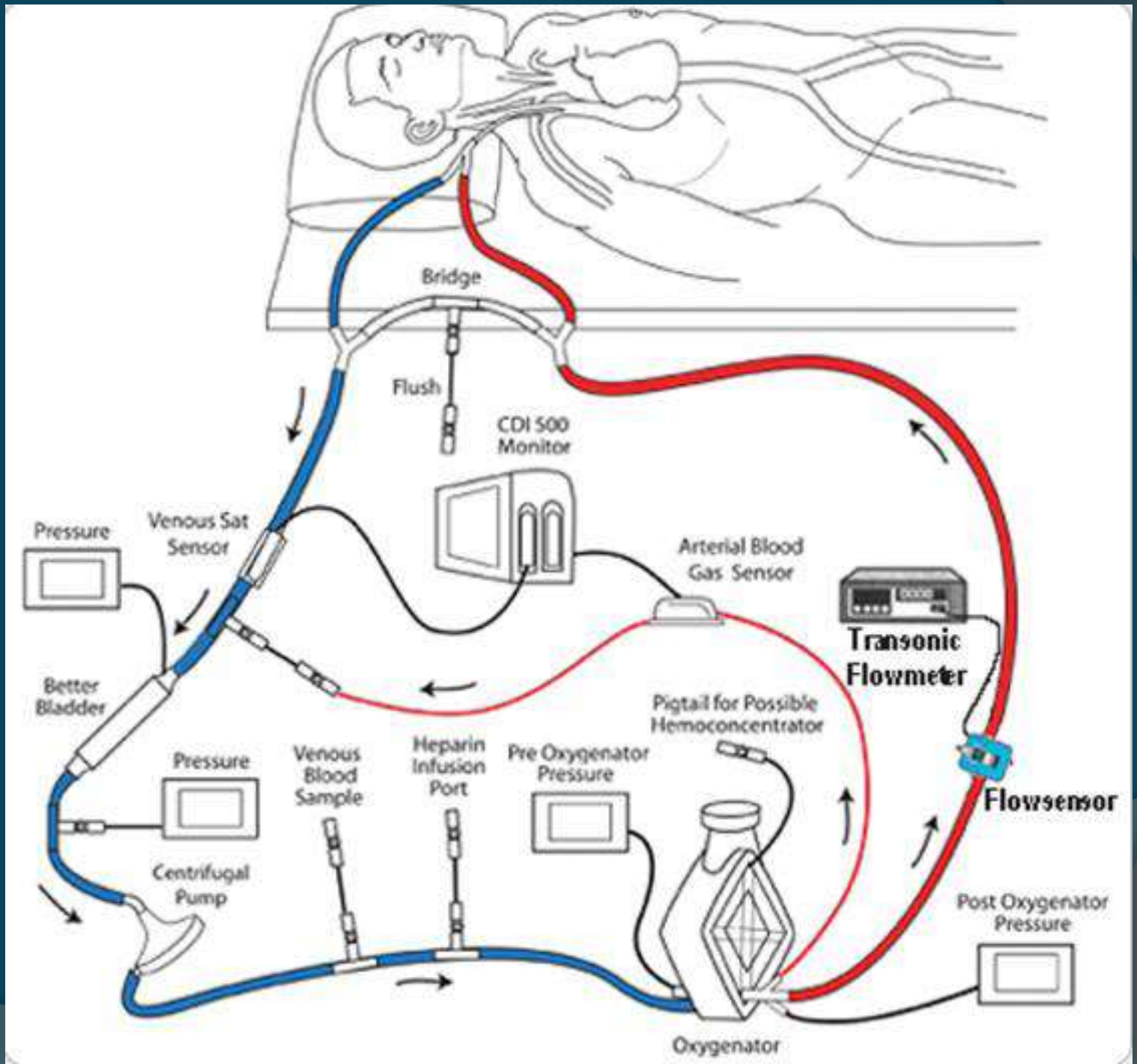
ECMO

ECMO UCI



TECNOLOGIA DEL ECLS


Bronchoscopy
Lung Therapy
BP
FiO2 0.4
Rate 5-10
P 30/15
TV
V/P
Dry Weight
VV Access
Patient
VO2
VCO2
Circuit
Blood Flow
Hct>40
DO2
SAT
Nutrition
DP
Heparin
ACT
O2
Carbogen
VECO2
Pump


Bridge
Flush
CDI 500
Monitor
Pressure
Venous Sat
Sensor
Arterial Blood
Gas Sensor
Transonic
Flowmeter
Better
Bladder
Pigtail for Possible
Hemoconcentrator
Pressure
Venous
Blood
Sample
Heparin
Infusion
Port
Pre Oxygenator
Pressure
Flowsensor
Centrifugal
Pump
Post Oxygenator
Pressure
Oxygenator

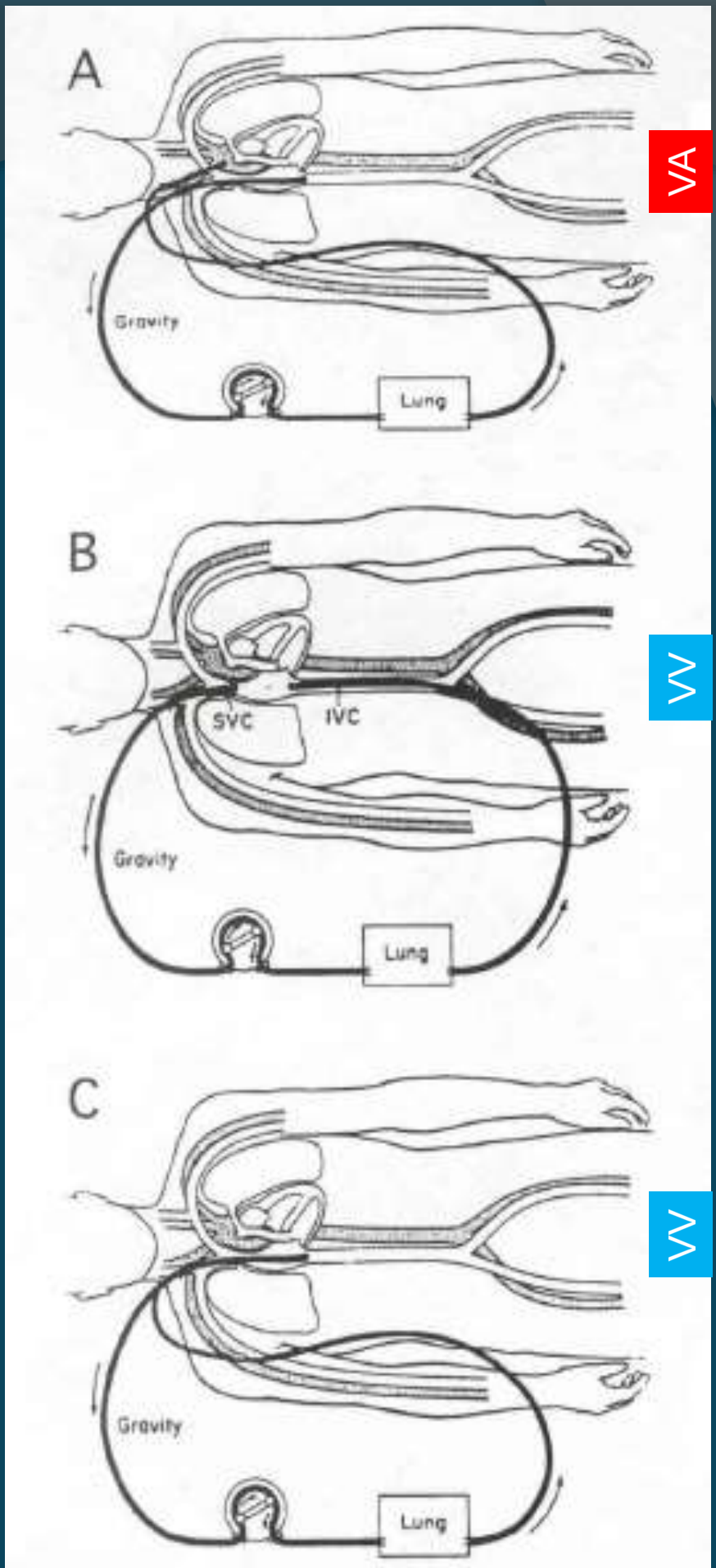
Metodología

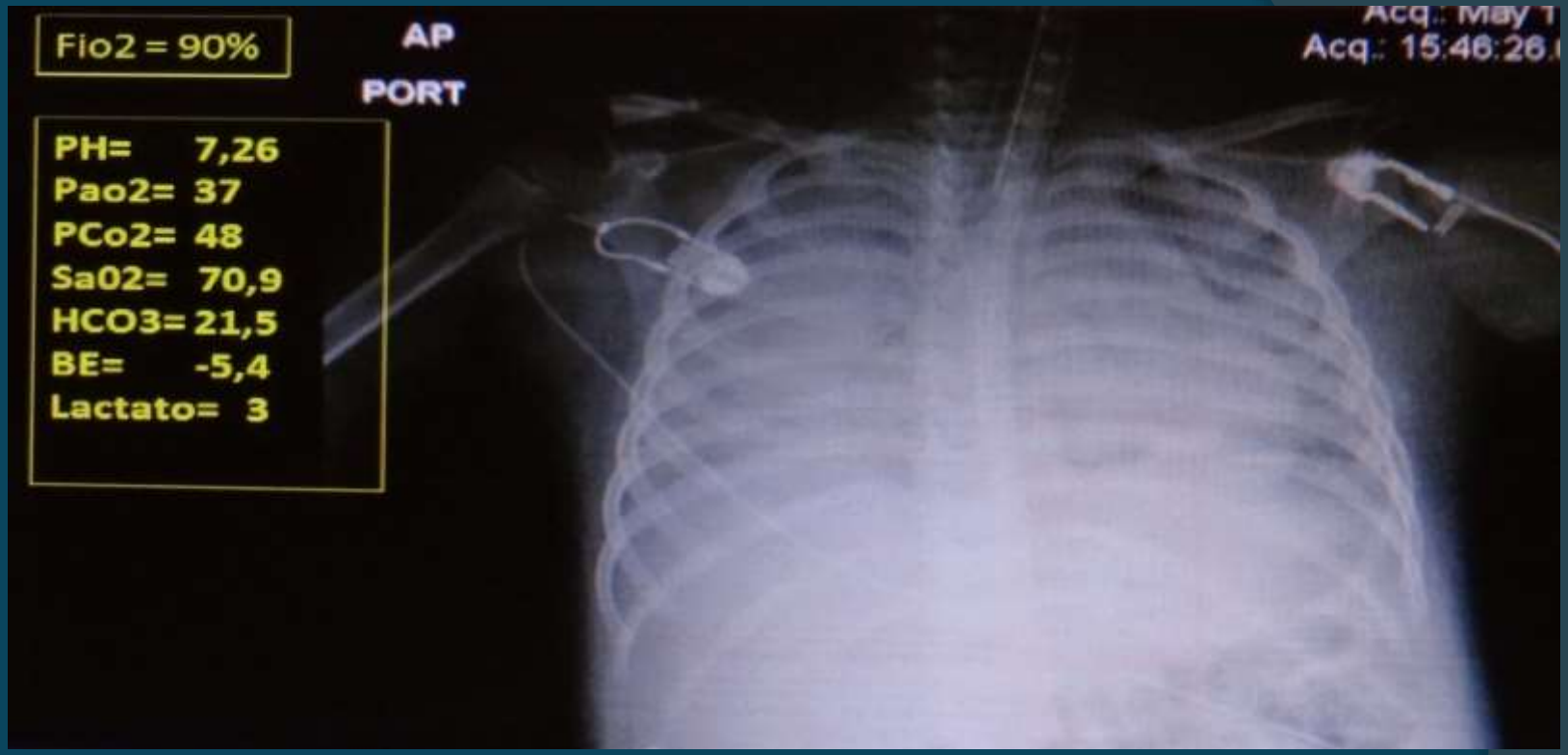
Cualquiera que sea la técnica utilizada, un circuito de asistencia extracorpórea incluye

El acceso vascular utilizado:
venoarterial (VA) o venovenoso (VV).
Según se requiera soporte cardiovascular, respiratorio, o ambos

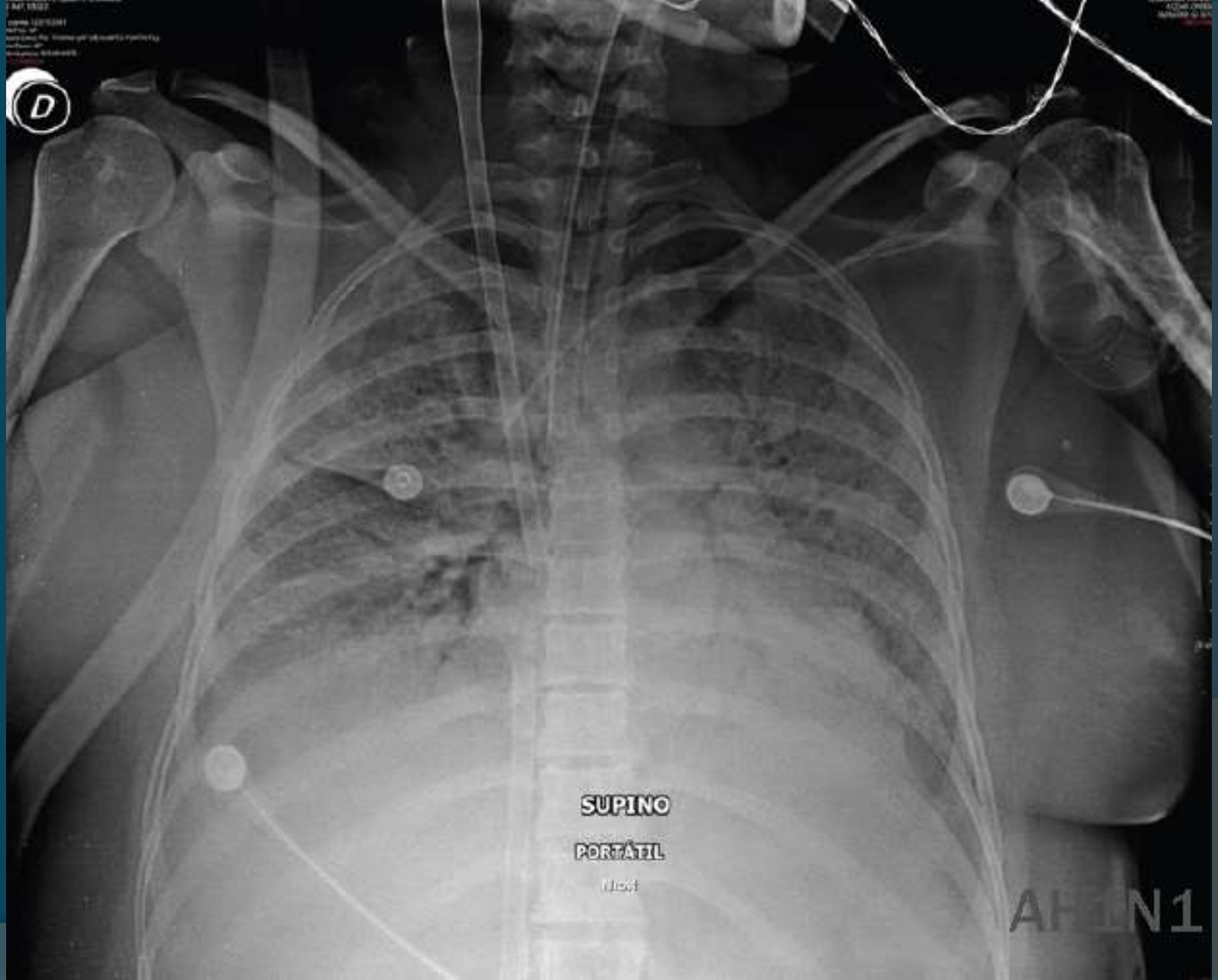
La cantidad de flujo sanguíneo extracorpóreo (ECBF) en relación con el volumen minuto cardíaco (CO).
Cuanto mayor sea la relación ECBF/CO mayor será la contribución del sistema extracorpóreo a la oxigenación.

El manejo ventilatorio asociado del paciente


A
Gravity
Lung
VA
B
SVC
IVC
Gravity
Lung
VV
C
Gravity
Lung
VV



QUE PACIENTES SE BENEFICIAN CON ECMO ?


D
SUPINO
PORTÁTIL

Fisiología de la oxigenación por membrana extracorporea

Objetivo:
transporte adecuado de oxígeno a los tejidos

- ECMO garantiza, el contenido de oxígeno en la sangre al poder saturarse la hemoglobina extracorporalmente y no depender de la función pulmonar primitiva del paciente.
- La cantidad de sangre oxigenada que el ECMO envía al torrente sanguíneo asegura el transporte de oxígeno

Ambas variables del transporte de oxígeno se aseguran en ECMO de forma independiente

GC

Volúmen Sistólico

X

Frecuencia Cardíaca

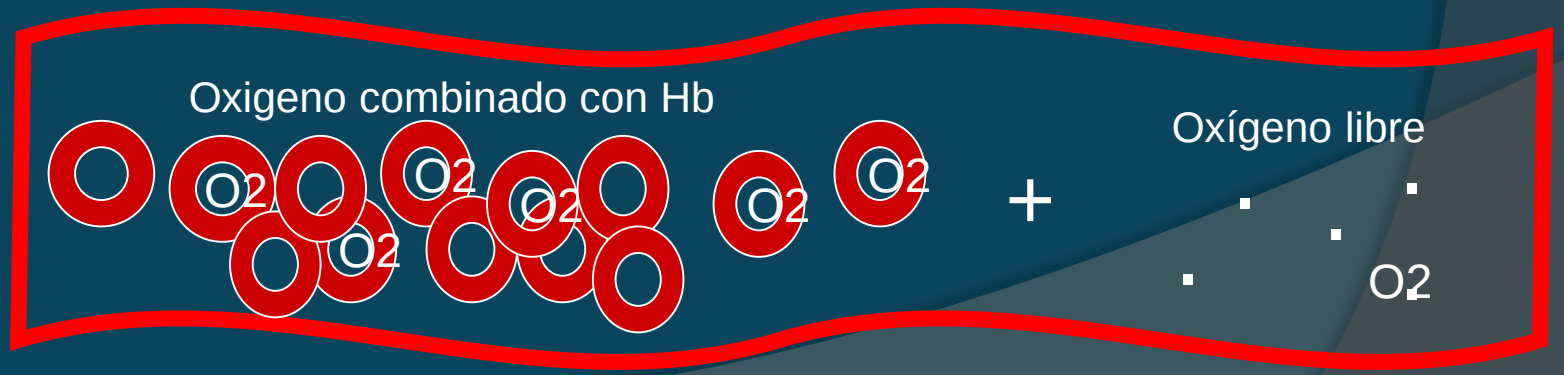
GC

X

Volúmen Sistólico Cardíaca

Frecuencia

CaO_2

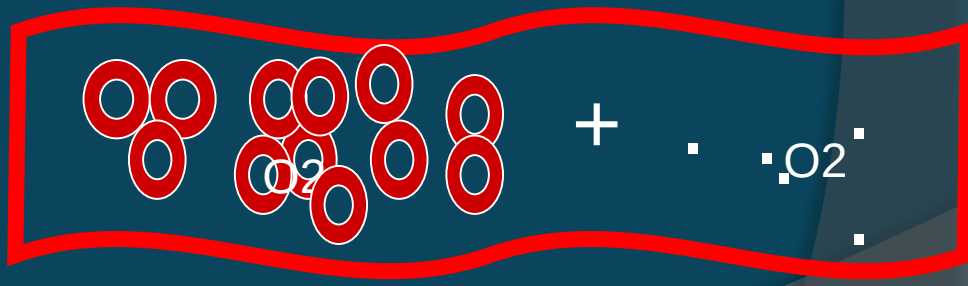


DO2 = GC x CaO_2

DO2 = Delivery

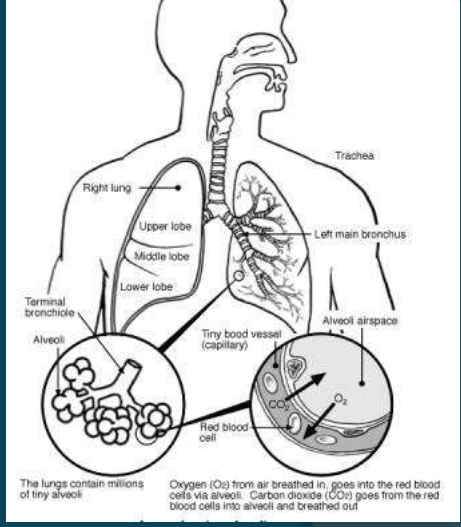
TRANSPORTE
APORTE

x



(VS x FC)

