"Presión y Flujo como determinantes en el manejo del paciente en Shock"

Dr. Juan Víctor Lorente Olazábal

U.G.C. Anestesiología, Reanimación y T. del Dolor.

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SARTD-CHGUV Sesión de Formación Continuada
Valencia 11 de Noviembre de 2019

AGENDA

- 1-Definición de **Shock**
- 2-Formas de corregir la **hipoperfusión**
    - 2.1. Precarga. Elección del fluido de reanimación
    - 2.2. Contractilidad. ¿Utilidad absoluta de la fracción eyección?.
    - 2.3. Postcarga:
        - 2.3.1. ¿Resistencias venosas como parámetro postcarga?
        - 2.3.2. Flujo y presión
        - 2.3.3. Análisis onda de presión
        - 2.3.4. Elastancia arterial dinámica
- 3-Monitorización de la **microcirculación**: ¿Futuro o Realidad?
- 4-**Conclusiones**

1-Definición de Shock

Intensive Care Med (2014) 40:1795–1815
DOI 10.1007/s00134-014-3525-z

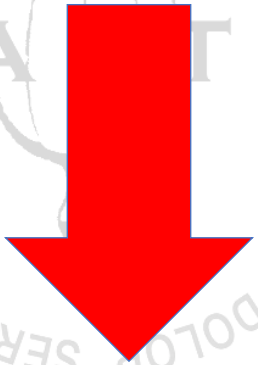
CONFERENCE REPORTS AND EXPERT PANEL

Maurizio Cecconi
Daniel De Backer
Massimo Antonelli
Richard Beale
Jan Bakker
Christoph Hofer
Roman Jaeschke
Alexandre Mebazaa
Michael R. Pinsky
Jean Louis Teboul
Jean Louis Vincent
Andrew Rhodes

Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine

1-Definición de Shock

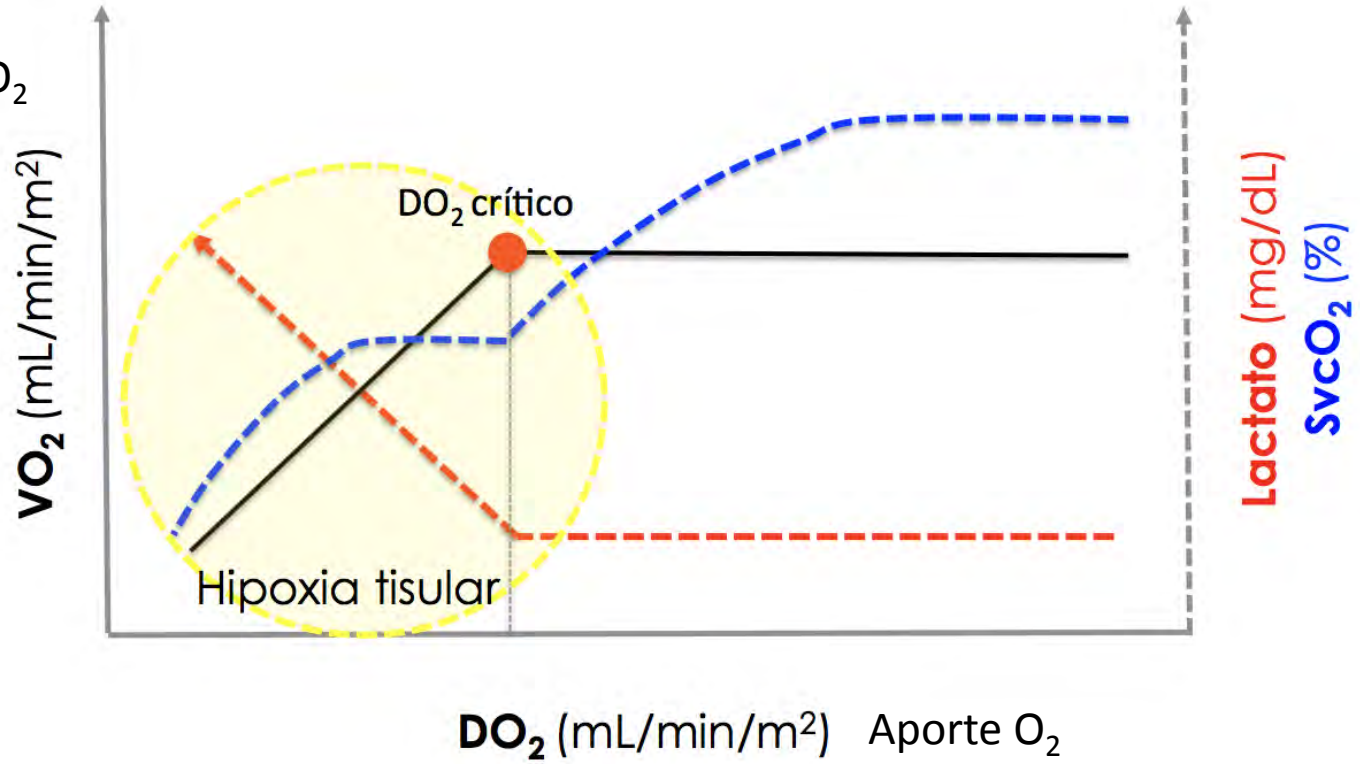
Estado caracterizado por una **perfusión del tejido insuficiente** para cubrir sus necesidades metabólicas