(Hb x 1.34 x SaO2)+(PaO2 x 0.23)



MEMBRANE OXYGENATOR

BLOOD FLOW

$PvCO_2$= 48 mmHg

PvO_2= 30 mmHg

SILICONE LAYER

CO_2

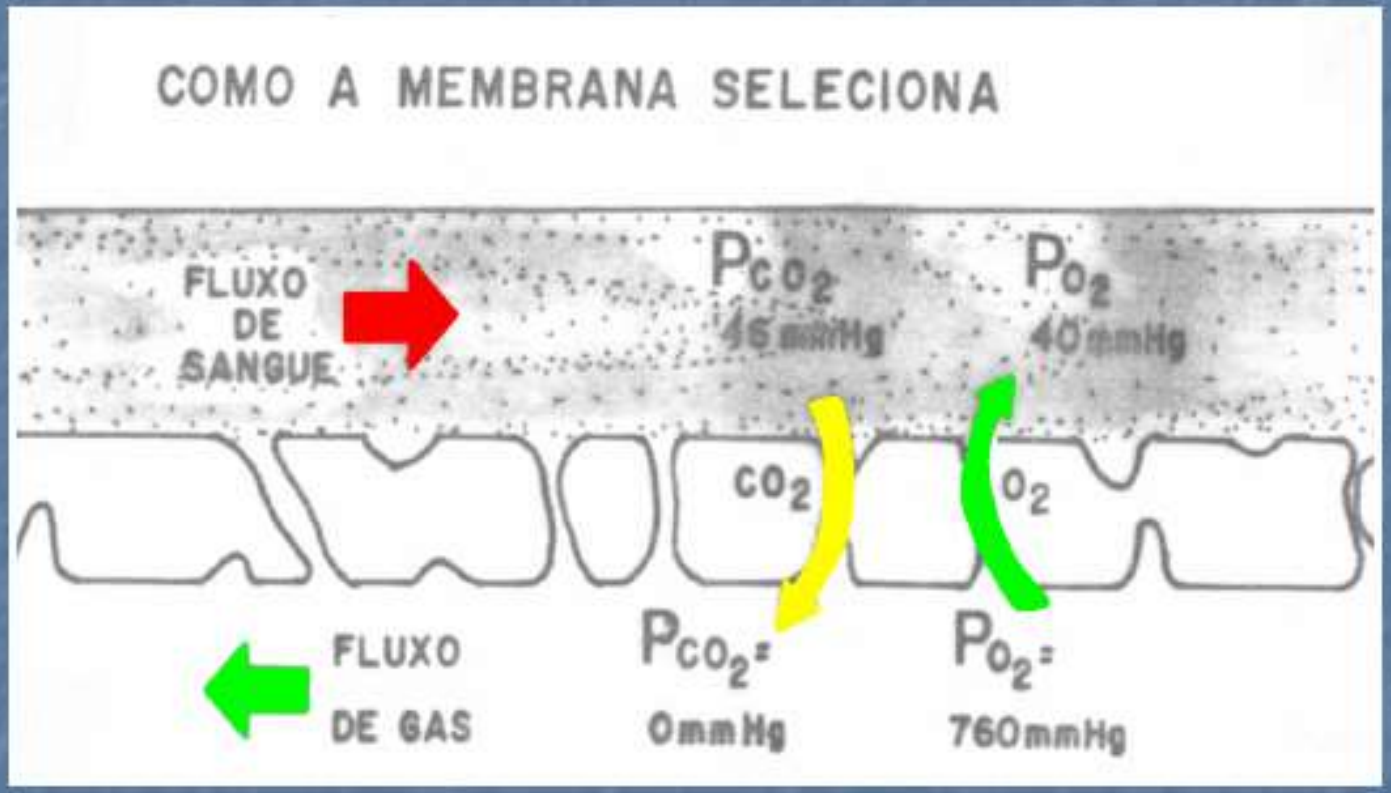
O_2

GAS FLOW

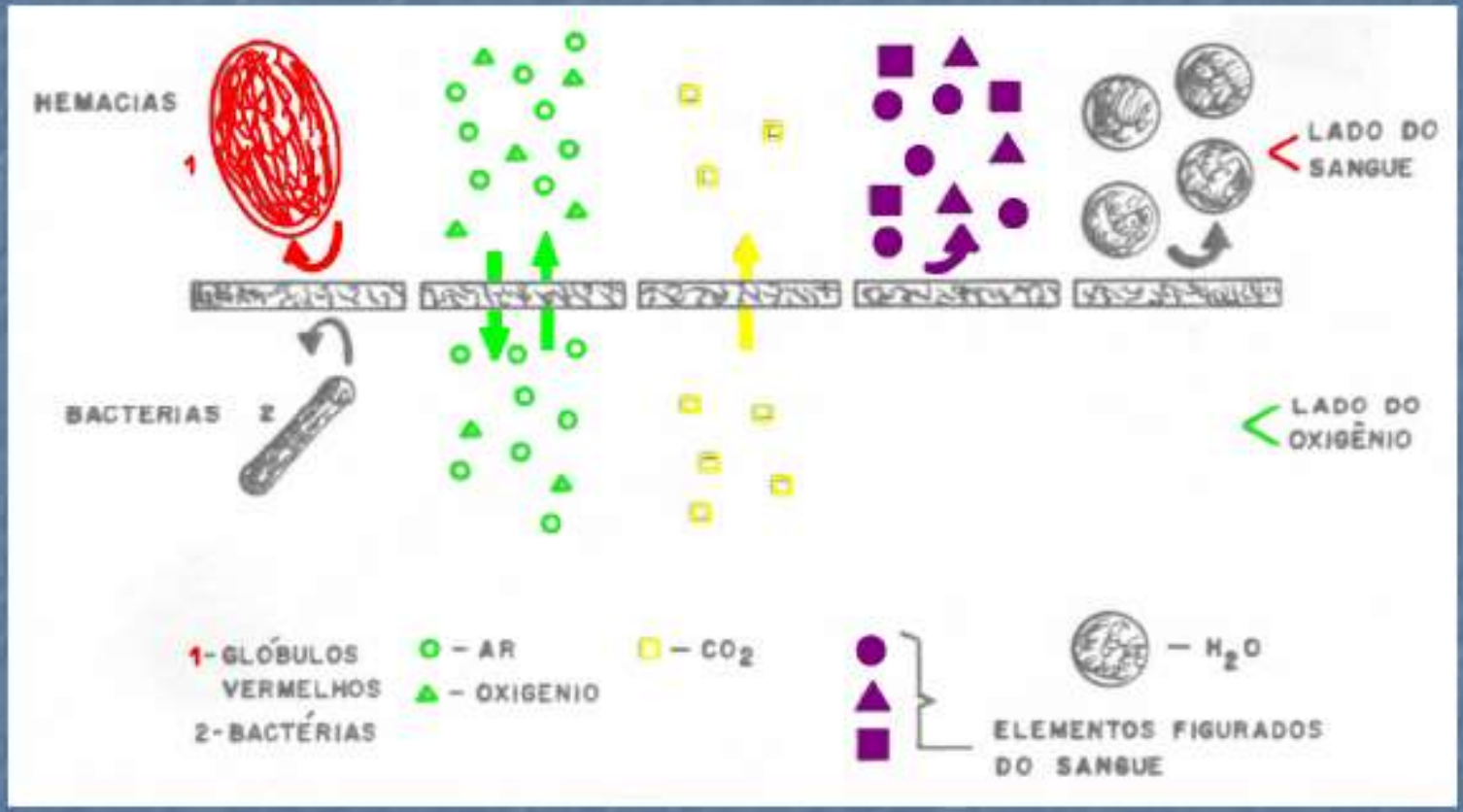
PCO_2= 0mmHg

PO_2= 760mmHg

ESQUEMA DEL PRINCIPIO DE DIFUSIÓN DE CO_2 Y O_2 A TRAVÉS DE LA MEMBRANA

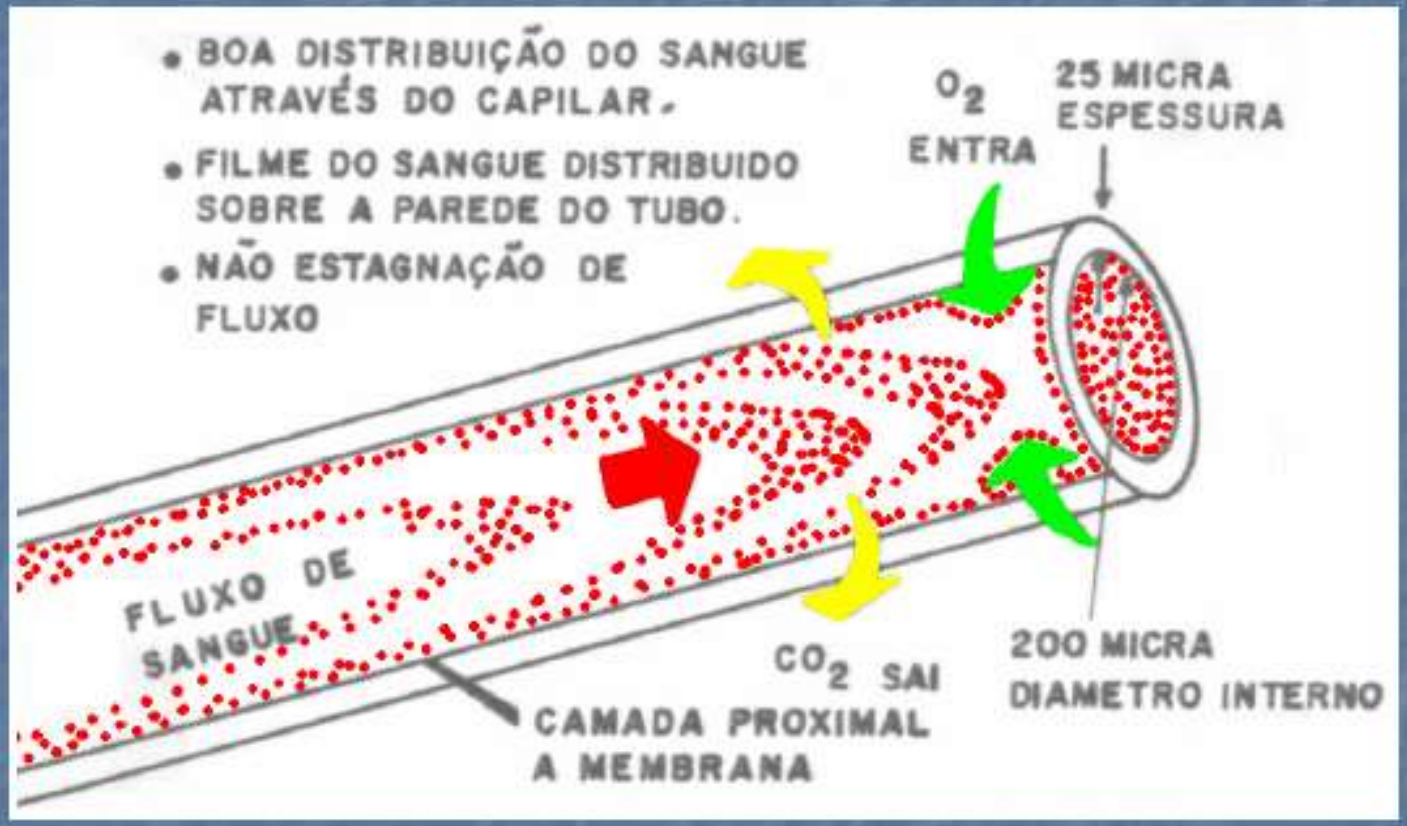


PRINCIPIO DE TRANSFERENCIA POR DIFUSIÓN A TRAVÉS DE LA MEMBRANA



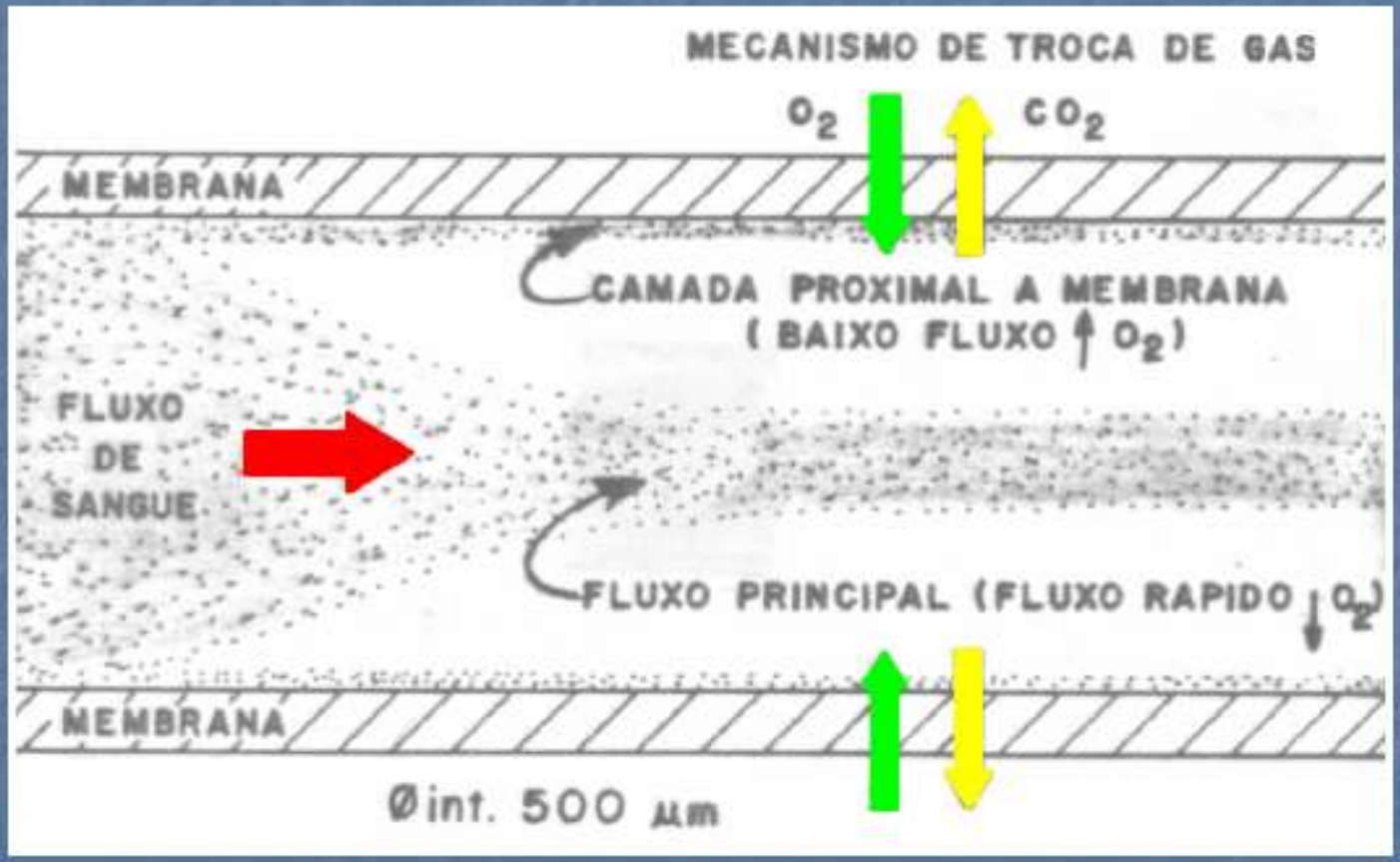
MEMBRANA CAPILAR

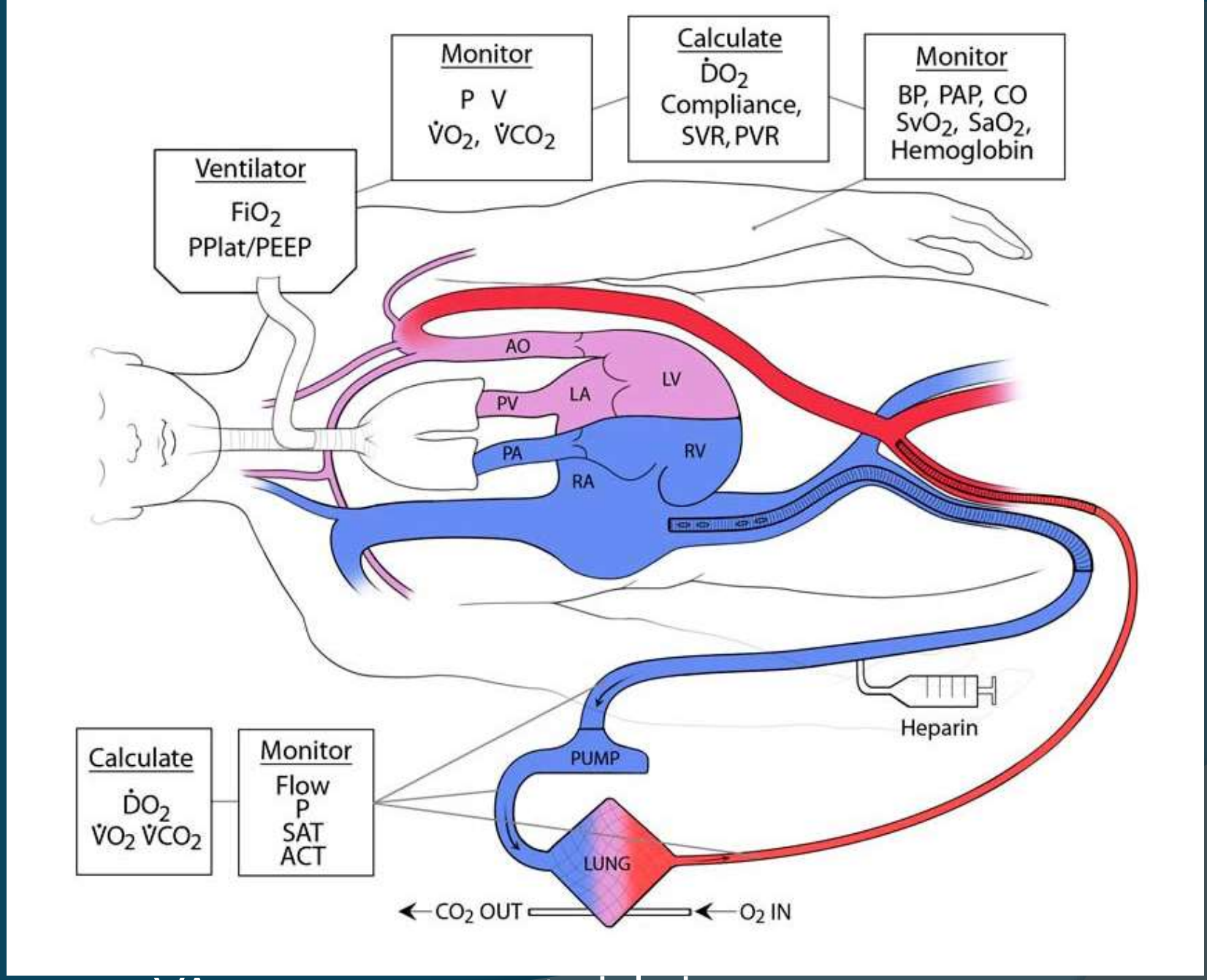
SANGRE DENTRO DEL CAPILAR



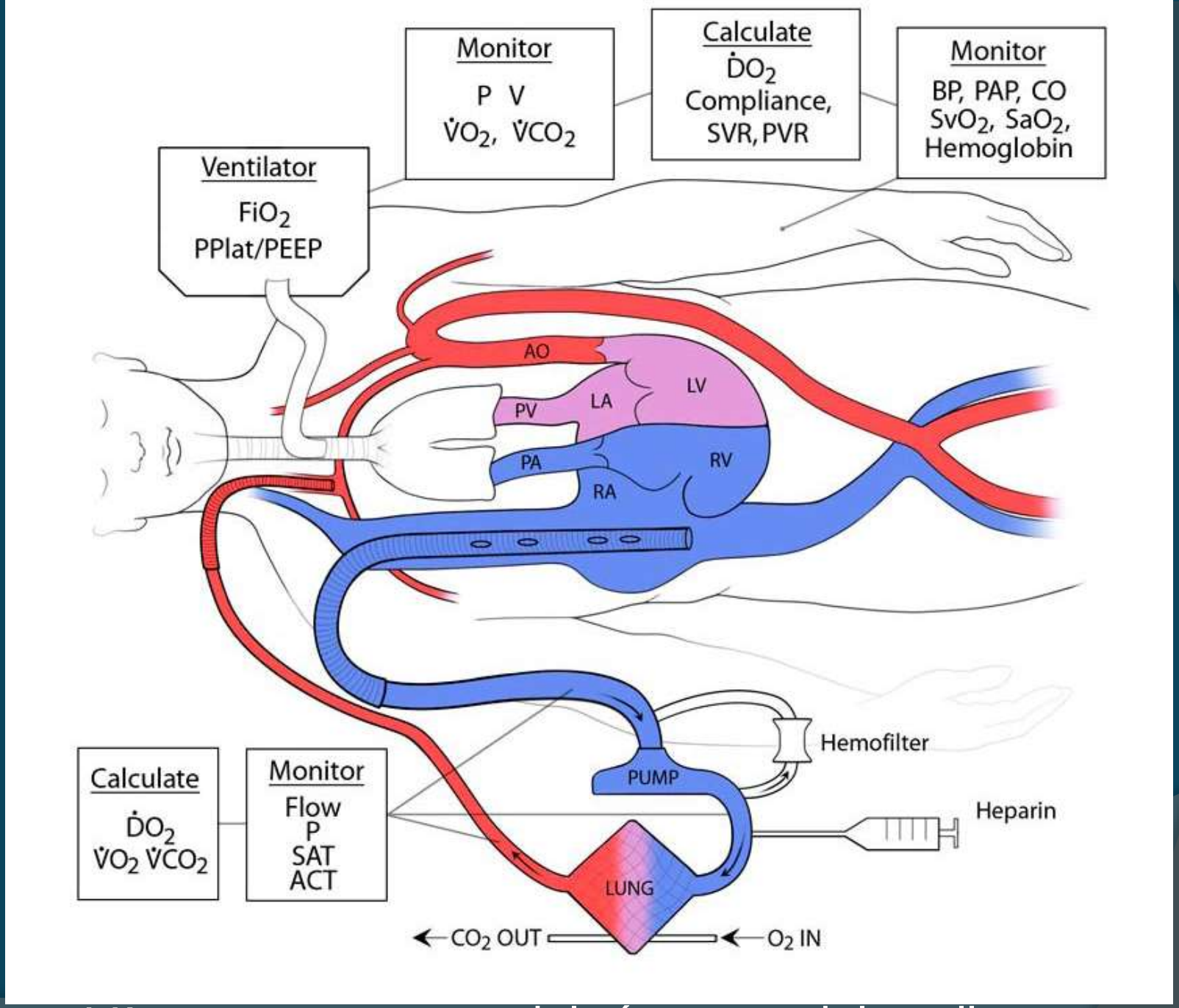
MEMBRANA CAPILAR
SANGRE DENTRO DEL CAPILAR

PROBLEMA DE EFECTO DE BORDE

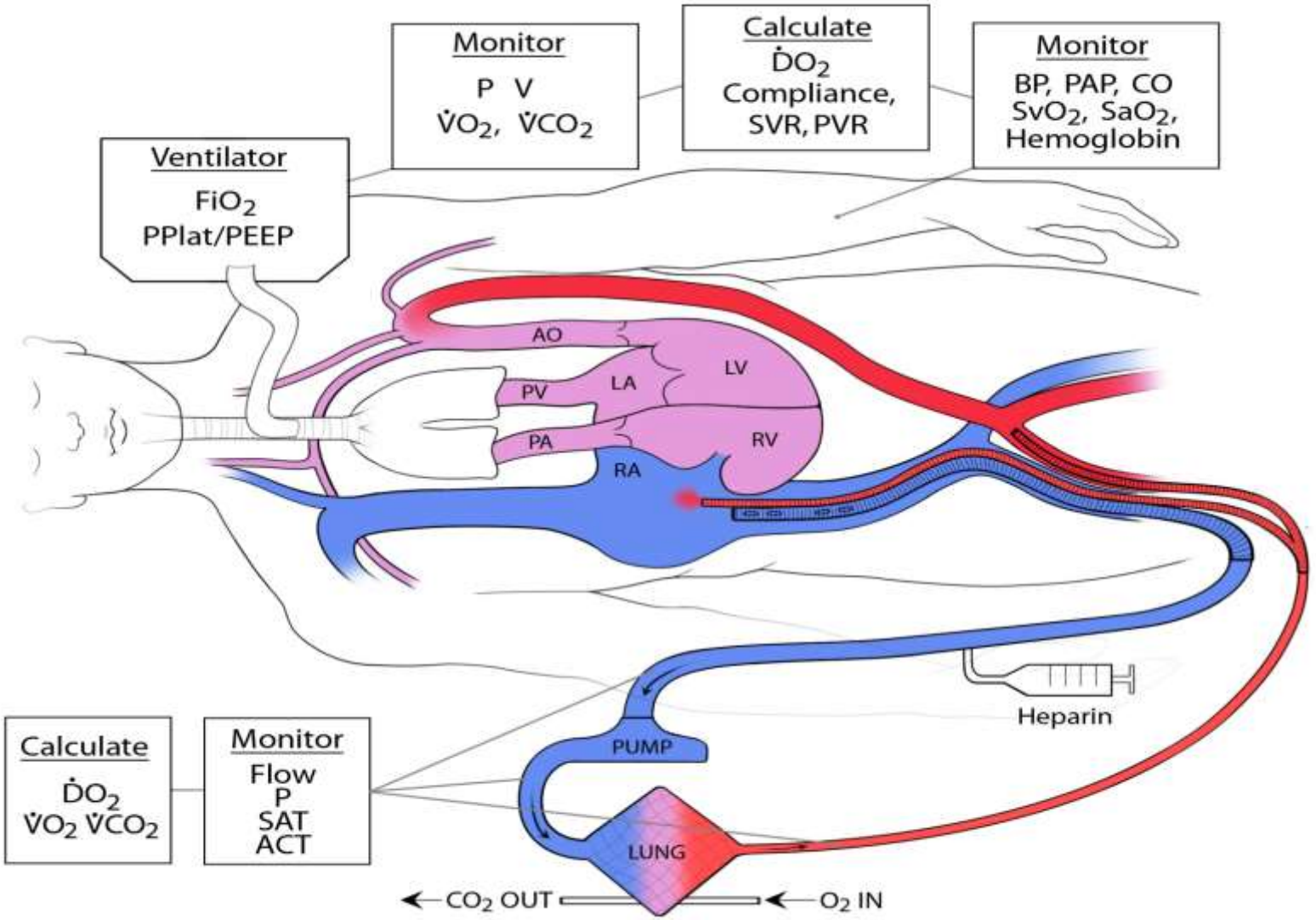




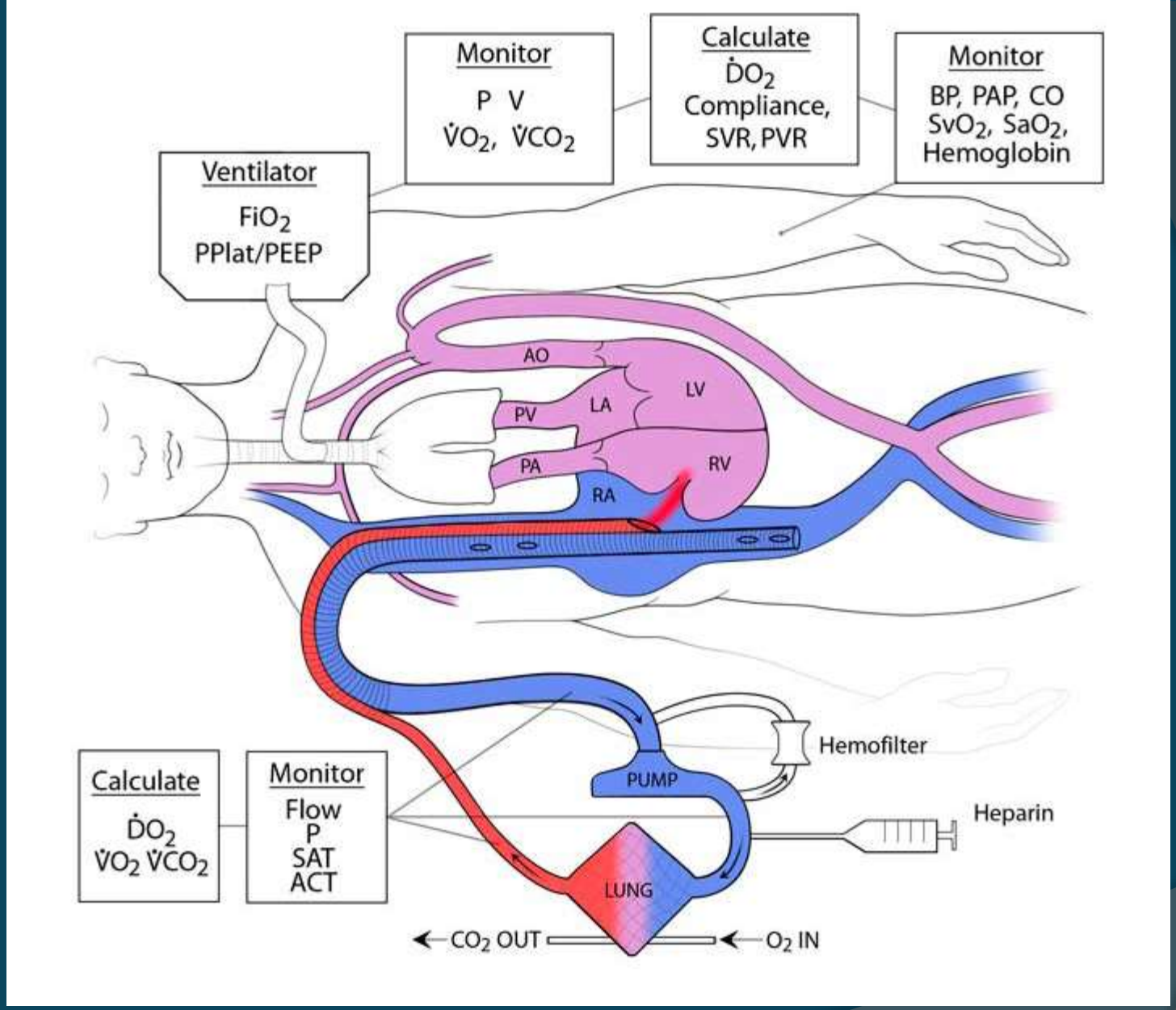
VA: acceso venoarterial via vasos femorales



VA: acceso venoarterial vía vasos del cuello



VAV: acceso venoarterial con algo de retorno venoso por AD

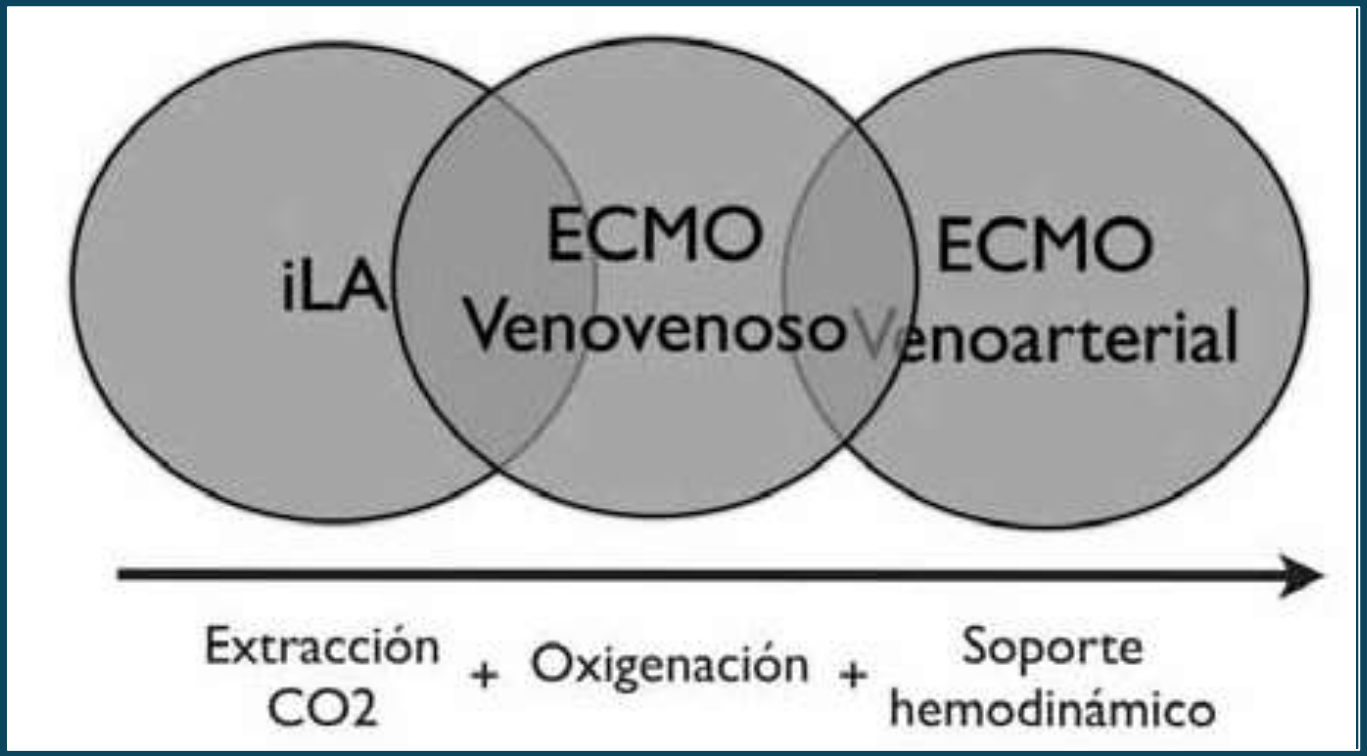


ECLS Veno-venoso con cánula de doble lumen