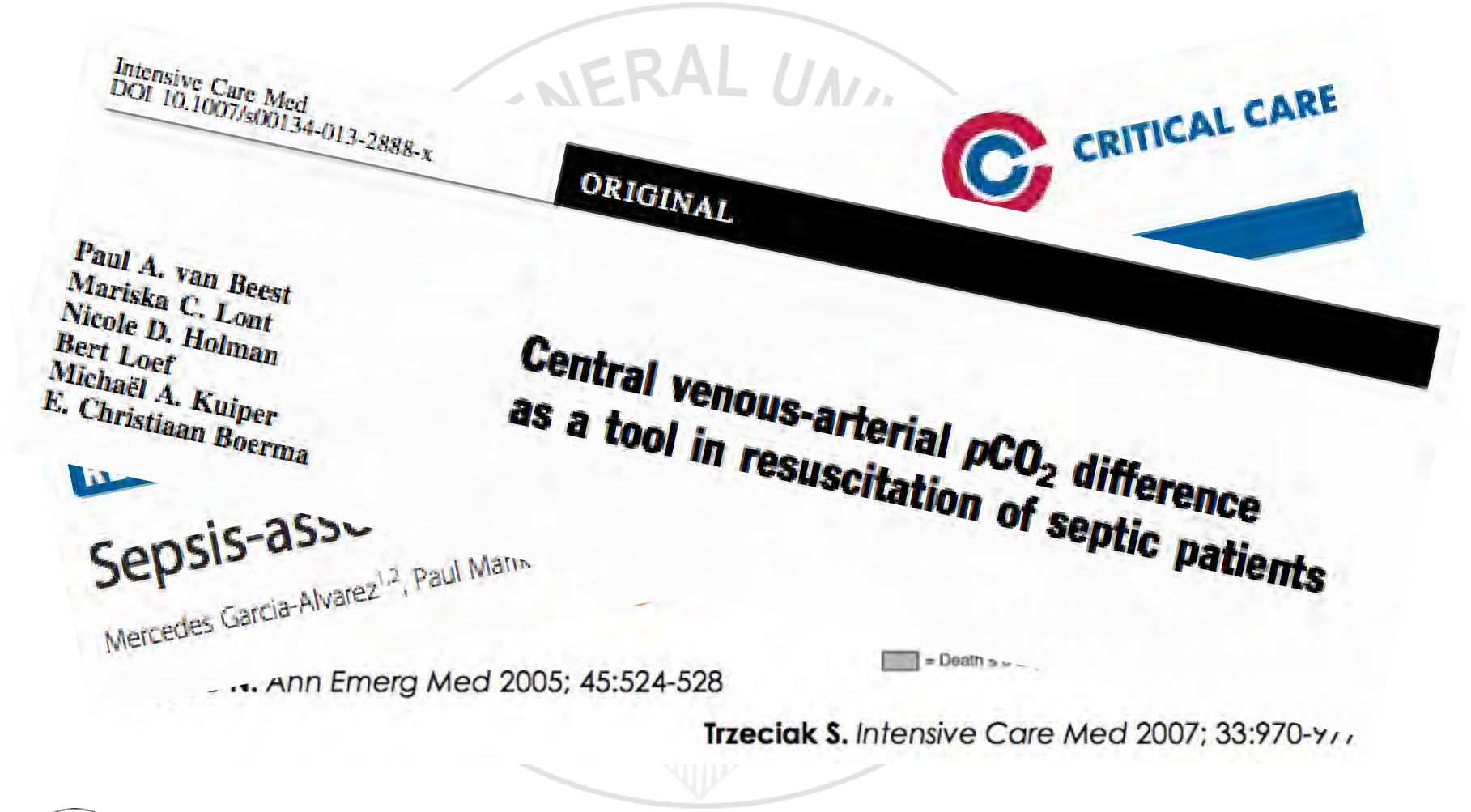
Desequilibrio entre el **aporte** y la **demanda** de oxígeno

1-Definición de Shock

Consumo O_2



1-Definición de Shock



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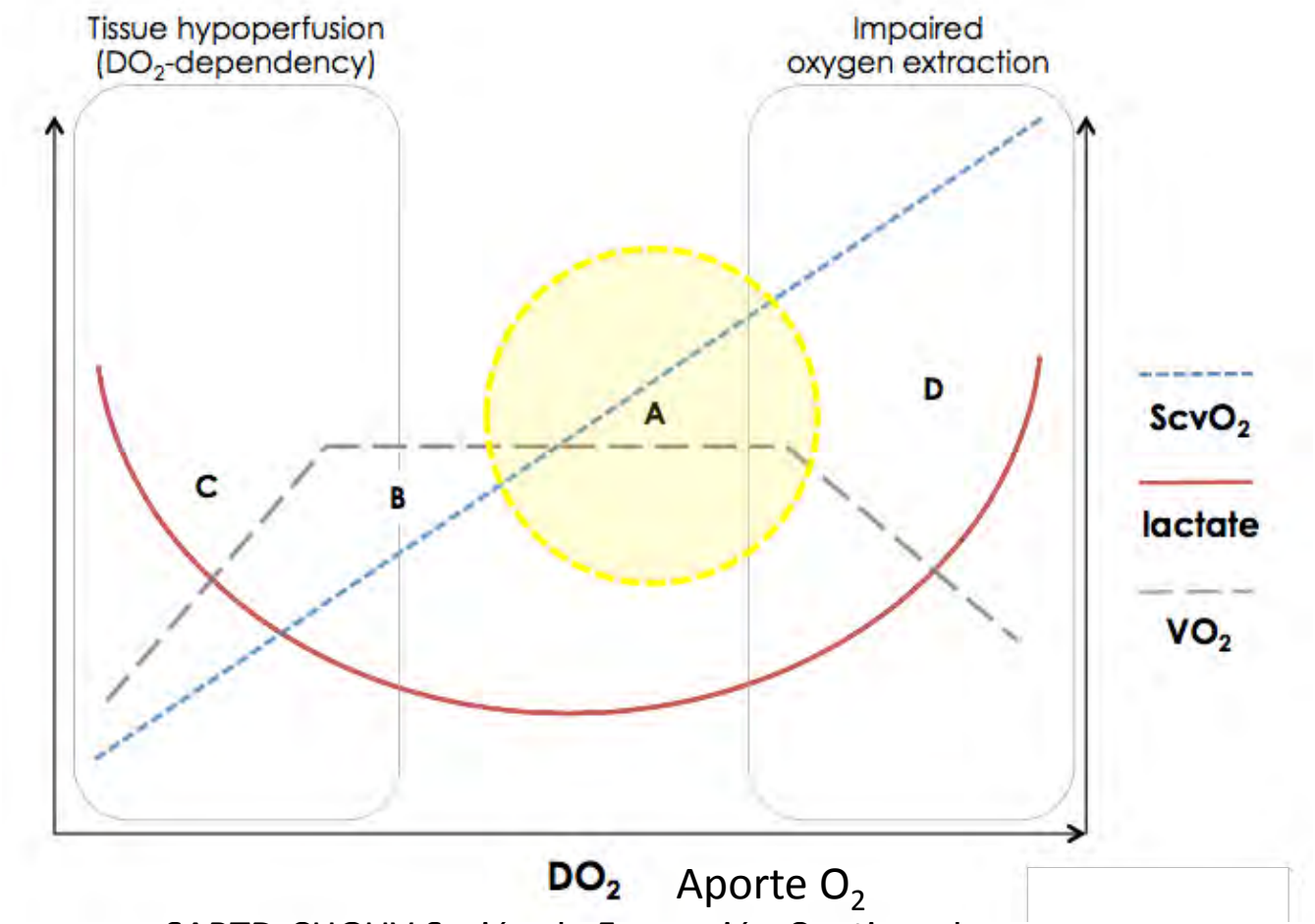