SOPORTE VITAL EXTRACORPOREO

TÉCNICA	DENOMINACIÓN GENÉRICA	USOS	EJEMPLOS	TIPO DE MEMBRANA
Circulación extra-corpórea (CEC)		Utilizado en cirugía cardiaca		Polipropileno microporoso
Extracción Arterio Venosa de CO_2	iLA (asistencia respira-toria invasiva)	Destinado a barrer CO_2	Novalung (iLA)	Polimetilpentene
ECMO VV	ECCOR	ECMO VV destinado a barrer CO_2	Quadrox D Medtronic ECMO Medos LT	Silicona o polimetilpentene
	ECMO	Soporte respiratorio		
ECMO VA	ECMO	Soporte hemodinámico y/o respiratorio	Bomba Centrifuga (rotaflow, biomedicus, levitronix)	
Asistencia Ventricular		Soporte hemodinámico ventricular izquierdo, derecho o biventricular	Bomba Neumática Extra-corpórea (Abiomed, BVS 5000 y AB 5000)	No aplica

**: ECCOR es "extracción de CO2 extracorpórea". Se refiere al uso de un ECMO VV con un flujo se sangre de 20 a 30% del GC del paciente

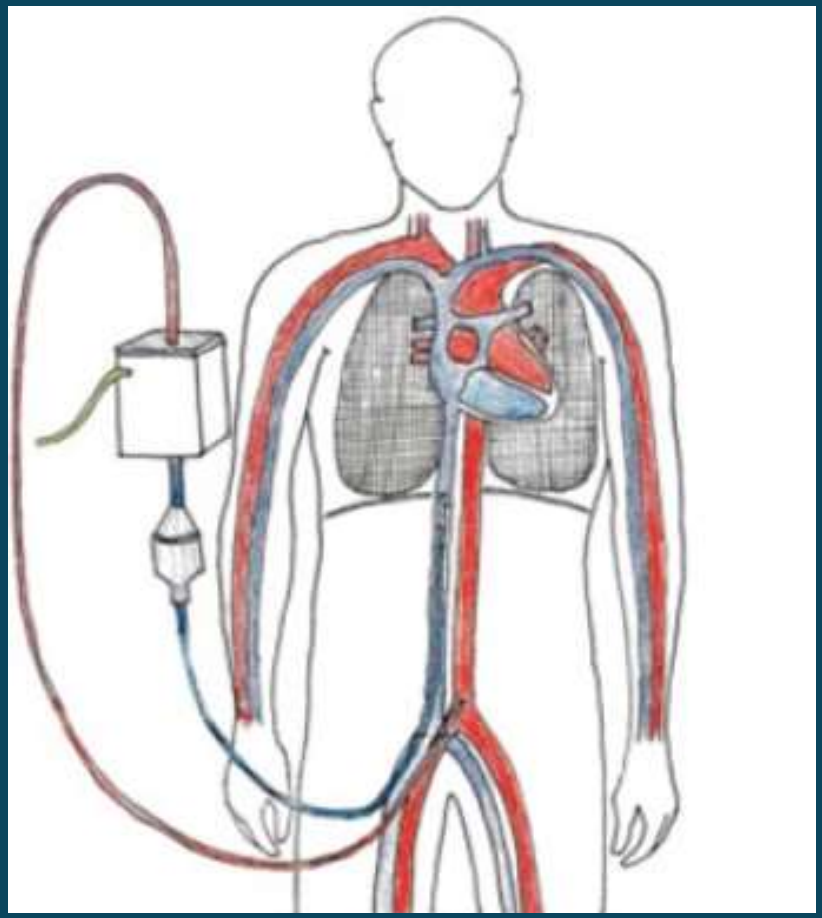


Rodrigo Díaz G. ECMO y ECMO Mobile. Soporte Cardio Respiratorio Avanzado. REV. MED. CLIN. CONDES - 2011; 22(3) 377-387.

PRINCIPALES DIFERENCIAS EN LOS SOPORTES VITALES EXTRACORPÓREOS

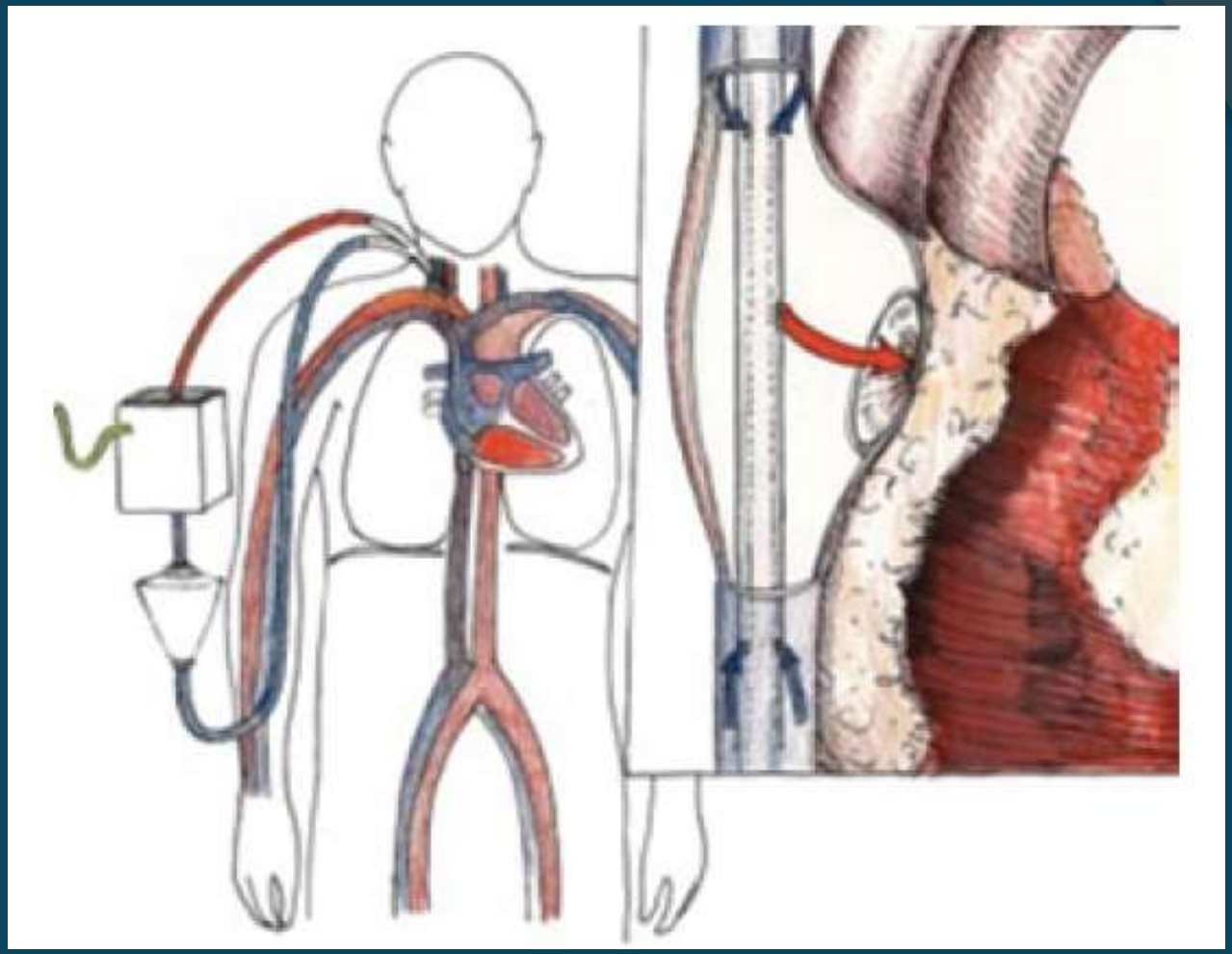
	CEC	ECMO VA	ECMO VV	ART-VENOSO (iLA)
Flujo extracorpóreo (% GC)	100%	30-80%	30-90%	20-30%
Efecto cardiaco	Soporte total	Soporte parcial	Sin soporte	Extracarga
Duración habitual	< 6 horas	< 21 días	< 21 días	< 30 días
TCA	> 400	150-250	150-250	150
% O2 aportado por membrana	100%	20-90%	20-90%	20%
% CO2 extraído por membrana	100%	20-90%	20-90%	50%
Canulación de retorno más habituales	AO, fem, axilar	fem, axilar Central	YID o fem	fem

Rodrigo Díaz G. ECMO y ECMO Mobile. Soporte Cardio Respiratorio Avanzado. REV. MED. CLIN. CONDES - 2011; 22(3) 377-387.



ECMO Veno Arterial: dibujo con configuración habitual que muestra drenaje por vía femoral y reinfusión por vía arterial femoral

Rodrigo Díaz G. ECMO y ECMO Mobile. Soporte Cardio Respiratorio Avanzado. REV. MED. CLIN. CONDES - 2011; 22(3) 377-387.

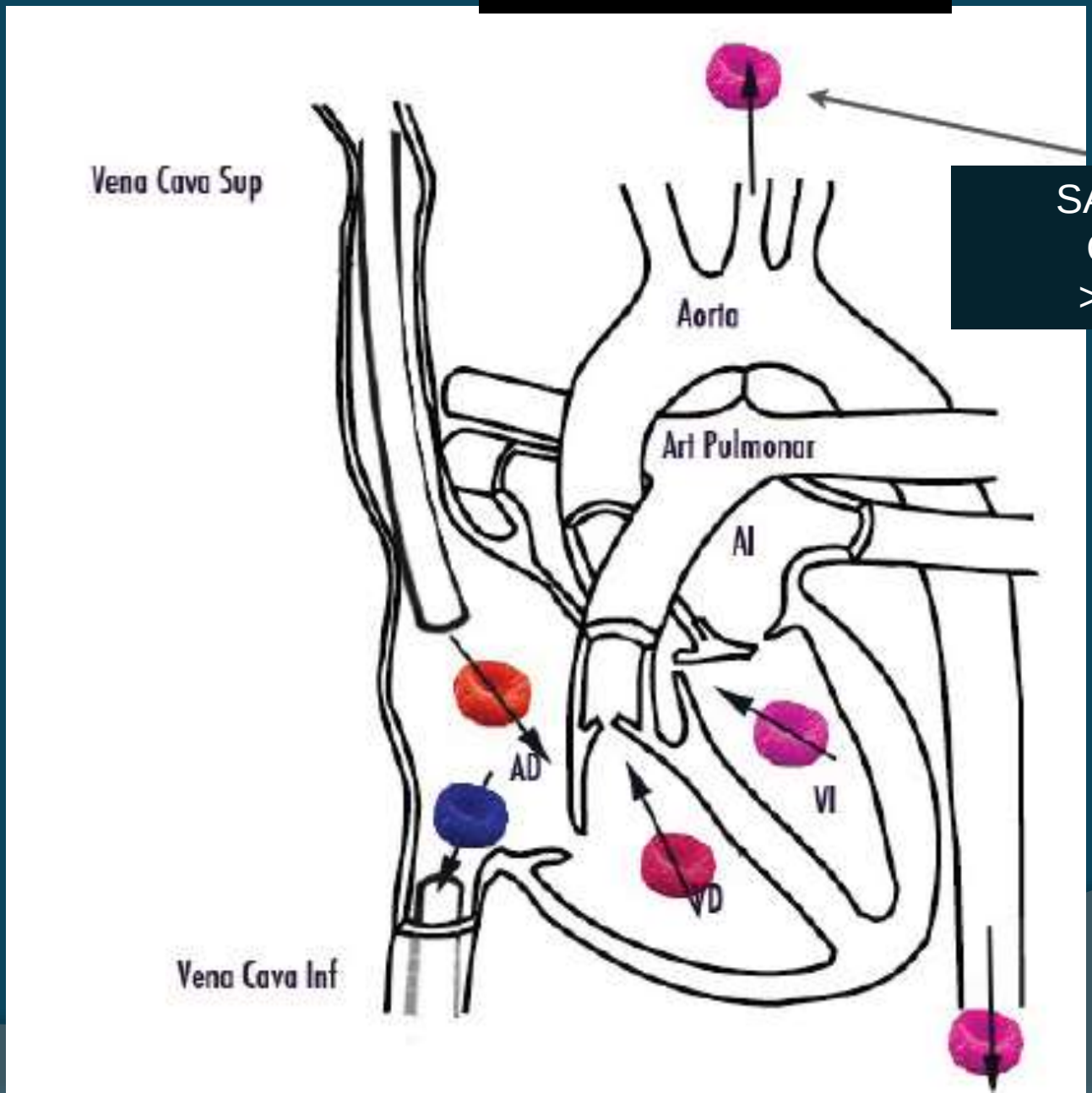


ECMO Veno Venoso la salida y retorno se hace por la vena yugular derecha, en el dibujo del detalle se observa la llegada de sangre oxigenada a la aurícula derecha y la extracción desde la vena cava inferior y superior.

Rodrigo Díaz G. ECMO y ECMO Mobile. Soporte Cardio Respiratorio Avanzado. REV. MED. CLIN. CONDES - 2011; 22(3) 377-387.

ECMO Veno Venoso: Rx de tórax que muestra cánula de retorno desde el ECMO hacia el paciente en aurícula derecha y la cánula de salida hacia el circuito se ve a nivel del diafragma y sale por vena femoral. Paciente con Influenza por AH1N1

ECMO V-V



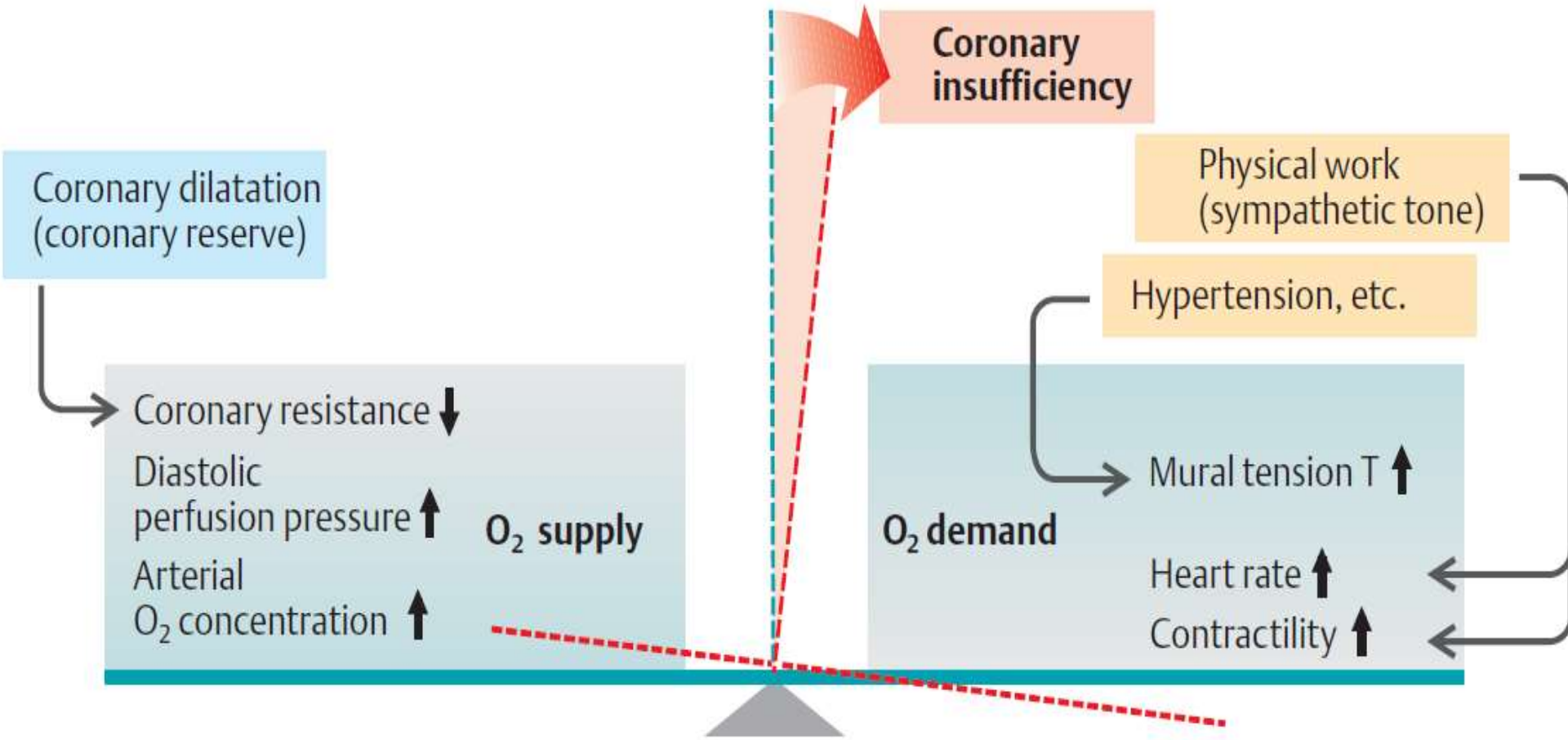
SATURACION
OBJETIVO
> 80 – 85 %

Criterios para ECMO respiratorio

PaO_2/FIO_2 ratio, < 100 on FIO_2 of 1.0, or $P(A\text{-}a)O_2$ of > 600 mm Hg, or Murray lung score of ≥ 3.0,[35] or uncompensated hypercapnea with a pH of < 7.20
Age < 65 yr
Receipt of mechanical ventilation for < 7 d
No known contraindication to limited anticoagulation
Patients who are not moribund and do not have contraindication to full intensive therapy

*$P(A\text{-}a)O_2$ = alveolar-arterial gradient.

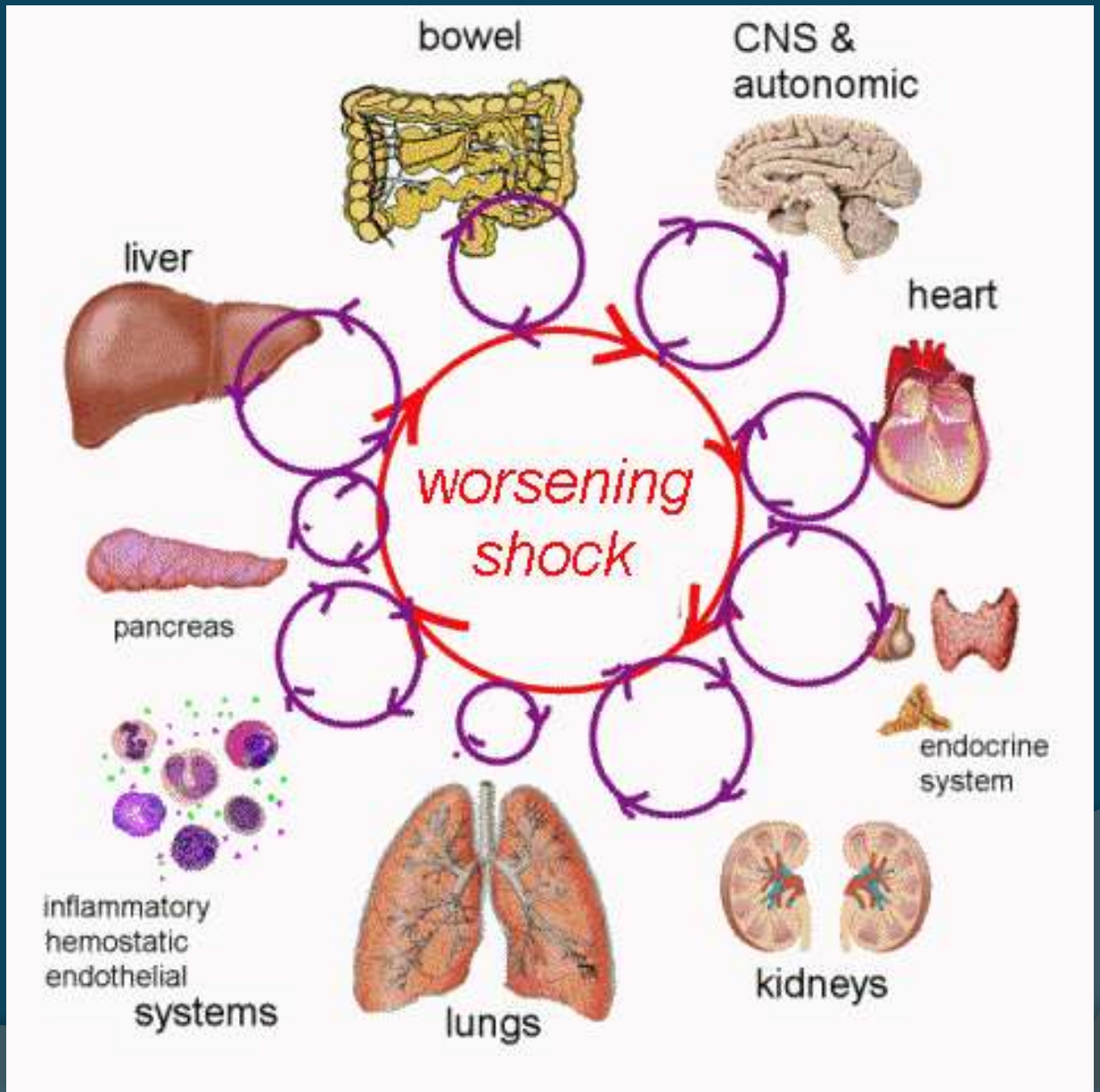
SHOCK CARDIOGENICO



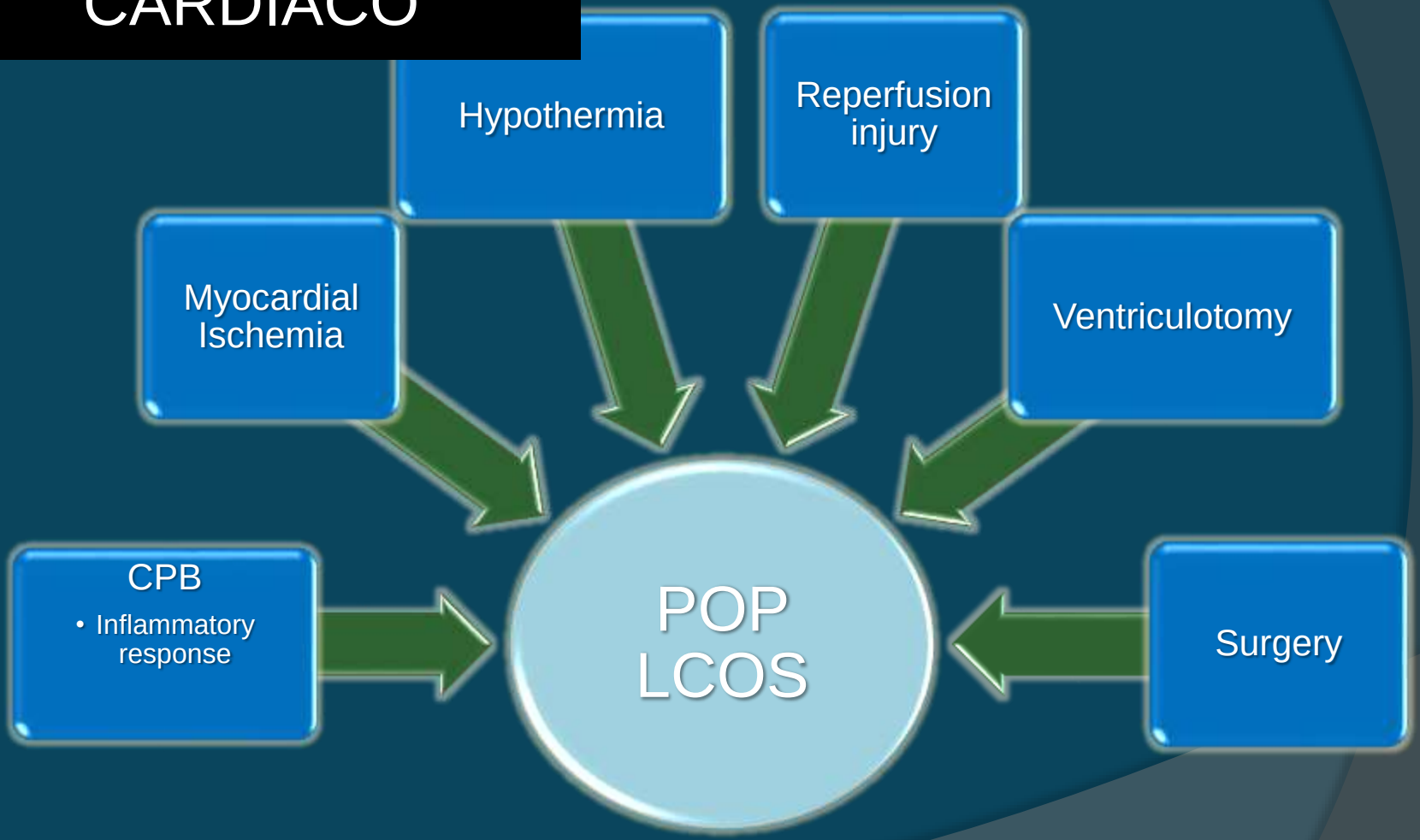
BALANCE DE OXIGENO EN EL MIOCARDIO

Despopoulos, Color Atlas of Physiology. 2003.