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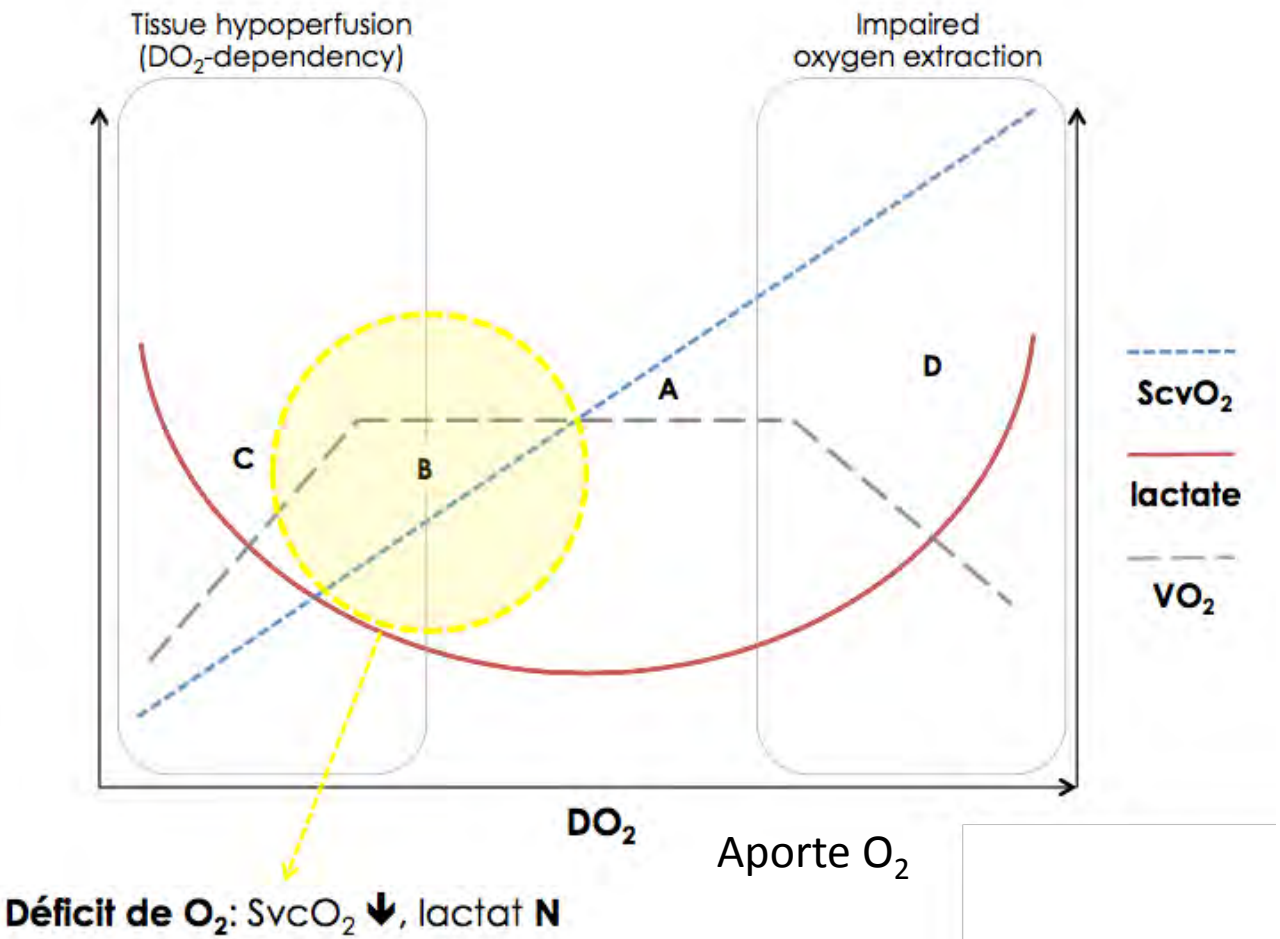

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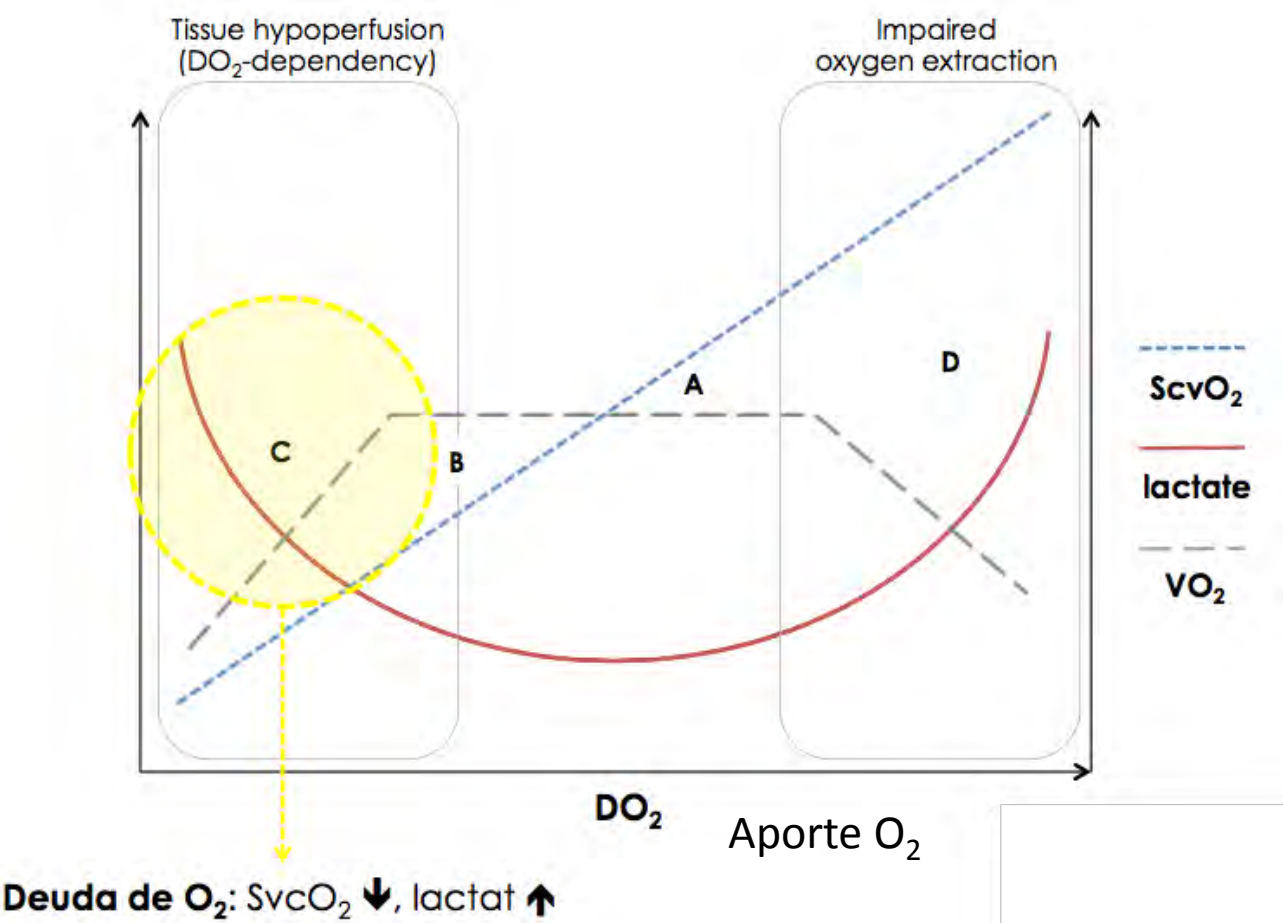