SHOCK CARDIOGENICO



SINDROME DE BAJO GASTO CARDIACO

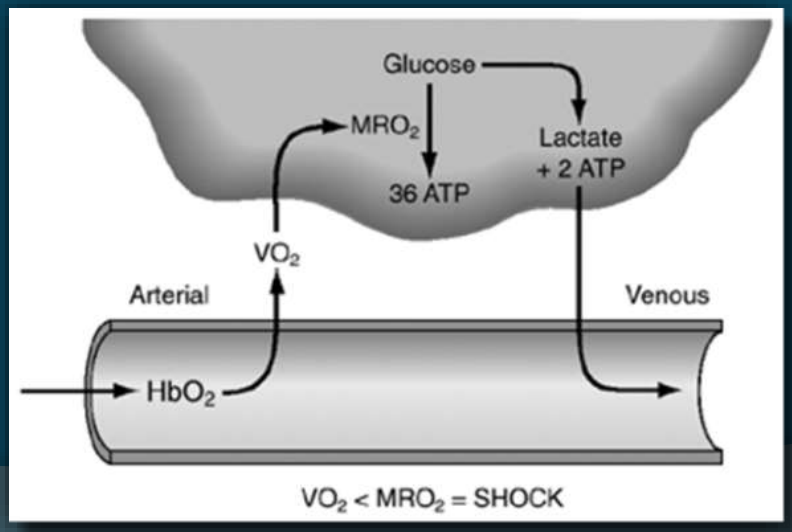


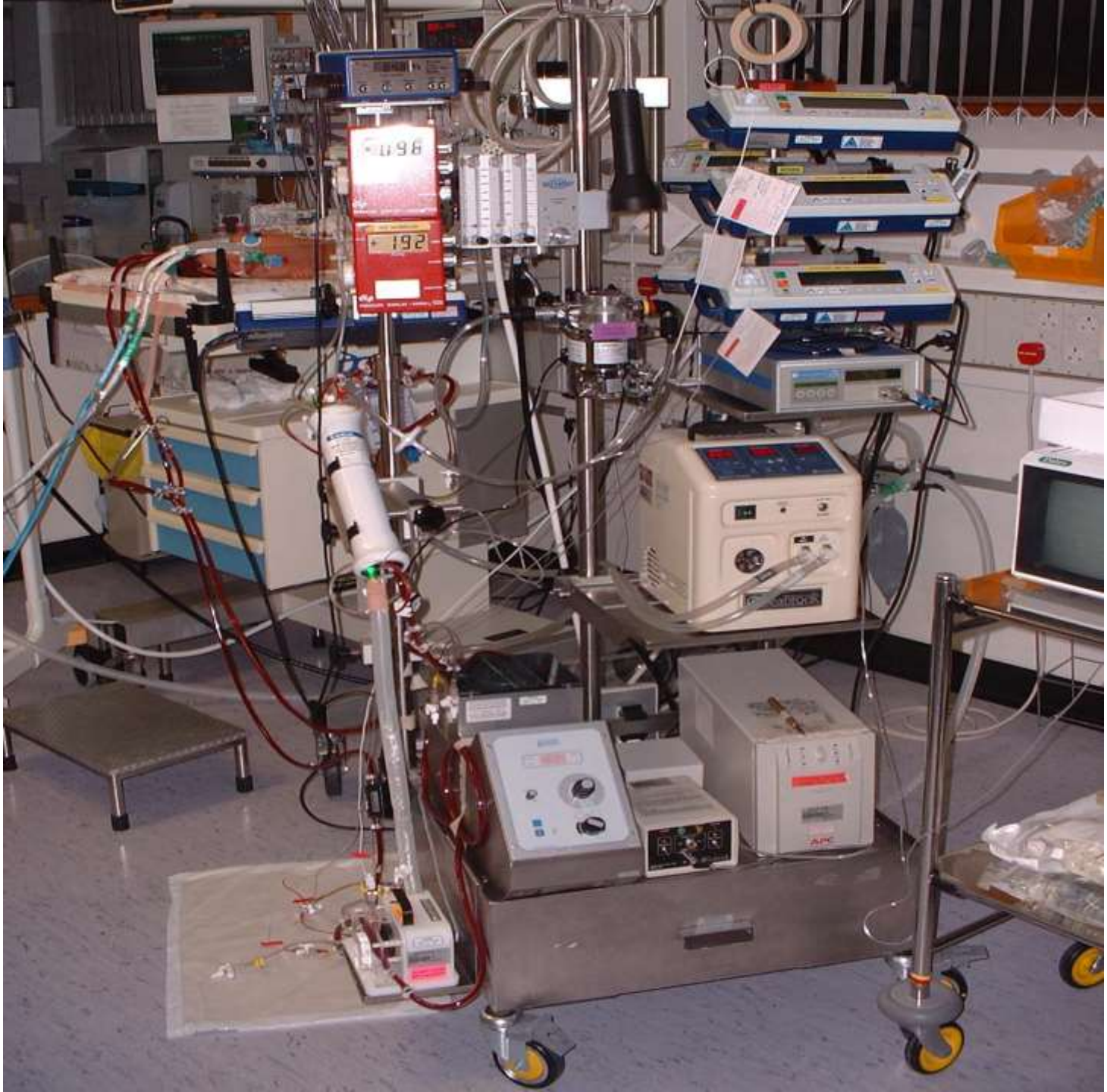
SINDROME DE BAJO GASTO CARDIACO

VO_2

ECMO

EL GASTO CARDIACO ES INSUFICIENTE PARA MANTENER LAS DEMANDAS METABOLICAS SISTEMICAS

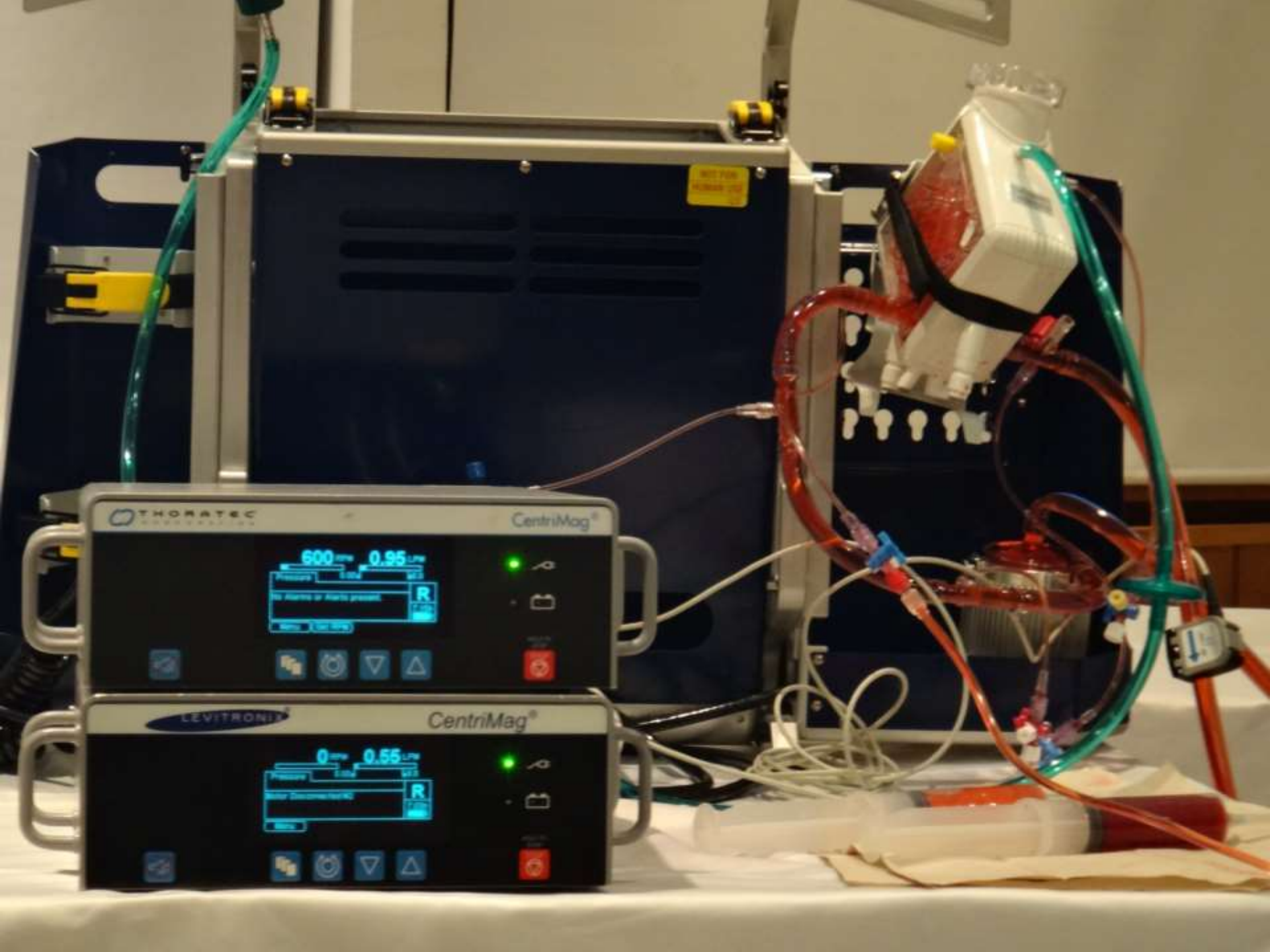




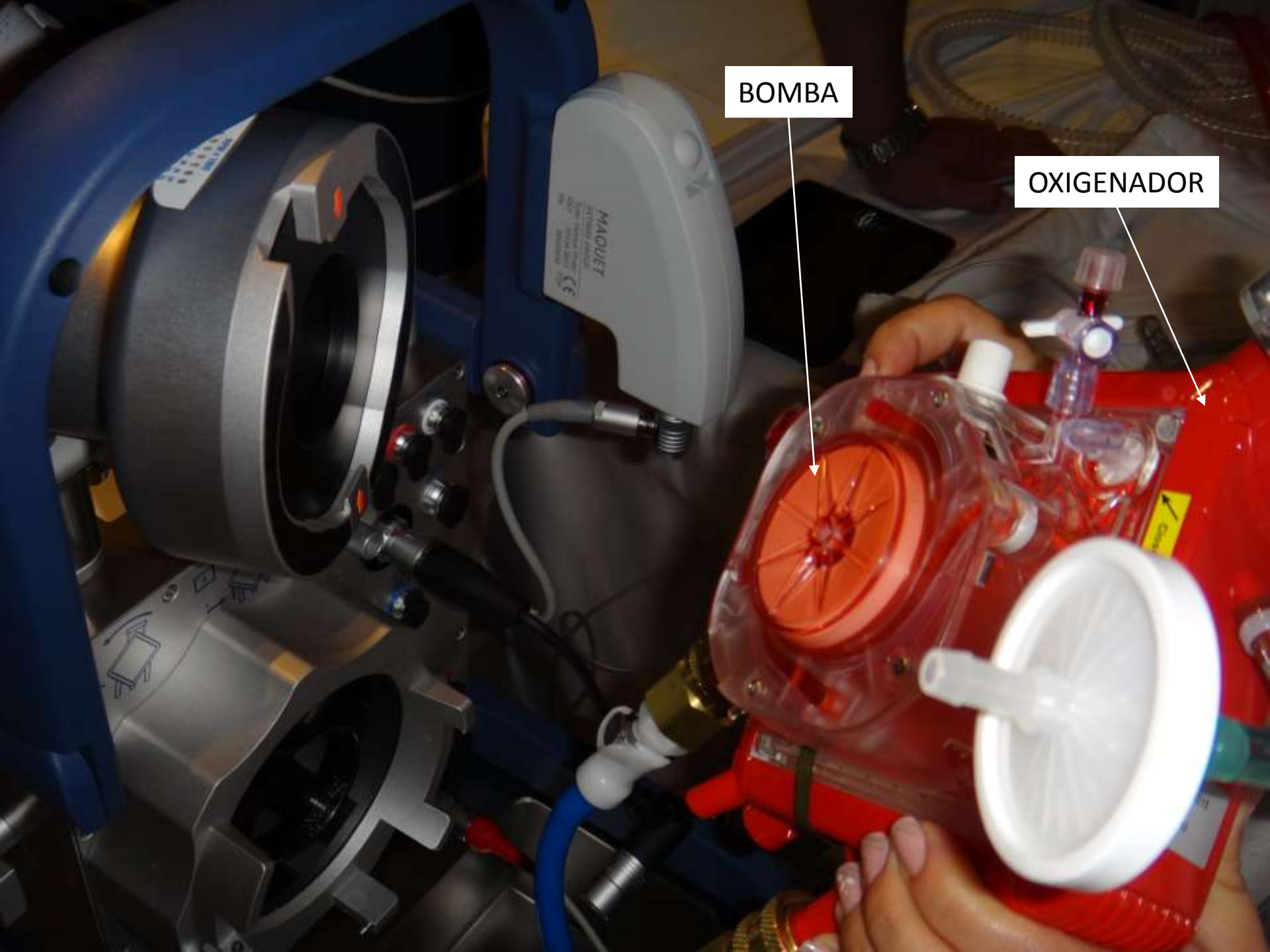

BOMBA DE RODILLO


HEPARINA


PBS
PORTABLE BYPASS SYSTEM


THORATEC
CentriMag
600 rpm 0.95 L/m
R
LEVITRONIX
CentriMag
0 rpm 0.55 L/m
R


OXIGENADOR
BOMBA CENTRIFUGA DE LEVITACION MAGNETICA
LEVITRONIX
CentriMag


BOMBA
OXIGENADOR
MAQUET

CARDIOHELP


ECMO
+
CRRT


ECMO
+
CRRT
CentriMag
CentriMag

EXPERIENCIA MUNDIAL EN ECMO

Hill JD et al: *NEJM* 1972; 286:629-34

Evolución del ECLS

70 s

1972: Hill y col.

Primer éxito en un adulto con soporte Extracorporeo prolongado (75 h)

Politraumatizado
24 años
IRA postoperatoria
Reparación de aorta

N Engl J Med 1972; 286: 629

Evolución del ECLS

70 s

1976: Barlett.

Primer éxito en RN con SDRN
Mejoría importante en la sobrevida

Cardiopatías congénitas
Hernia congénita diagragmática
Hipoplasia pulmonar
Hipoxia neonatal
Gran número de casos

Latinoamérica

Chile

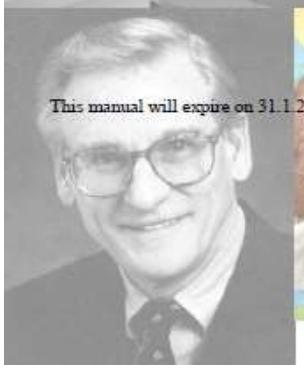
70 s

PRIMER RN TRATADA EN ECMO 1975

ECMO, VAD and Circulatory support

Extra Corporeal Membrane Oxygenation,
Ventricular Assist Device
Procedures of the Paediatric Intensive Care Unit
Freeman Hospital

J H Smith



This manual will expire on 31.1.2010.

Neonatal ECMO
BOSTON CHILDREN'S HOSPITAL

Prospectivo randomizado 1986-88

PPHN
(19 pacientes)

80 s

ECMO
(9 pacientes randomizados)

+ 20 ECMO
(no randomizados)
1 muerte

Tratamiento convencional
(10 pacientes randomizados)
4 muertes

97 %
SOBREVIDA

✓

60 %
SOBREVIDA

ECMO - ADULTOS

Evolución del ECLS

70 s

- 1979: Zapol y col.

- Multicéntrico avalado por NIH
- ECMO vs. VM convencional en Insuficiencia Respiratoria

JAMA 1979; 242: 2193

  - Mortalidad de 90% en ambos grupos
  - Se abandono el uso de ECMO para falla respiratoria

1979

Extracorporeal membrane oxygenation in severe acute respiratory failure. A randomized prospective study

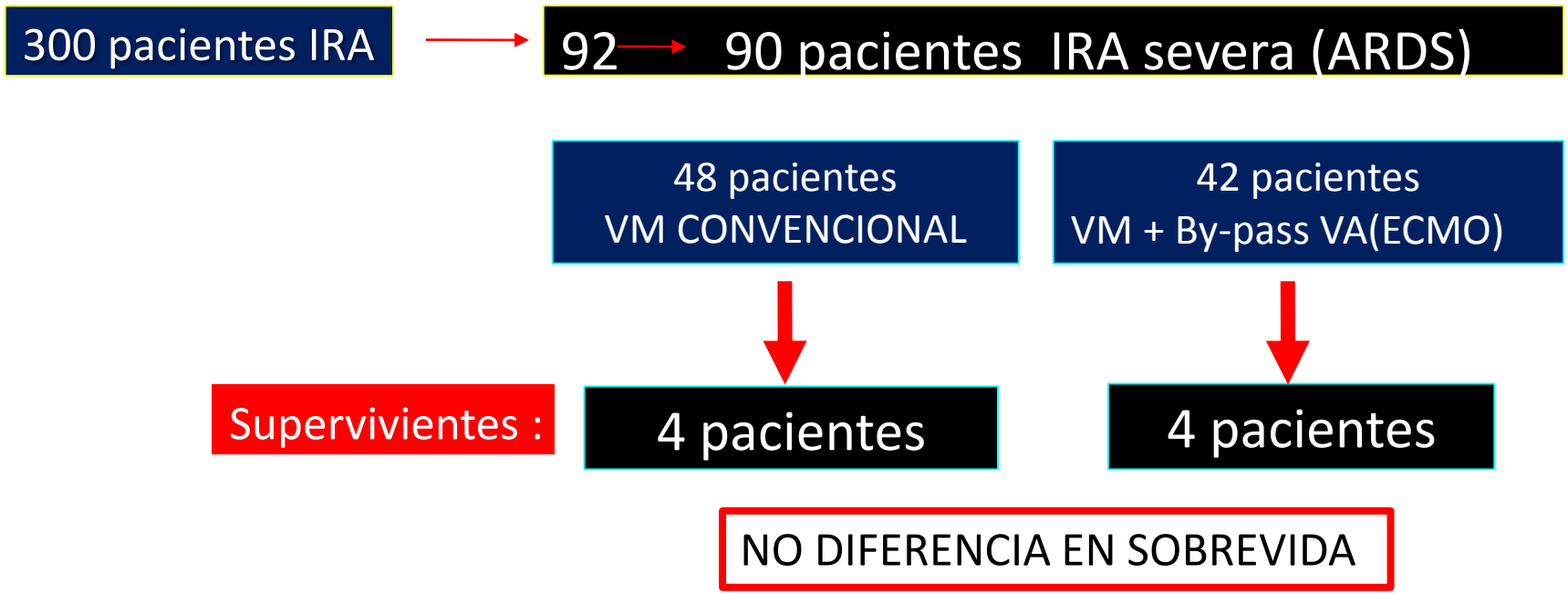
JAMA®
The Journal of the American Medical Association
Vol. 242 No. 20, November 16, 1979

W. M. Zapol, M. T. Snider, J. D. Hill, R. J. Fallat, R. H. Bartlett, L. H. Edmunds, A. H. Morris, E. C. Peirce 2nd, A. N. Thomas, H. J. Proctor, P. A. Drinker, P. C. Pratt, A. Bagniewski and R. G. Miller Jr

Extracorporeal membrane oxygenation in severe acute respiratory failure.