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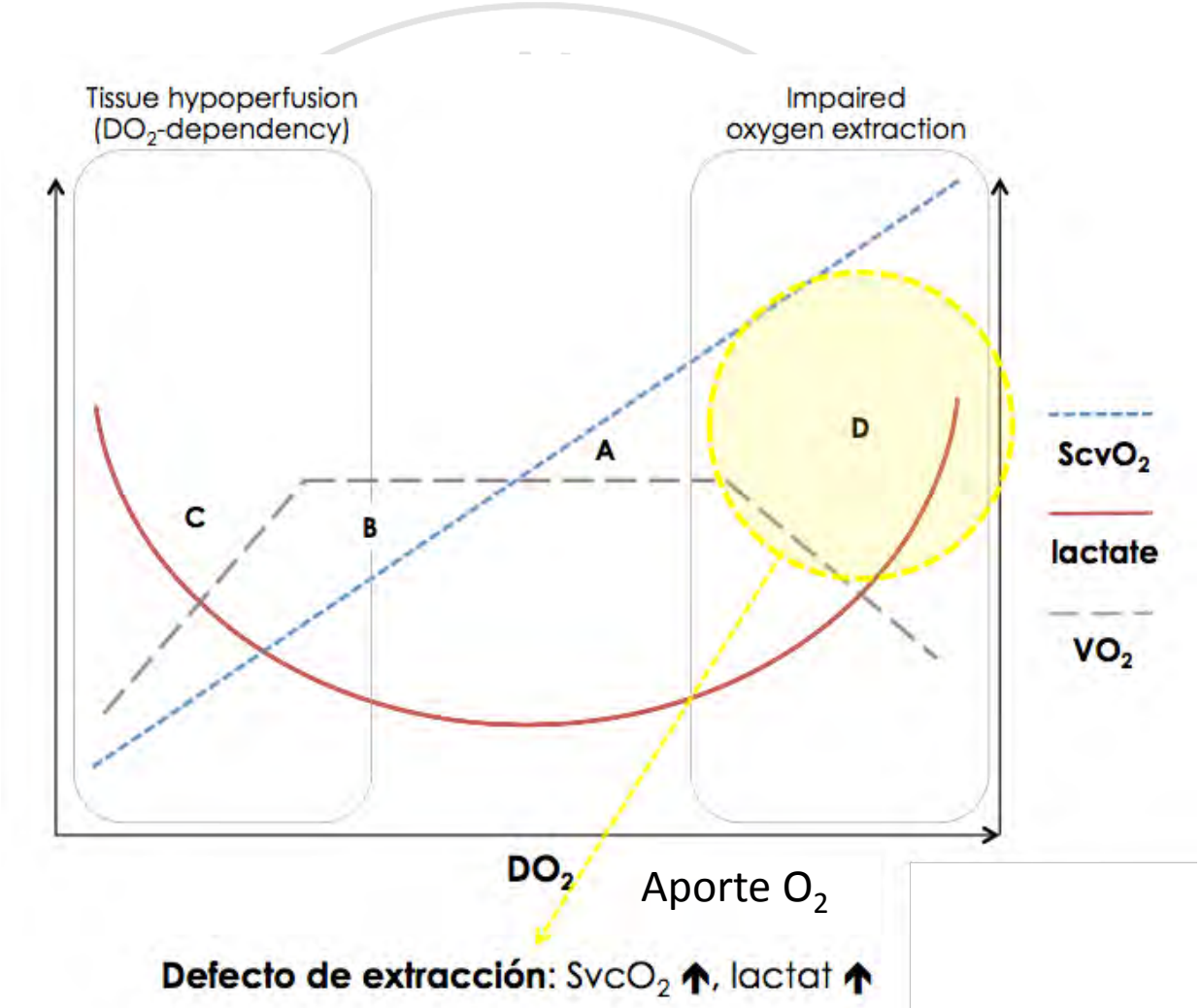

1-Definición de Shock

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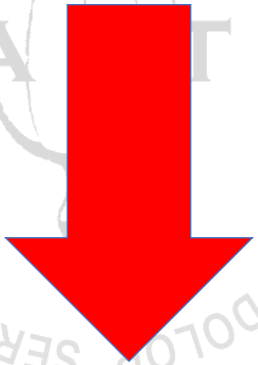
Estado caracterizado por una **perfusión del tejido insuficiente** para cubrir sus necesidades metabólicas



Desequilibrio entre el **aporte** y la **demanda** de oxígeno

Shock compensado y descompensado

1-Definición de Shock

Journal of Thoracic Disease, Vol 11, Suppl 11 July 2019 S1555

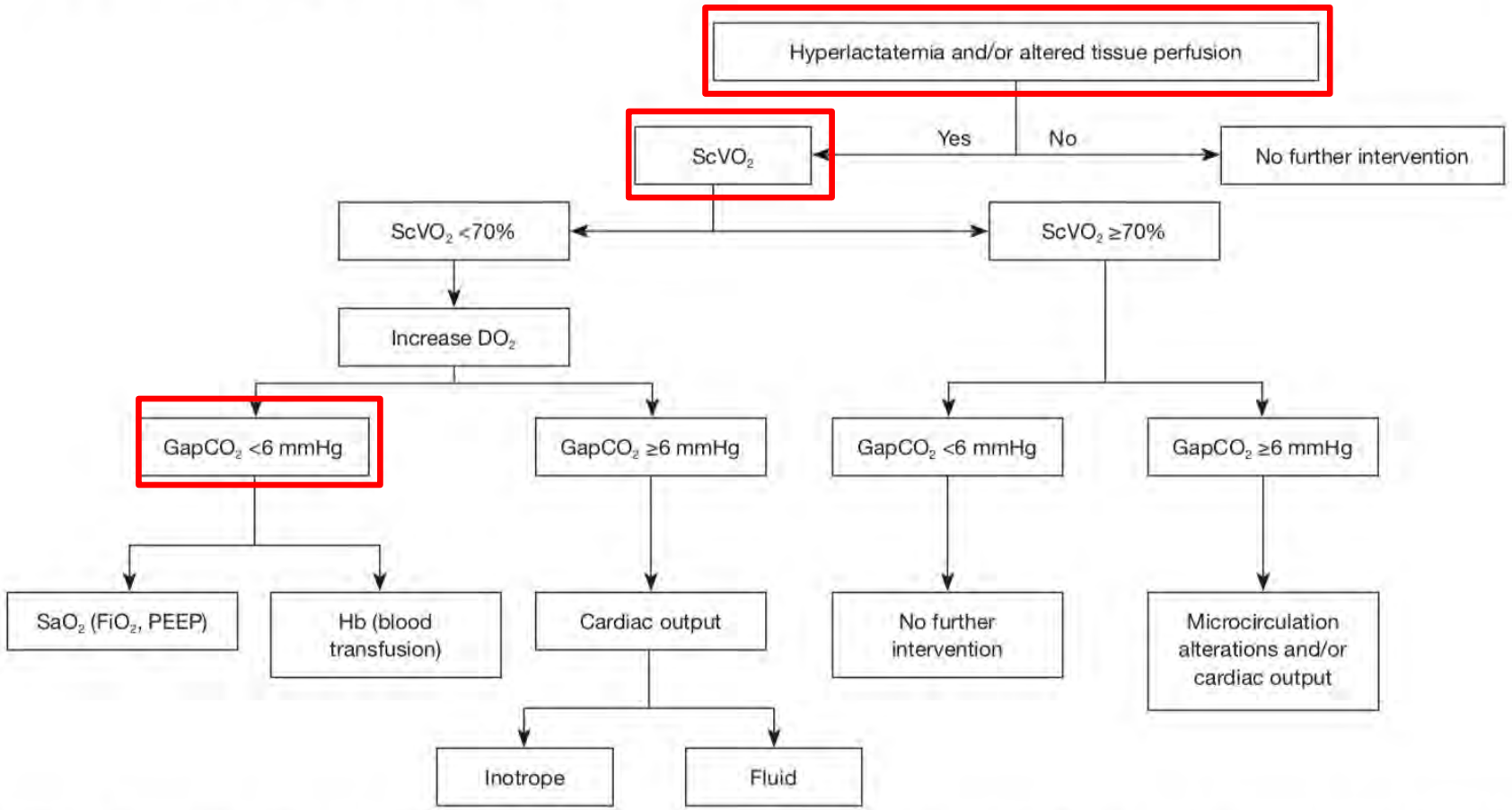
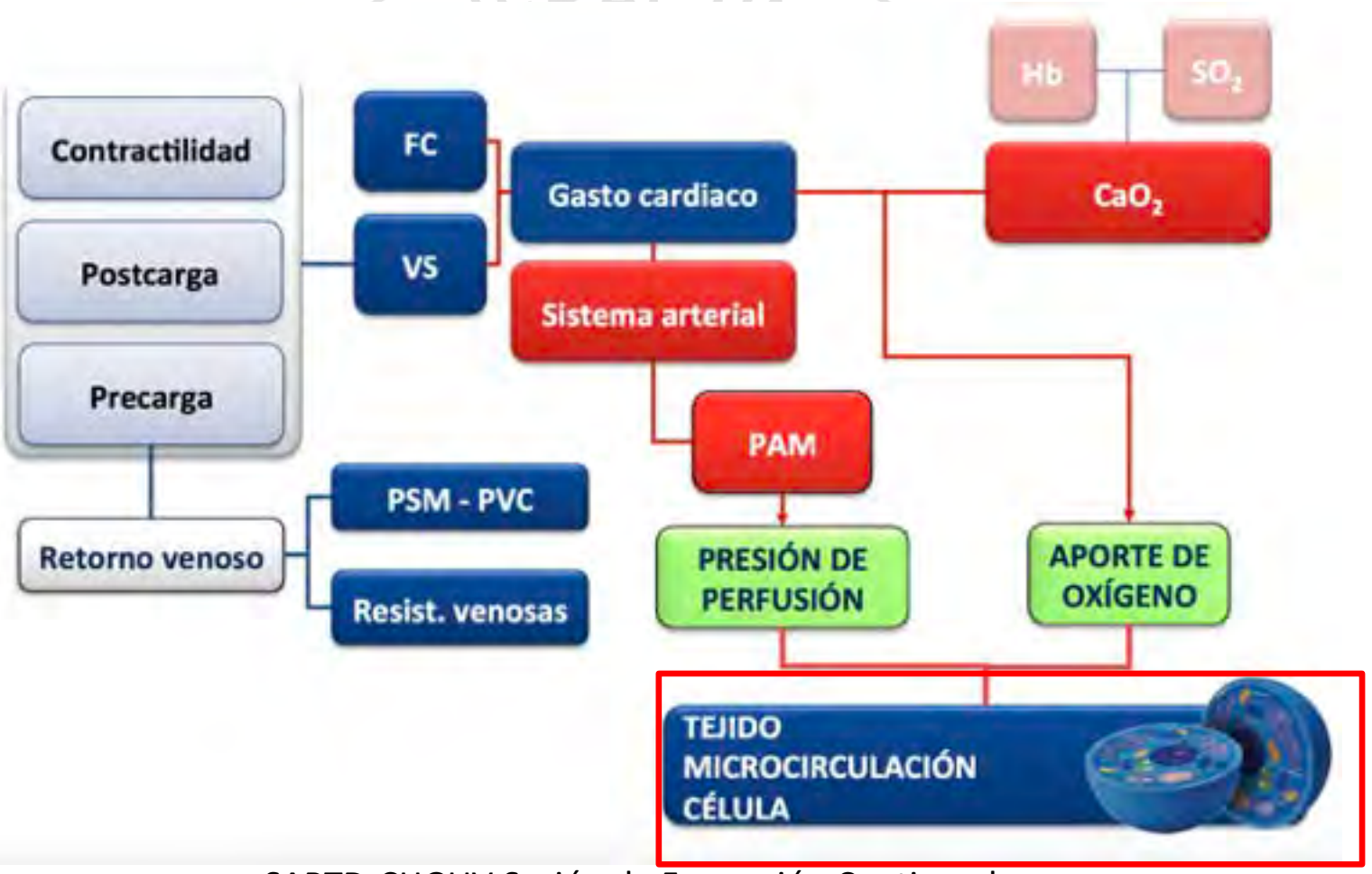


Figure 1 Proposed algorithm to guide hemodynamic treatment in high-risk surgical patients. $ScVO_2$, central venous oxygen saturation; PEEP, positive end-expiratory pressure.

1-Definición de Shock



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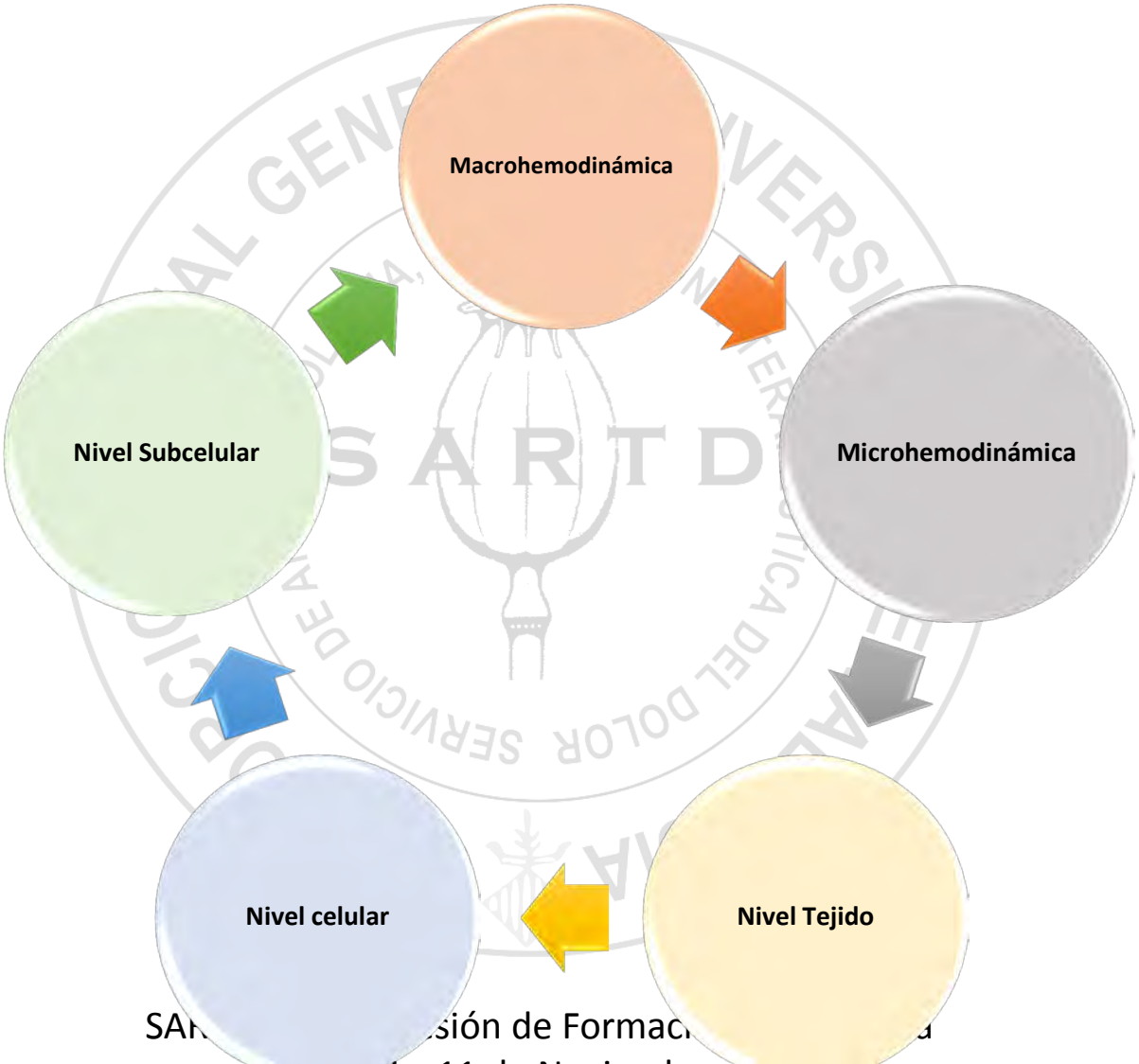