A randomized prospective study

- Multicentrico: 11
- Avalado por NIH
- ECMO vs. VM convencional en SDRA
- Técnica: By-pass veno-arterial



1986

Low-frequency positive-pressure ventilation with extracorporeal CO2 removal in severe acute respiratory failure

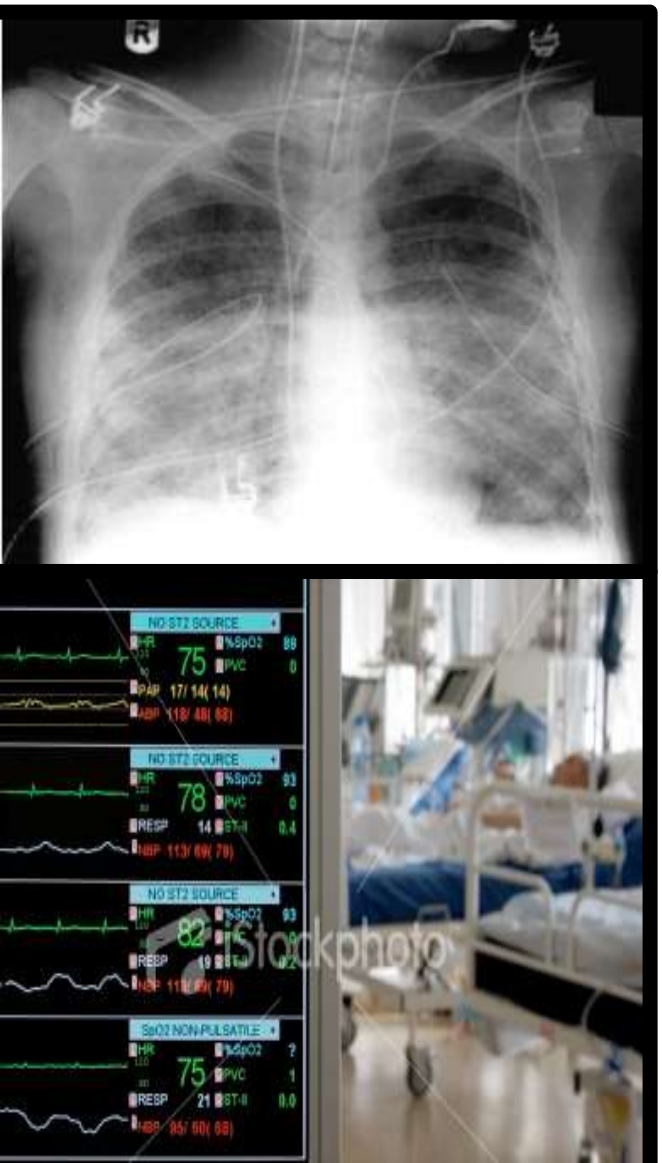
Vol. 256 No. 7, August 15, 1986

JAMA®
The Journal of the American Medical Association

L. Gattinoni, A. Pesenti, D. Mascheroni, R. Marcolin, R. Fumagalli, F. Rossi, G. Iapichino, G. Romagnoli, L. Uziel, A. Agostoni and al. et

Evolución del ECLS

80 s



- 1986: Gattinoni y col.
- Técnica de perfusión extracorporea con criterios de inclusión similares a los de Zapol.
- Umbral de entrada con mortalidad predecible del 90%
  - Bajo flujo
  - Acceso vascular percutáneo
  - Eliminación aumentada de CO2
  - Supervivencia 48.8%
  - Se retoma uso de ECLS para falla respiratoria

JAMA 1986; 256: 881

Low-frequency positive-pressure ventilation with extracorporeal CO2 removal in severe acute respiratory failure

- Estudio no controlado
- Técnica: perfusión extracorporea de bajo flujo con acceso vascular percutáneo. By-pass VV
- Eliminación aumentada de dióxido de carbono (ECCO2)
- Umbral de entrada: mortalidad predecible mayor de 90%

43 pacientes → ECMO V-V +
VM: FR: 3-5
PP: 35 -45 → SUPERVIVIENTES:
21 PACIENTES = 48.8%

The mean time on bypass for the survivors was 5.4 +/- 3.5 days.
No major technical accidents occurred in more than 8000 hours of perfusion.

Terminologia

ECMO

$PECO_2R$

$ECCO_2R$

VA-ECMO

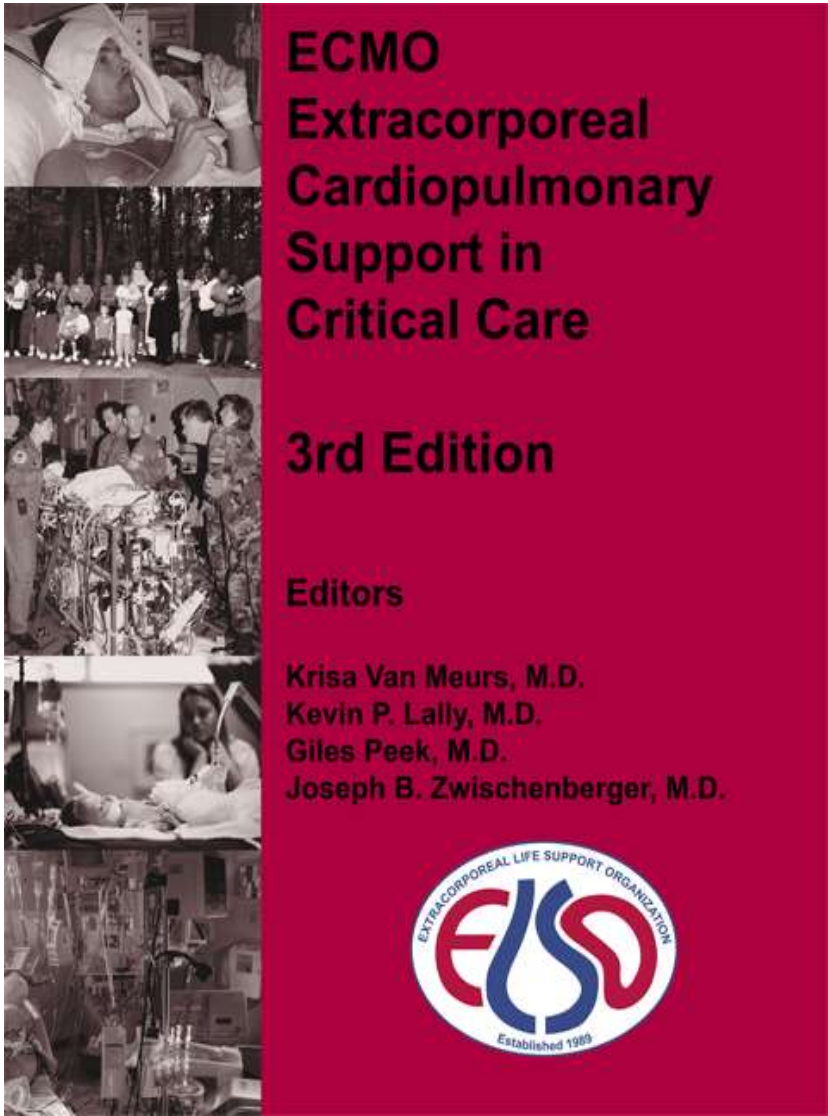
VV-ECMO

ECLS

Extracorporeal Life Support

1989

- The Extracorporeal Life Support Organization (ELSO)
- Grupo de centros que utilizan en forma activa el soporte vital extracorpóreo (ECLS) en el manejo de la falla cardiopulmonar.
- Funciones:
  - aumentar la comunicación
  - desarrollar guías para soporte extracorpóreo
  - mantener un registro de los casos de ECLS



Extracorporeal Life Support for 100 Adult Patients With Severe Respiratory Failure

ANNALS OF SURGERY
Vol. 226, No. 4, 544–566

Srinivas Kolla, M.D., Samir S. Awad, M.D., Preston B. Rich, M.D.,
Robert J. Schreiner, M.D., Ronald B. Hirschl, M.D., Robert H. Bartlett, M.D.

Selection Criteria

The original selection criteria we used for ECLS were the following: transpulmonary shunt >30%, compliance <0.5 mL/cm water/kg, mechanical ventilation <5 days, and age younger than 60 years of age.

VV-ECMO
100 adultos
Supervivencia : 54 %

Table 1. PATIENT CHARACTERISTICS FOR ADULT RESPIRATORY ECLS

	Hypoxemic Respiratory Failure (n = 94)	Hypercarbic Respiratory Failure (n = 6)
Survival/recovery (%)	(52.1/59.6)	(83.0/83.0)
Male/female (%)	(46.8/53.2)	(33.3/66.7)
Weight (kg)	77.6 ± 22.2	73.0 ± 17.5
Age (yr)	33.9 ± 12.5	37.8 ± 9.3
Duration of ECLS (hr)	285.3 ± 249.9	54.0 ± 41.5
p_aO_2/F_iO_2 ratio	55.7 ± 16.0	266.2 ± 161.8
Shunt (Q_s/Q_t)	0.52 ± 0.22*	0.25 ± 0.20
Pre-ECLS vent days	3.5 ± 2.7	3.8 ± 4.3
Last pre-ECLS ABG		
p_aO_2 (mmHg)	54.7 ± 15.0	187.5 ± 158.0
p_aCO_2 (mmHg)	45.4 ± 12.3	84.0 ± 31.5
pH	7.26 ± 0.76	7.19 ± 0.18
S_aO_2 (%)	82.0 ± 12.0	95.0 ± 7.5
Last pre-ECLS ventilator settings		
F_iO_2	1.00 ± 0.10	0.70 ± 0.30
PIP (cmH_2O)	46.5 ± 13.4	51.3 ± 9.9
PEEP	13.9 ± 4.8	2.2 ± 3.5
S_vO_2	49.8 ± 21.5*	72.2 ± 12.5

Extracorporeal Life Support for 100 Adult Patients With Severe Respiratory Failure

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Vol. 226, No. 4, 544–566

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Robert J. Schreiner, M.D., Ronald B. Hirschl, M.D., Robert H. Bartlett, M.D.

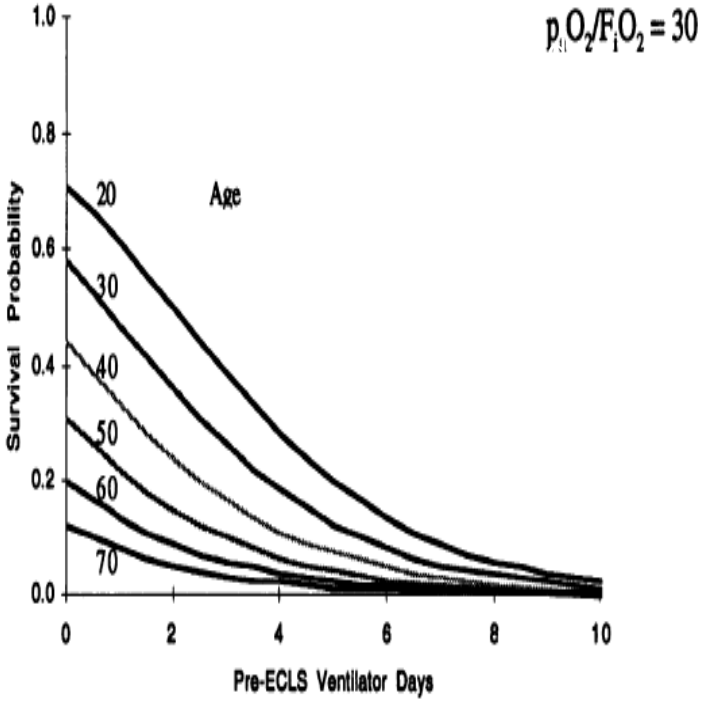


Table 7. SUMMARY OF THE STEPWISE LOGISTIC REGRESSION MODELS OF THE DEPENDENT VARIABLE "SURVIVAL" FOR 94 PATIENTS WITH PRIMARY HYPOXEMIC RESPIRATORY FAILURE TREATED WITH ECLS

Variable	β	SE	Chi Square	p Value	Odds Ratio
Pre-ECLS					
Age (yr)	>0.0580	0.0209	7.7005	0.0055	1.060
p_aO_2/F_iO_2 ratio	0.0628	0.0204	9.4636	0.0021	0.939
Ventilator days	−0.4607	0.1261	13.3422	0.0003	1.585
Constant	0.1962	1.2164	—	—	—
During ECLS					
Bleeding	−2.0247	0.5819	12.1080	0.0005	7.574
Creatinine >1.5 mg/dL	−2.6513	0.5805	20.8618	<0.0001	14.172
Constant	2.7127	0.6148	—	—	—

2000

Extracorporeal Life Support
The University of Michigan Experience

JAMA®
The Journal of the American Medical Association

2000;283:904-908.

Robert H. Bartlett, MD; Dietrich W. Roloff, MD; Joseph R. Custer, MD; John G. Younger, MD; Ronald B. Hirschl, MD

Extracorporeal Life Support
The University of Michigan Experience

- Universidad de Michigan
- Grupo trabaja especificamente con técnica V-A (Hemmila y col.)
- Son tratados aproximadamente 20 pacientes por año con SDRA severo
- Criterio principal de ingreso: $PaO2/FiO2 \leq 100$
- Con una sobrevida estimada del 52%.VA-ECMO

Extracorporeal Life Support
The University of Michigan Experience

- 1000 pacientes consecutivos entre 1980 y 1998

Survival to hospital discharge

.

Respiratory failure

88% in 586 neonates
70% in 132 children
56% in 146 adults

Cardiac failure

48% in 105 children
33% in 31 adults.

■ Rev Méd Chile 2005; 133: 1065-1070

CASO CLÍNICO

Oxigenación con membrana extracorpórea en pacientes pediátricos. Comunicación de los 3 primeros casos tratados

Javier Kattan S[1,2], Alvaro González M[1,2], Pedro Becker R[1,3], José I Rodríguez C[1,2], Alberto Estay N[1,2], Miriam Faunes P[1,2,a], Christian Fajardo J[1,4], Roberto Canessa B[4], por Grupo ECMO-UC[1].

Conventional Ventilation or ECMO for Severe Adult Respiratory Failure

A Collaborative Randomised Controlled Trial

PROTOCOL
February 2003

ISRCTN47279827

- Adult patients (18-65 years)

- Severe, but *potentially reversible* respiratory failure:
  - Murray score >3.0, or
  - uncompensated hypercapnoea with a pH <7.20.

- The Murray score using all 4 parameters

- The Murray score of 3.0 is a MINIMUM entry criterion

- Duration of high pressure and/or high FIO2 ventilation < 7 days
- no intra-cranial bleeding
- no contra-indication to heparinisation

Conventional Ventilation or ECMO for Severe Adult Respiratory Failure

A Collaborative Randomised Controlled Trial

PROTOCOL
February 2003

ISRCTN47279827

Conventional Management

Plateau pressure <30 cm H2O (or if plateau pressure is not measured the peak inspiratory pressure).

This will usually mean a tidal volume of 4-8ml/kg body weight as defined in the low tidal volume ventilation strategy according to the ARDS Network group

Health Technology Assessment 2010; Vol. 14: No. 35

Randomised controlled trial and parallel economic evaluation of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR)

GJ Peek, D Elbourne, M Mugford,
R Tiruvoipati, A Wilson, E Allen,
F Clemens, R Firmin, P Hardy,
C Hibbert, N Jones, H Killer, M Thalanany
and A Truesdale

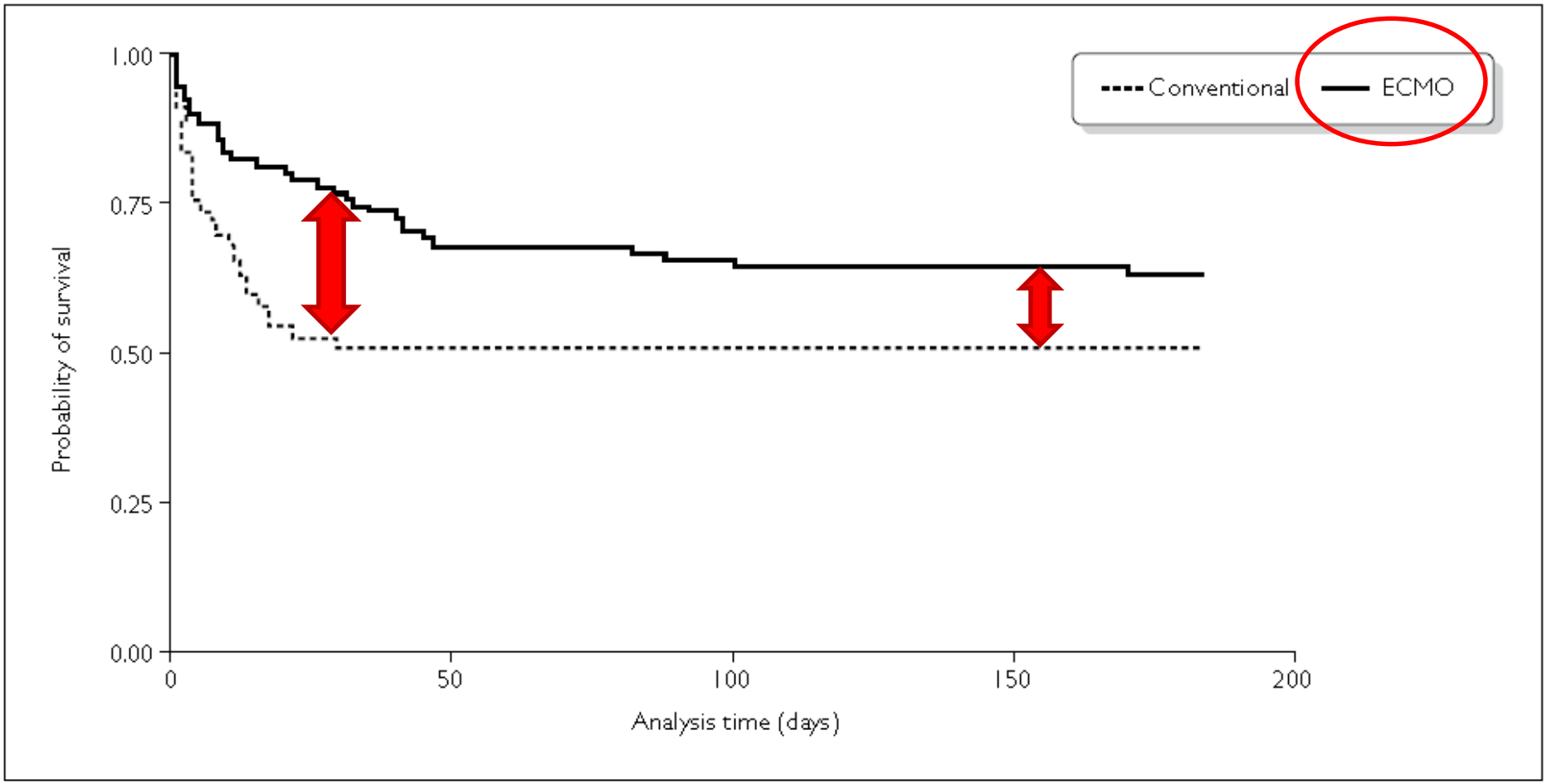
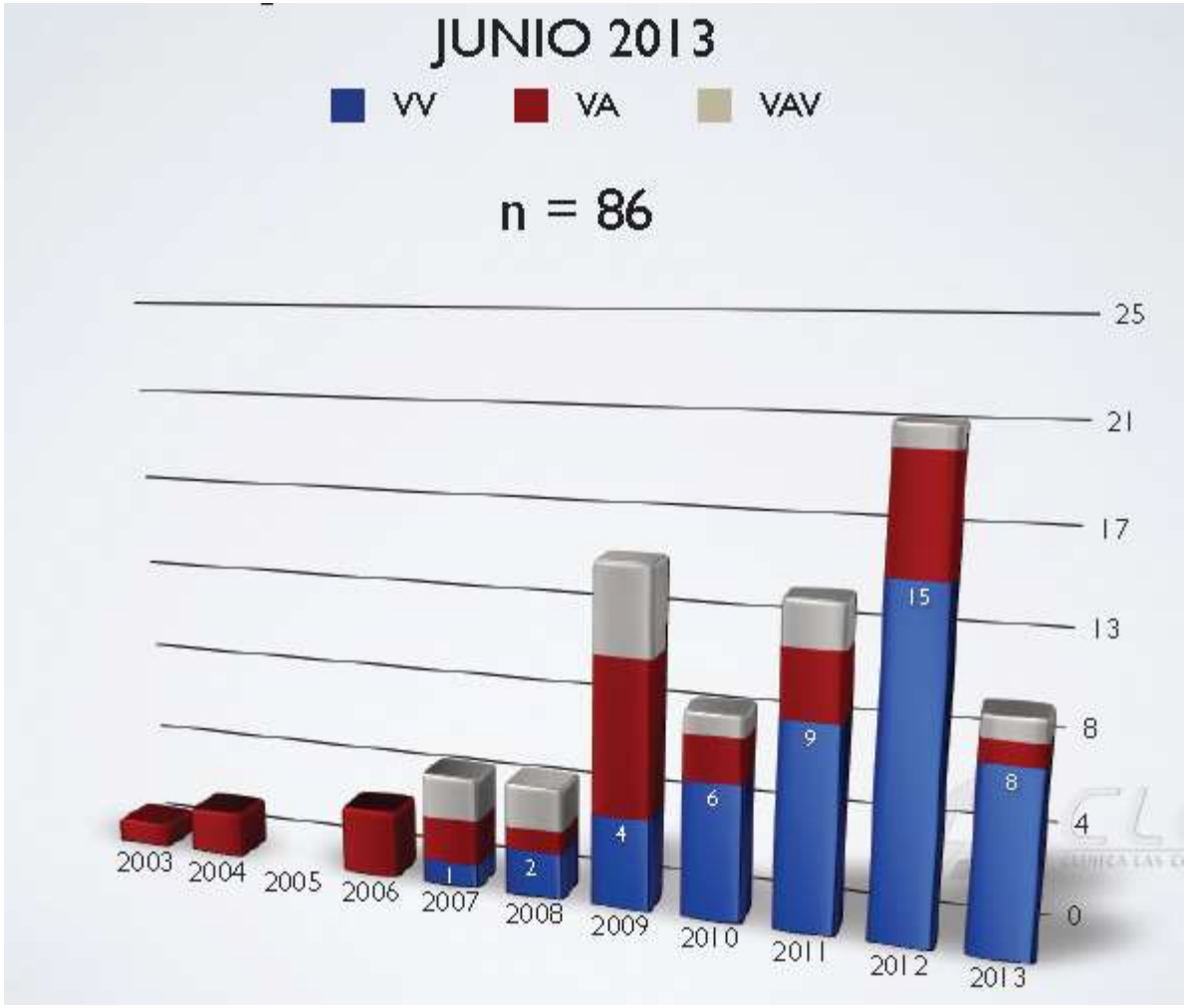


FIGURE 2 *Kaplan–Meier survival estimates, by allocation.*

CLINICA LAS CONDES – SANTIAGO DE CHILE



Extracorporeal Life Support Organization
Resultados CLC

Resumen Internacional - Junio 2013
SOBREVIDA

n=86

INDICACION	NEONATAL	PEDIATRICA	ADULTOS
Respiratoria	75% - 3/3	56% - (10/15) 67%	55% - (29/41)71%
Cardíaca	40% - NO	49% - NO	39% - (6/21)29%
ECPR	39% - NO	41% - 2/2	28% - 0/3

n=85 + 1 en curso

58% sobrevida global

registro ELSO

Soporte vital extracorpóreo para la falla respiratoria en adultos

	Total de casos	Sobrevivientes	% sobrevientes
Neumonía bacteriana	186	97	52
Neumonía viral	87	54	62
Neumonía por aspiración	32	18	56
SDRA postor/trauma	132	68	52
SDRA no postor/trauma	196	100	51
ALI, no SDRA	55	35	64
Otros	317	154	49

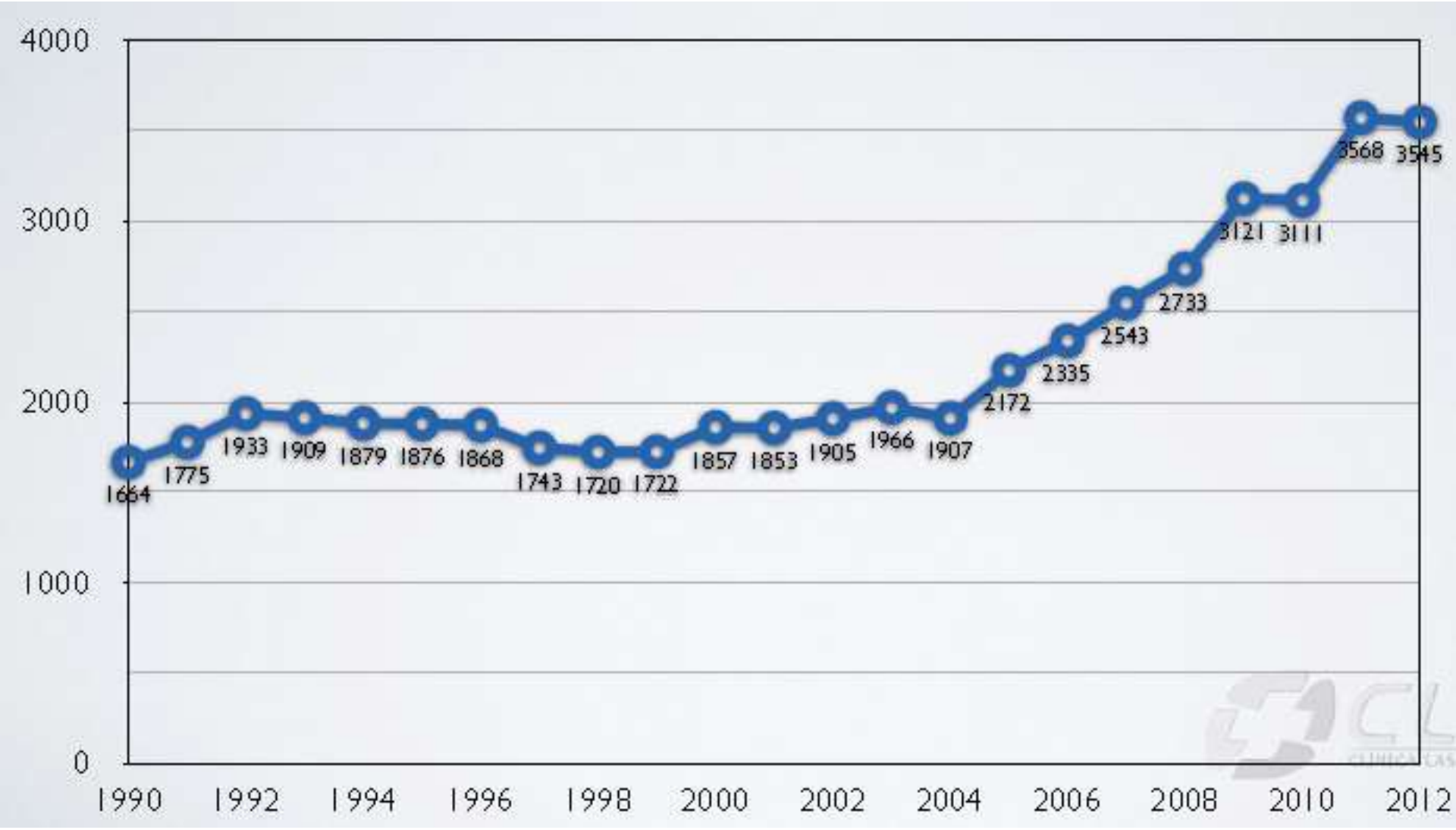
registro ELSO

TABLA 3. REGISTRO INTERNACIONAL ELSO ENERO 2011 (32)

	TOTAL (N)	SOBREVIVEN ECMO (%)	DE ALTA O TRASLADADOS (%)
NEONATAL			
Respiratoria	24344	20608 (85%)	18276 (75%)
Cardiaca	4232	2566 (61%)	1663 (39%)
ECPR	640	403 (63%)	245 (38%)
PEDIÁTRICA			
Respiratoria	4771	3094 (65%)	2656 (56%)
Cardiaca	5221	3322 (64%)	2502 (48%)
ECPR	1220	646 (53%)	479 (39%)
ADULTO			
Respiratoria	2340	1474 (63%)	1261 (54%)
Cardiaca	1540	812 (53%)	598 (39%)
516	381	201 (39%)	153 (30%)
TOTAL	44824	33126 (74%)	27833 (62%)

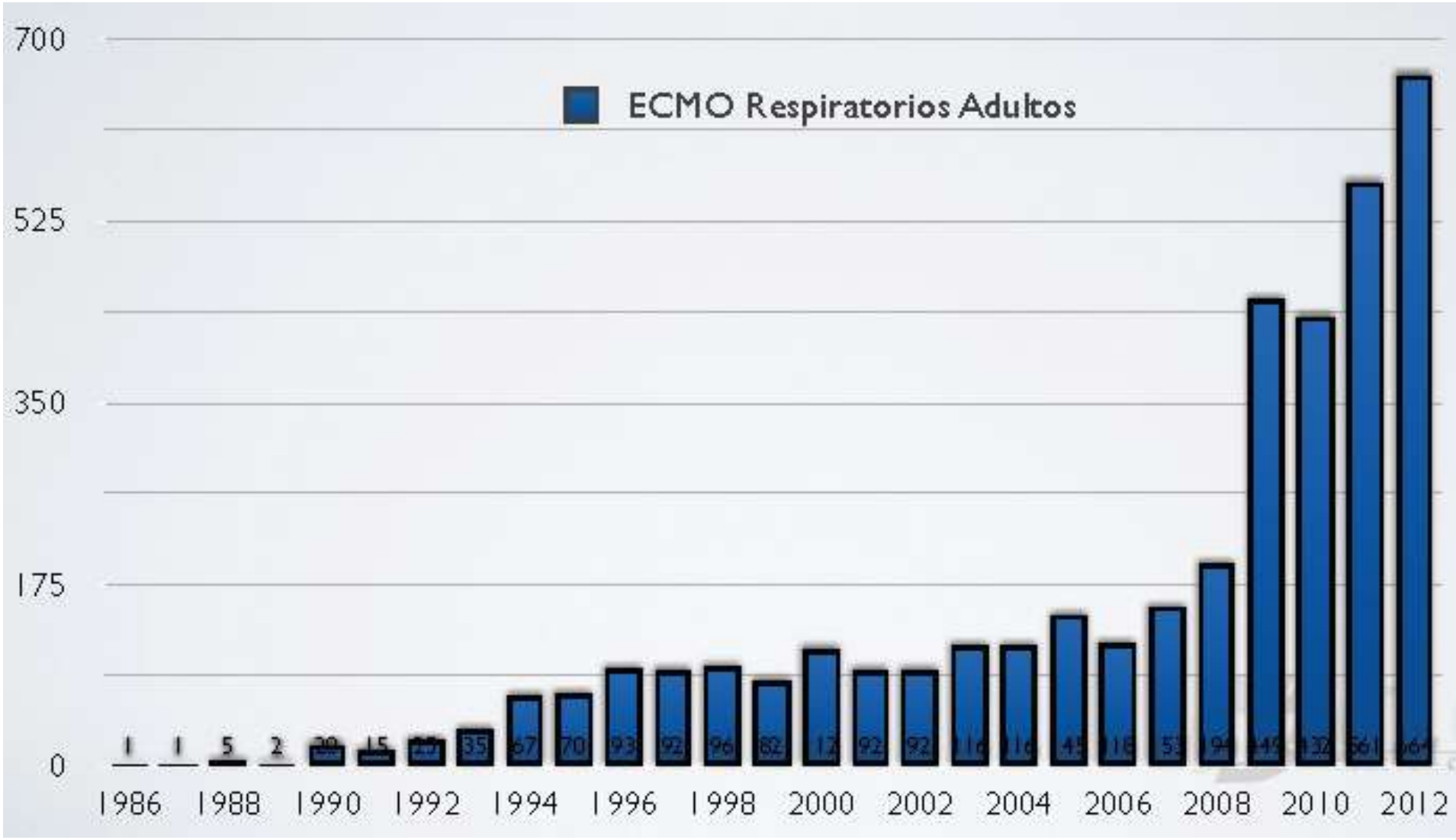
ELSO

NUMERO DE CASOS ECMO – ENERO 2013



ELSO

SOPORTE RESPIRATORIO – ENERO 2013



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Extracorporeal Life Support Organization

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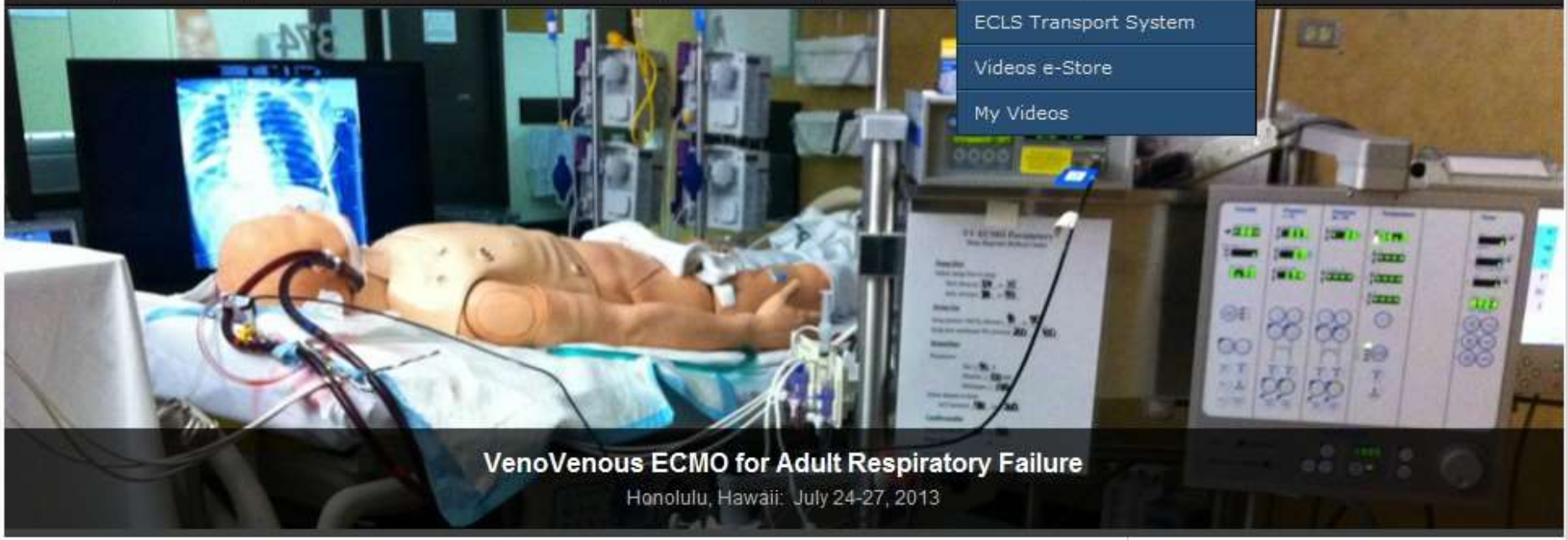
- ECLS Transport System
- Videos e-Store
- My Videos



Welcome!

Members, please log in on the top right.

The **Extracorporeal Life Support Organization** (ELSO) is an international consortium of health care professionals and scientists who are dedicated to the development and evaluation of novel therapies for support of failing organ systems. Crucial is the promotion of a broad multidisciplinary collaboration. The primary mission of the Organization

News Feeds | Announcements

Clinical Trials | Device | Research

- Transition from ECMO to left ventricular support via trans-

UTHealth
The University of Texas Health Science Center at Houston
Medical School

Children's Memorial Hermann Hospital

ELSO GUIDELINES FOR TRAINING AND CONTINUING EDUCATION OF ECMO SPECIALISTS

TRAINING OUTLINE: NEW ECMO PROGRAM

A. **Didactic Course**: The didactic course should include, but not be limited to the following topics. Between 24 to 36 hours will be required to cover the following material. Case presentations are encouraged.

B. **Water-drills**: These sessions should be small enough so that each individual has hands-on experience. A full understanding of all possible circuit emergencies and the appropriate intervention should be accomplished by the end of this session. Each trainee should be able to describe and conceptually demonstrate how to change the major equipment (oxygenator, heat exchange, bladder) in a reasonable period of time. They should be able to change less complicated components of the circuit (raceway, pigtails, and checking pump head occlusion on ECMO) in a pre-established period of time.

C. **Animal Laboratory Sessions:** As bedside training sessions are not possible in a new ECMO center, more extensive laboratory training is required compared to an experienced center.

UCI- HNERM

PROYECTO DE TRABAJO

UNIDAD DE SOPORTE VITAL EXTRACORPOREO(ECLS) – OXIGENACION EXTRACORPOREA POR MEMBRANA (ECMO)

SERVICIO DE CUIDADOS INTENSIVOS I - HNERM EsSALUD

UNIDAD DE SOPORTE VITAL EXTRACORPOREO(ECLS) – OXIGENACION EXTRACORPOREA POR MEMBRANA (ECMO)

SERVICIO DE CUIDADOS INTENSIVOS I - HNERM EsSALUD

PROGRAMA DE CAPACITACION

Modelo experimental animal para ECMO

sus scrofa domestica (especie porcina)

UCI 2C – HNERM - EsSALUD

ANEXO 4: IOT EN CERDOS

Relación entre el tamaño del tubo endotraqueal y el peso del animal

Peso del animal (kg)	Diámetro (mm)
< 10	3-4
10-15	4-5
15-25	5-6
25-50	6-9
50-100	8-10
> 1000	10-16