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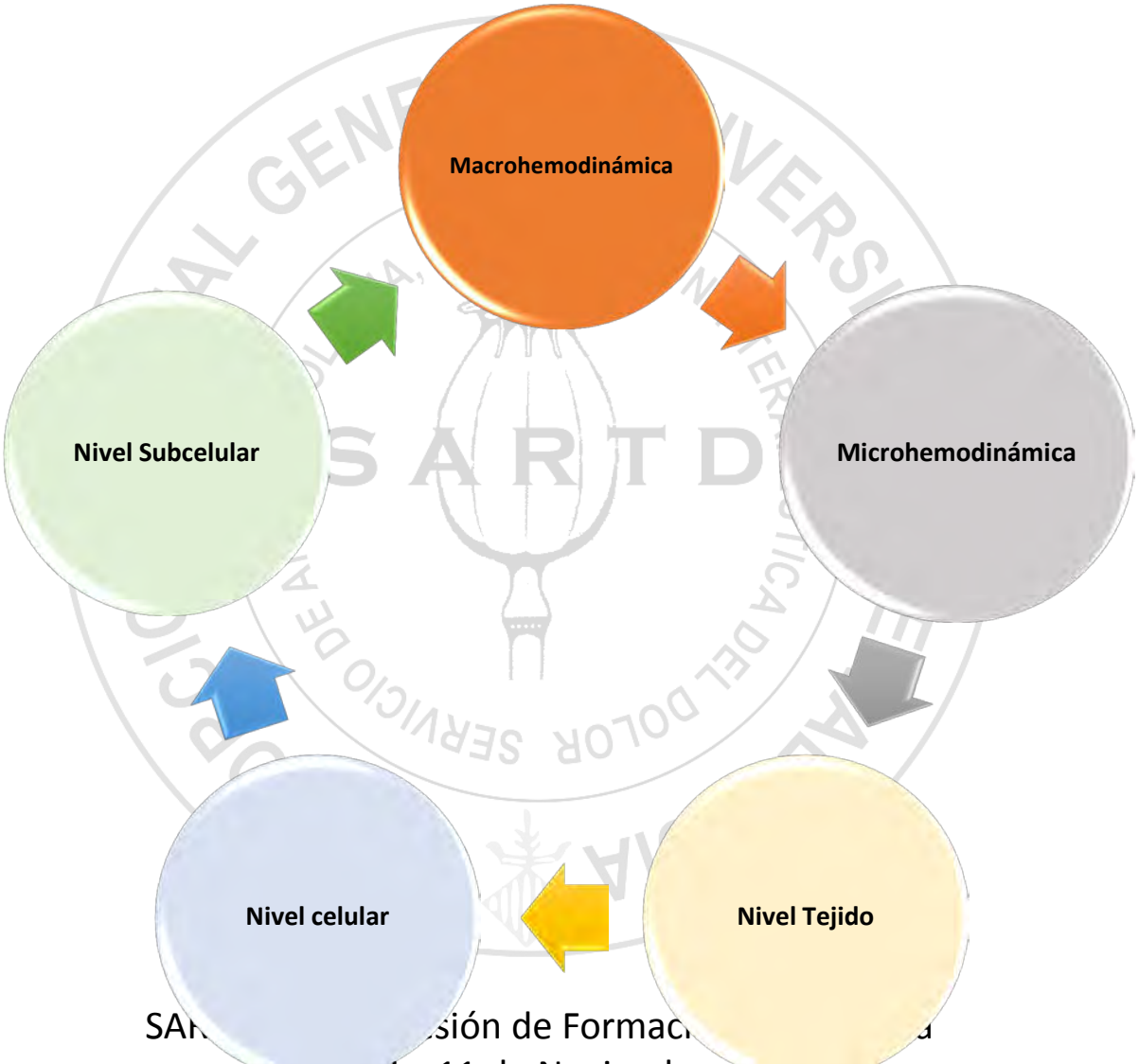

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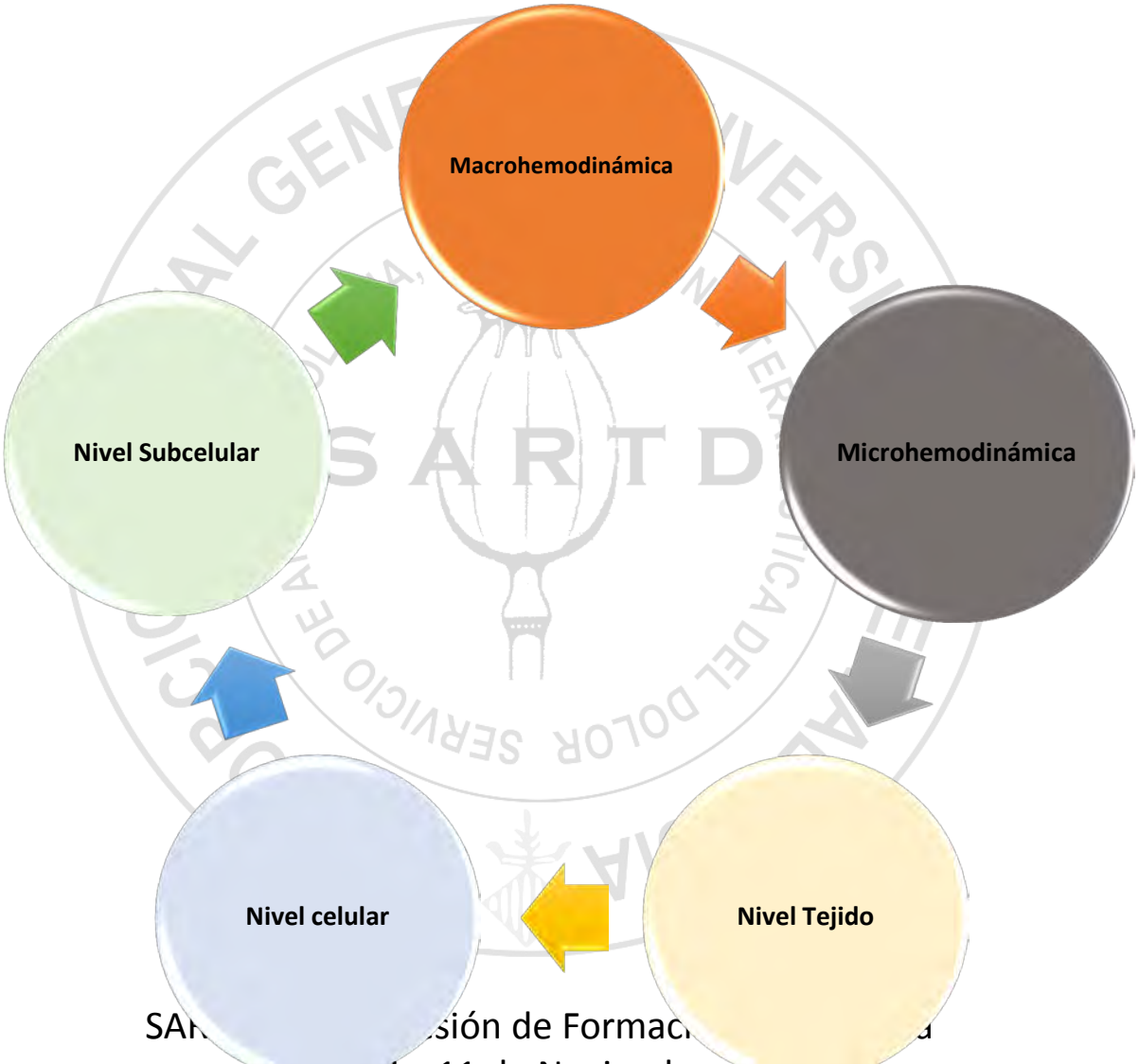

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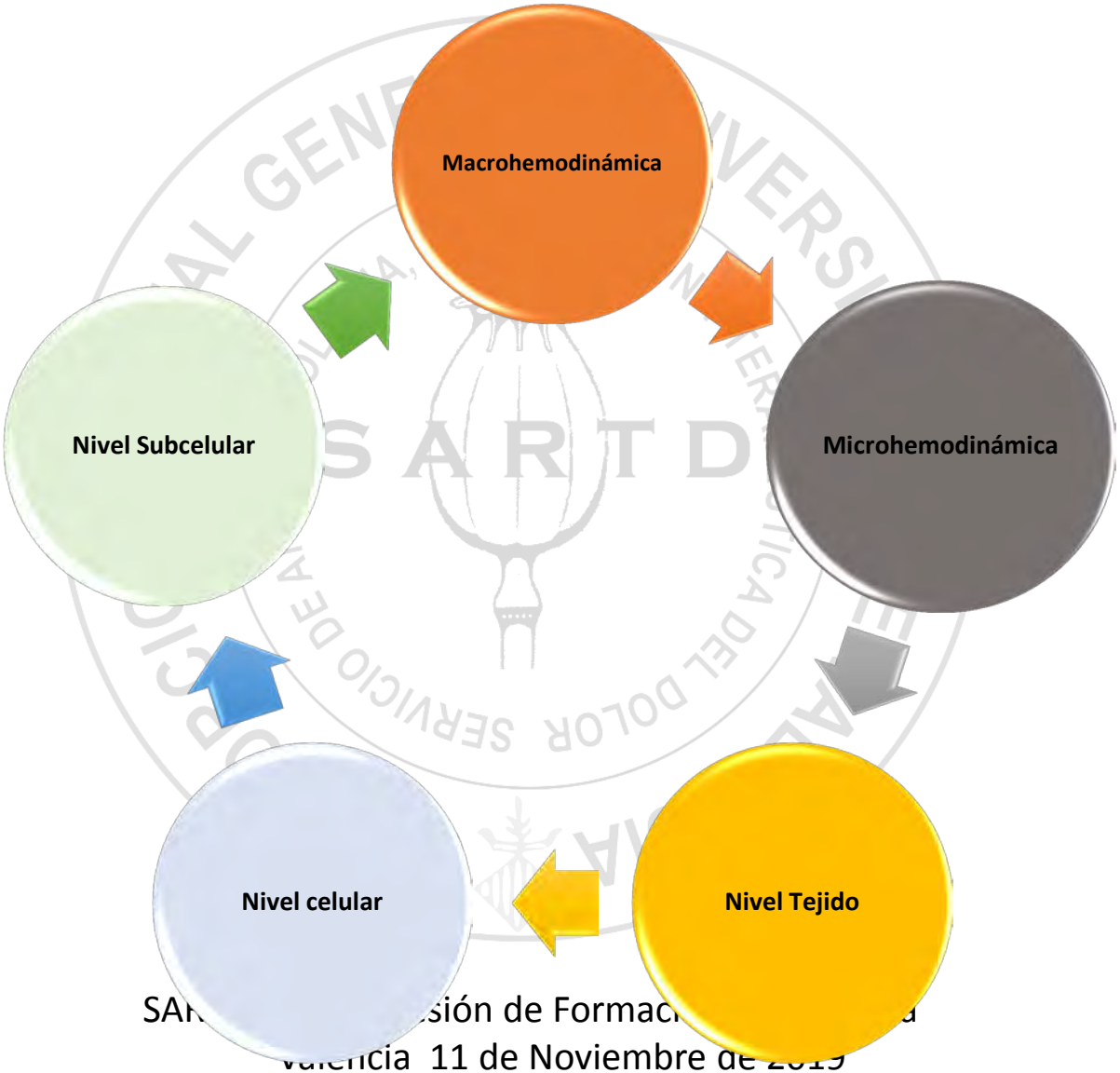