ORGANIZACIÓN DE LA SALA


2


UCI- HNERM
Animal Lab sessions
ECMO TEAM 1

ECMO TEAM 1


ECMO TEAM 3
ECMO TEAM 2

MODELO DE FALLA RESPIRATORIA AGUDA


HAMILTON
MEDICAL
(S)CMV
Adulto
Paciente
Otros
Modo
Controles
Alarmas

UCI- HNERM

Animal Lab sessions

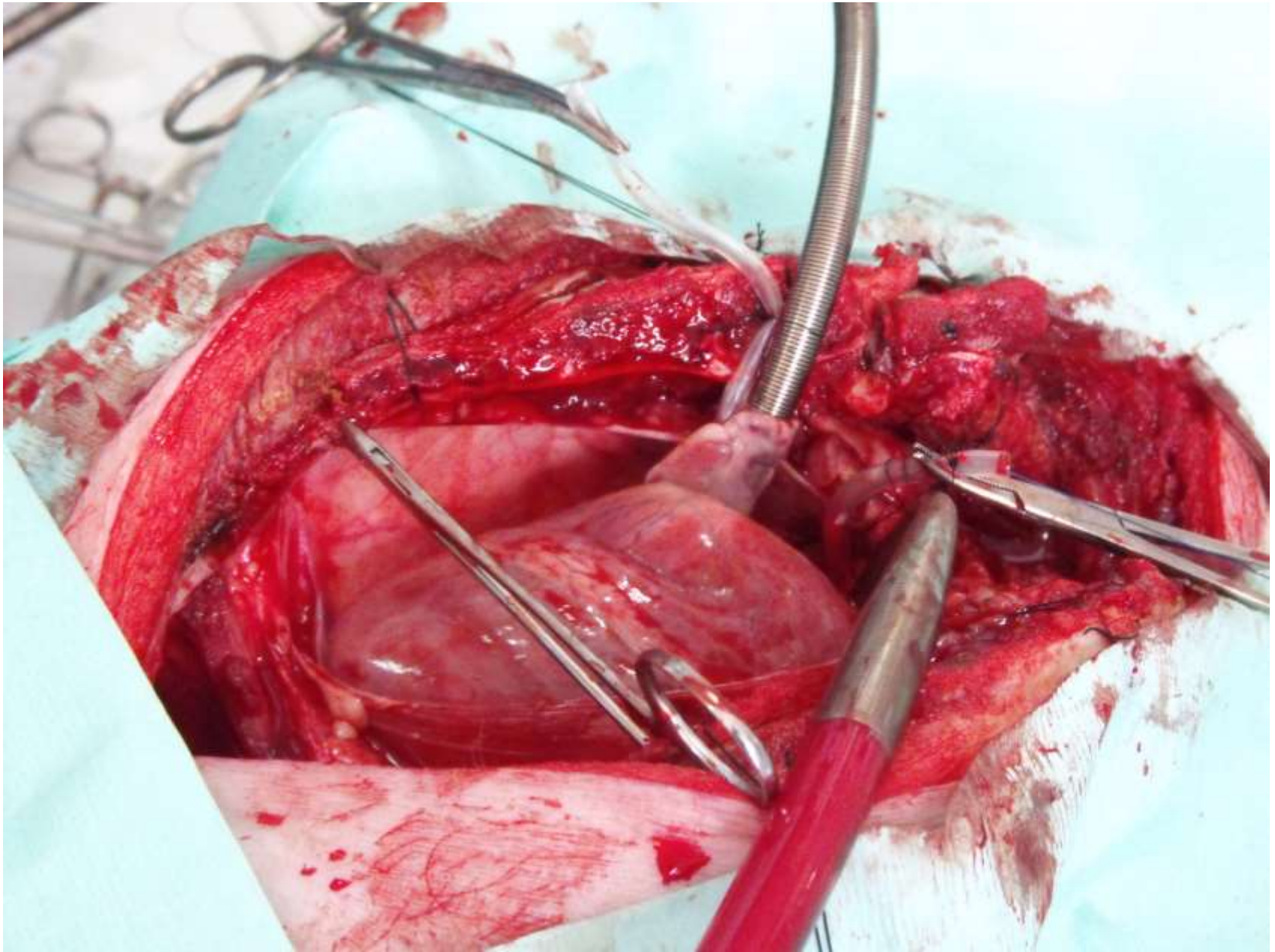
UCI- HNERM

Animal Lab sessions

FCV

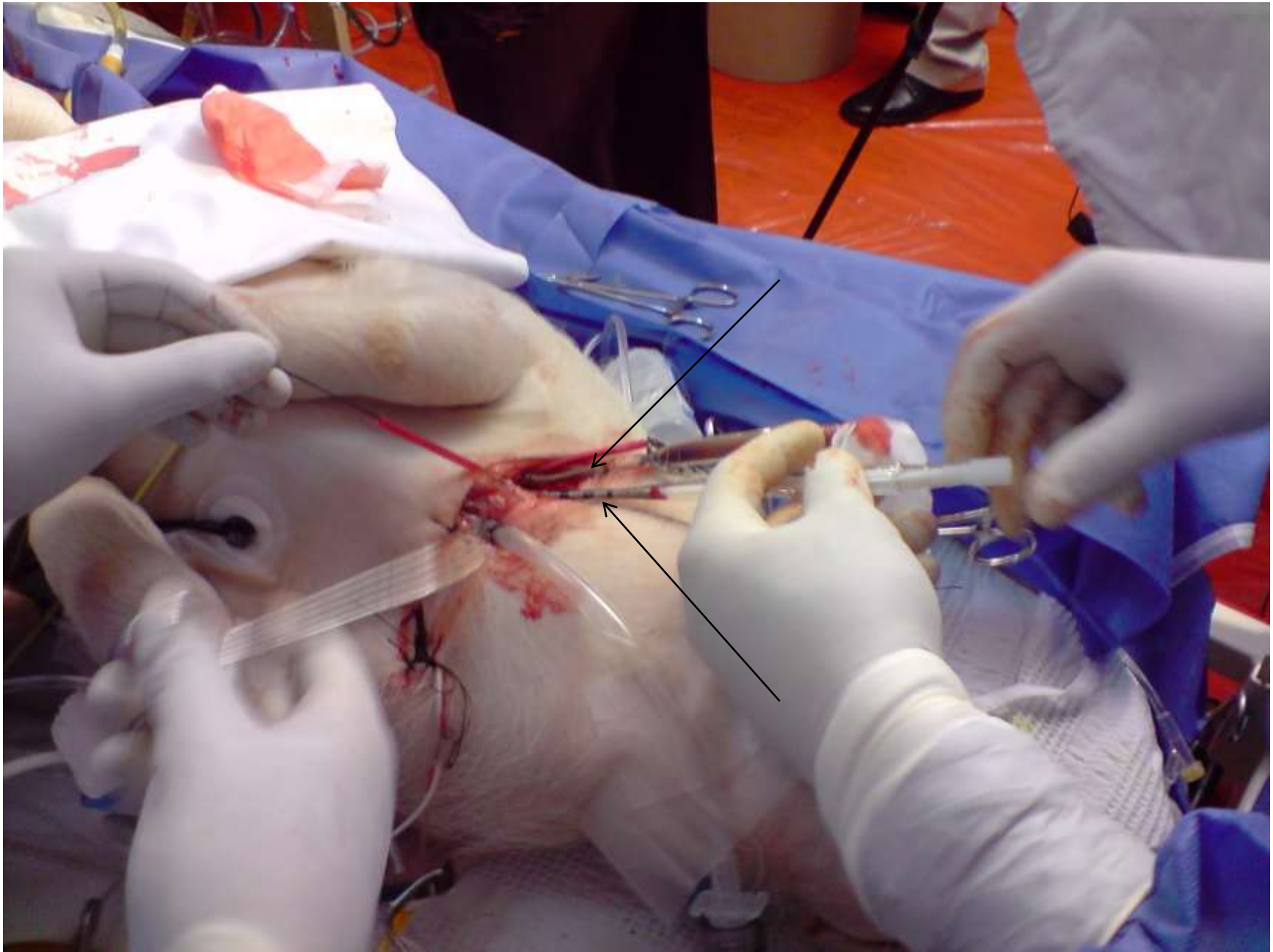
Colombia

CANULACION CENTRAL PARA ECMO

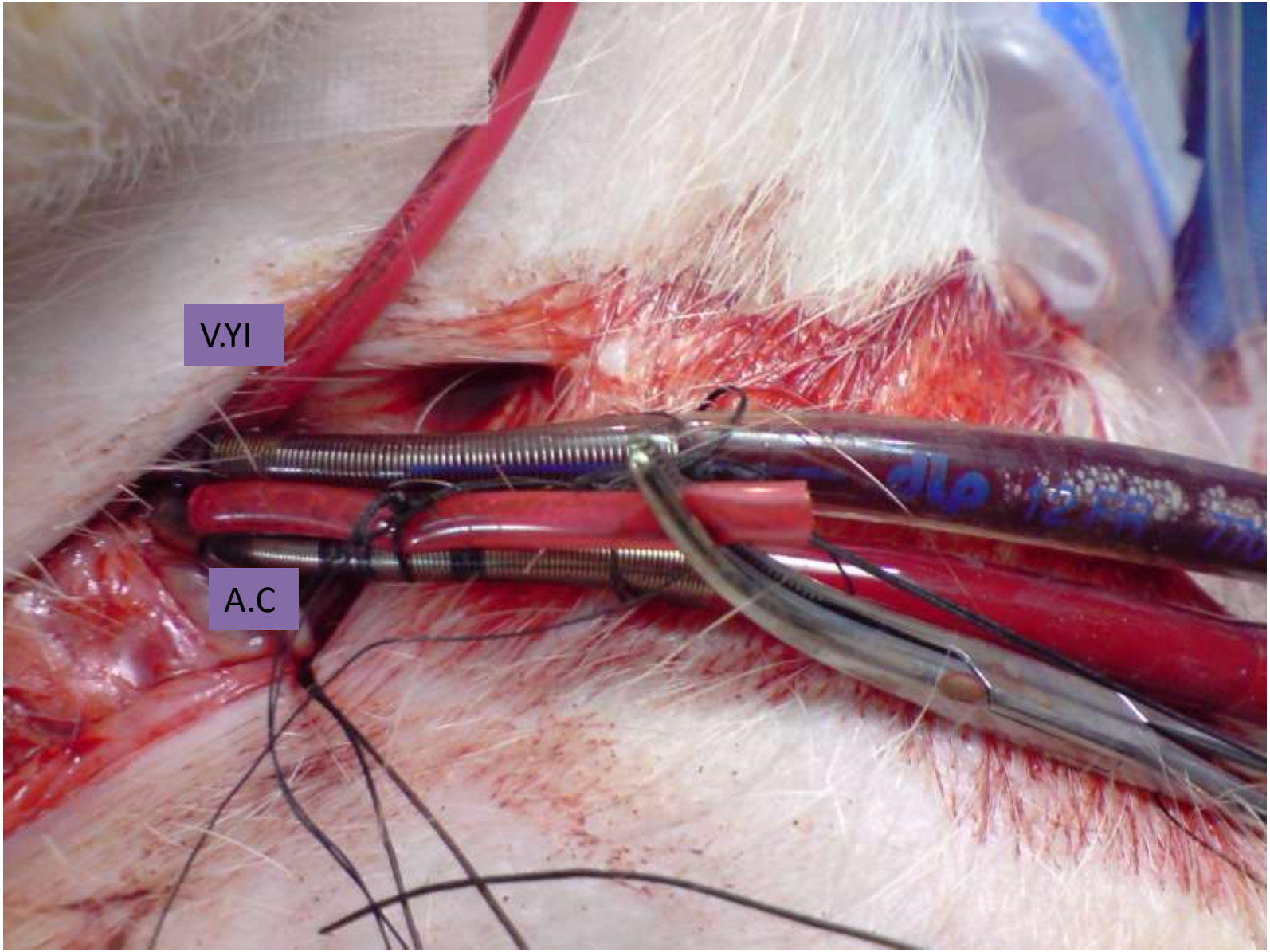


CANULACION CENTRAL PARA ECMO

CANULACION V-A

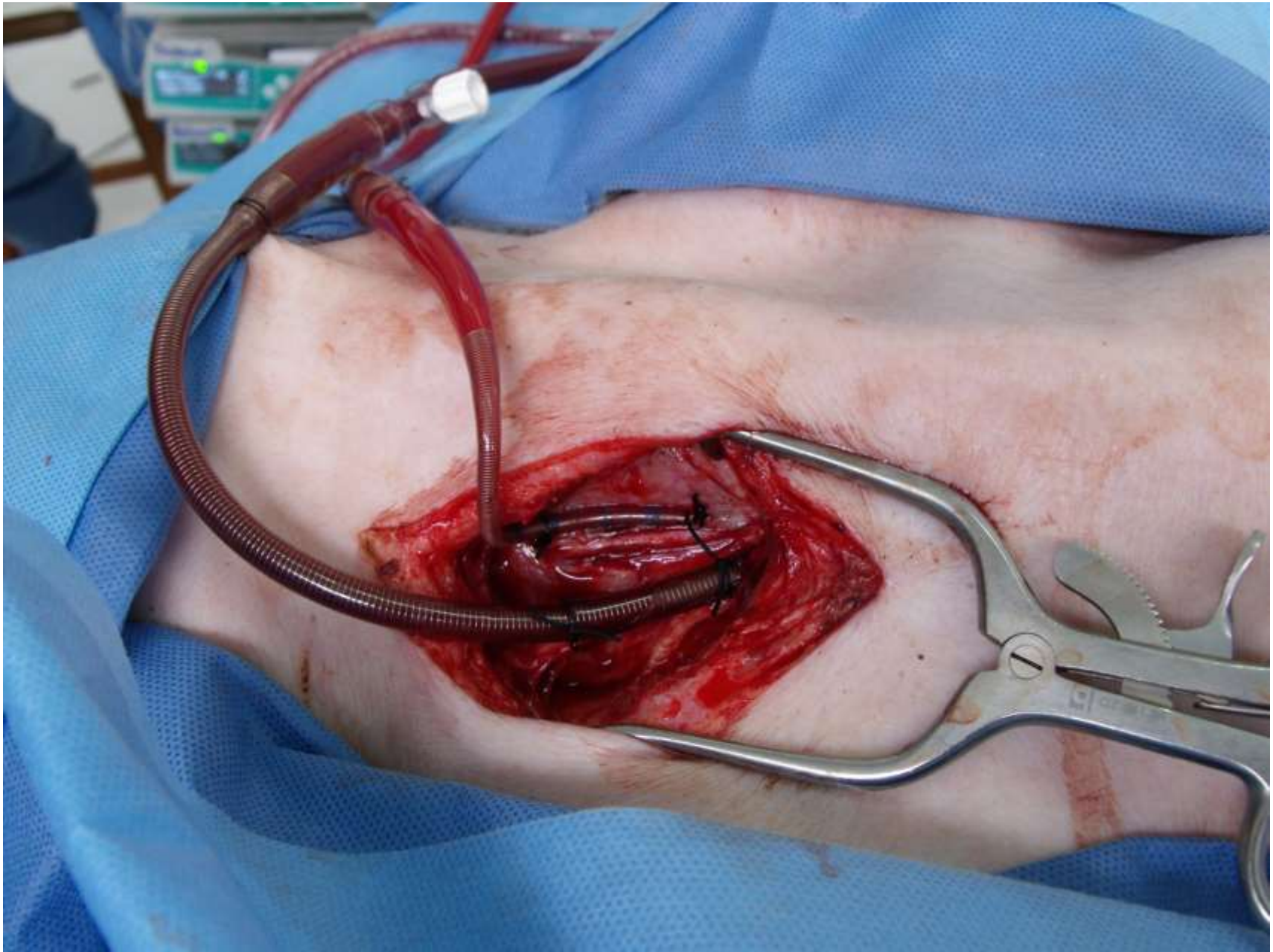


CANULACION V-A (cervical)

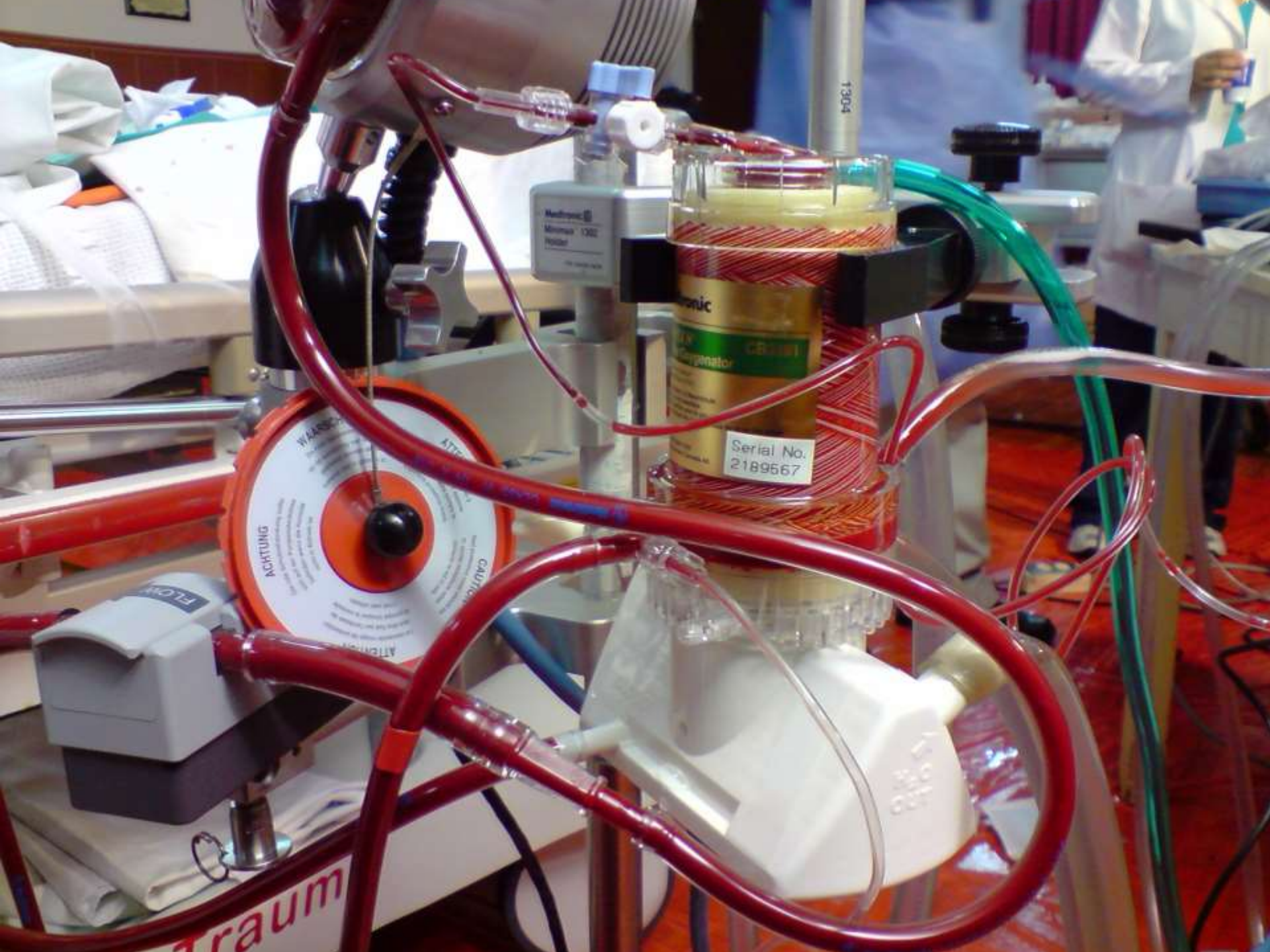



EsSalud

CANULACION V-A (femoral)




2.36
Bio-Console® 560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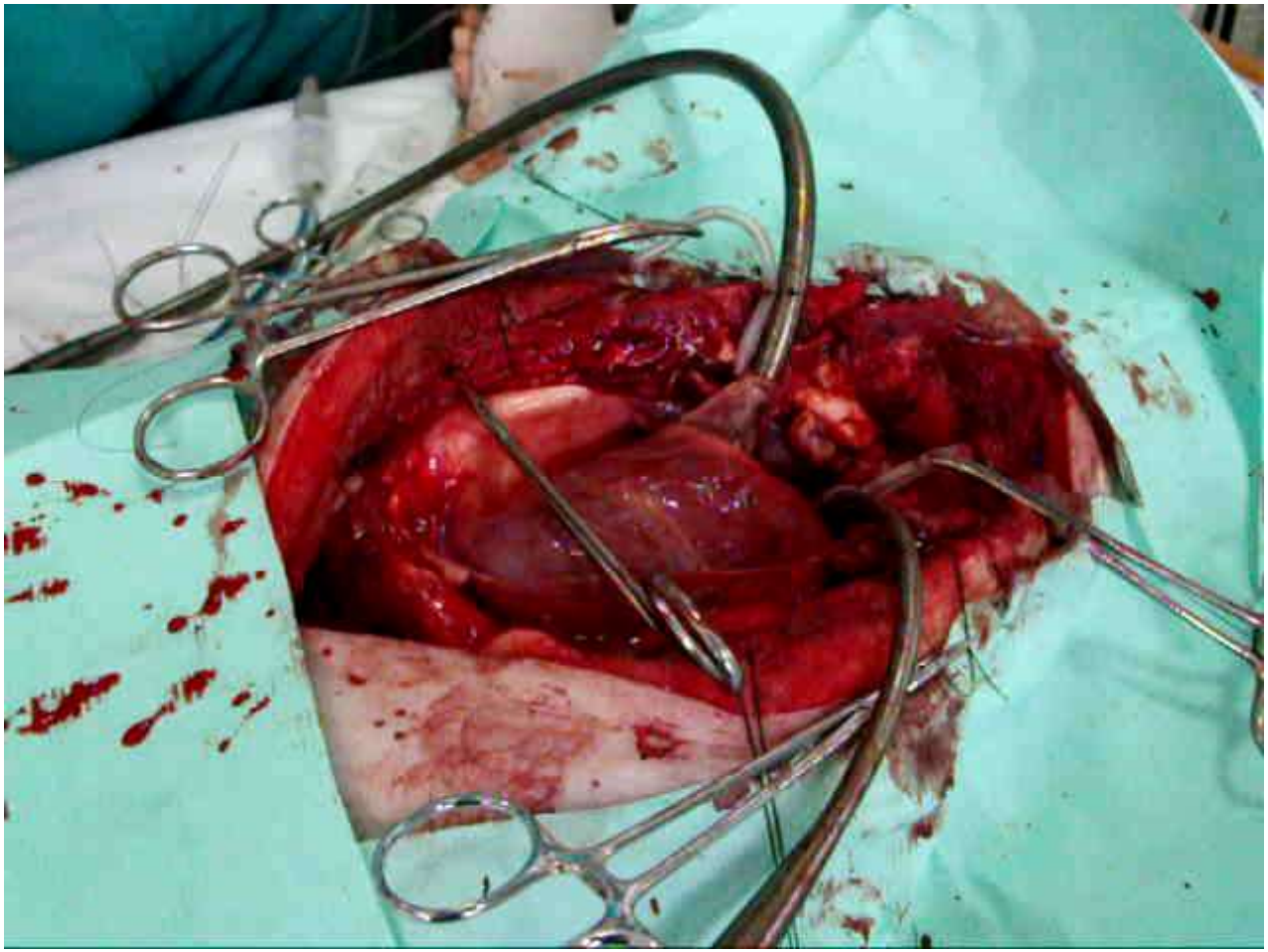
ANIMAL-LAB CANULACION CENTRAL



Curso PRINCIPIOS Y PRACTICAS DEL SOPORTE VITAL EXTRACORPÓREO

CLUB CAMPESTRE. FLORIDABLANCA COLOMBIA

“Si buscas resultados distintos, no hagas siempre lo mismo”

Albert Einstein