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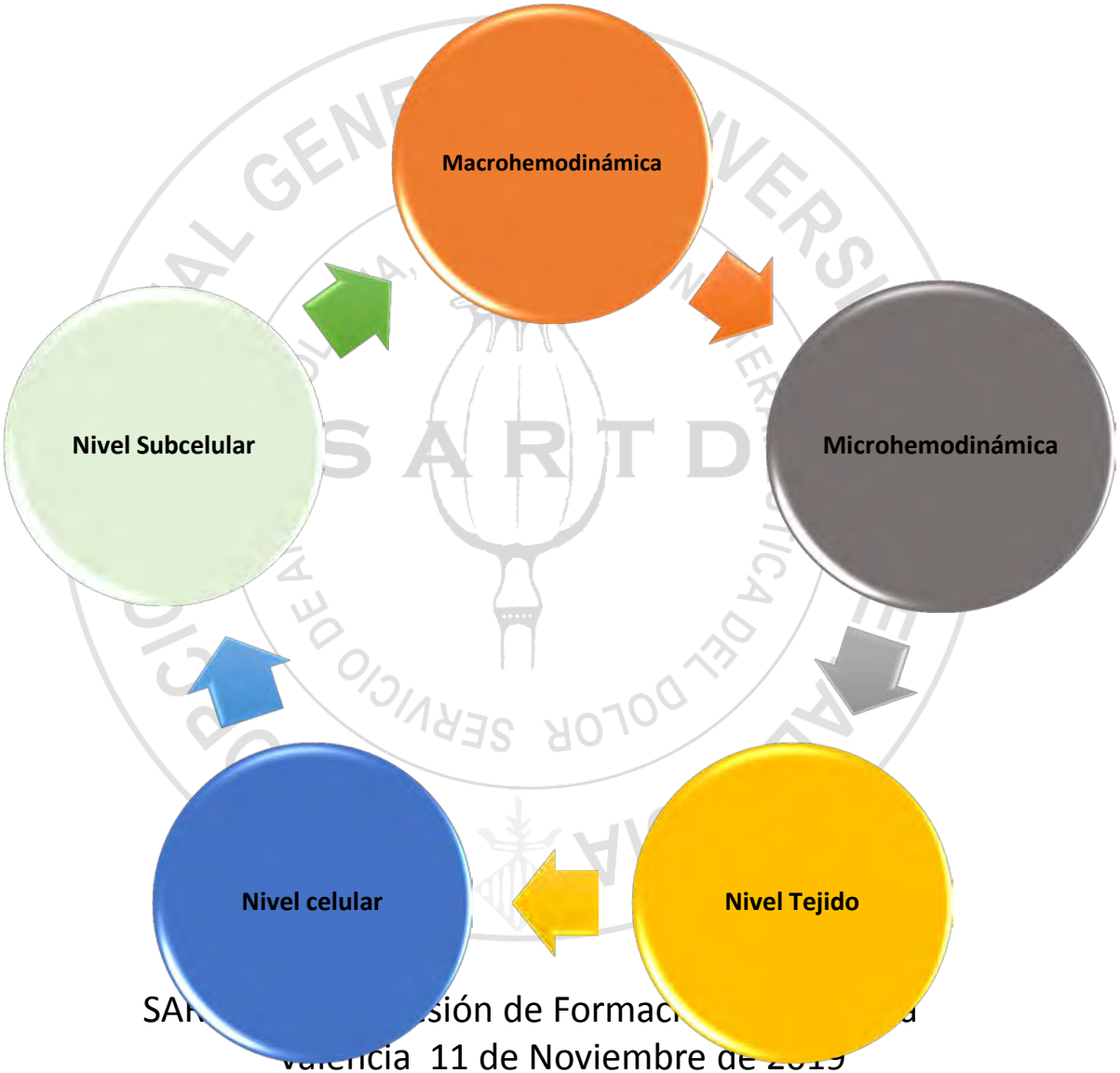

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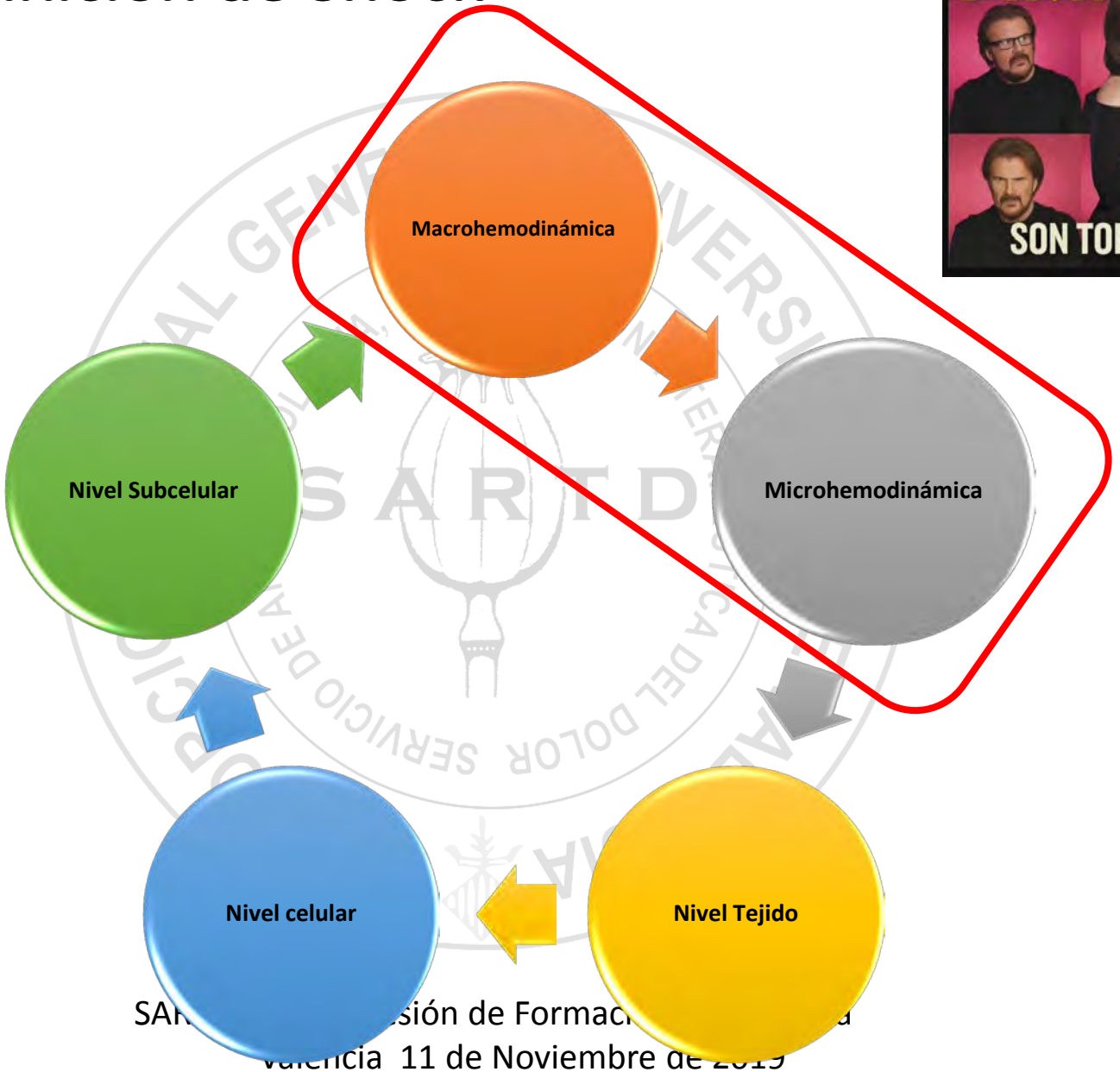


1-Definición de Shock

Ince *Critical Care* 2015, **19**:S8
http://www.ccforum.com/content/19/S3/S8

CRITICAL CARE

REVIEW Open Access

Hemodynamic coherence and the rationale for monitoring the microcirculation

Can Ince

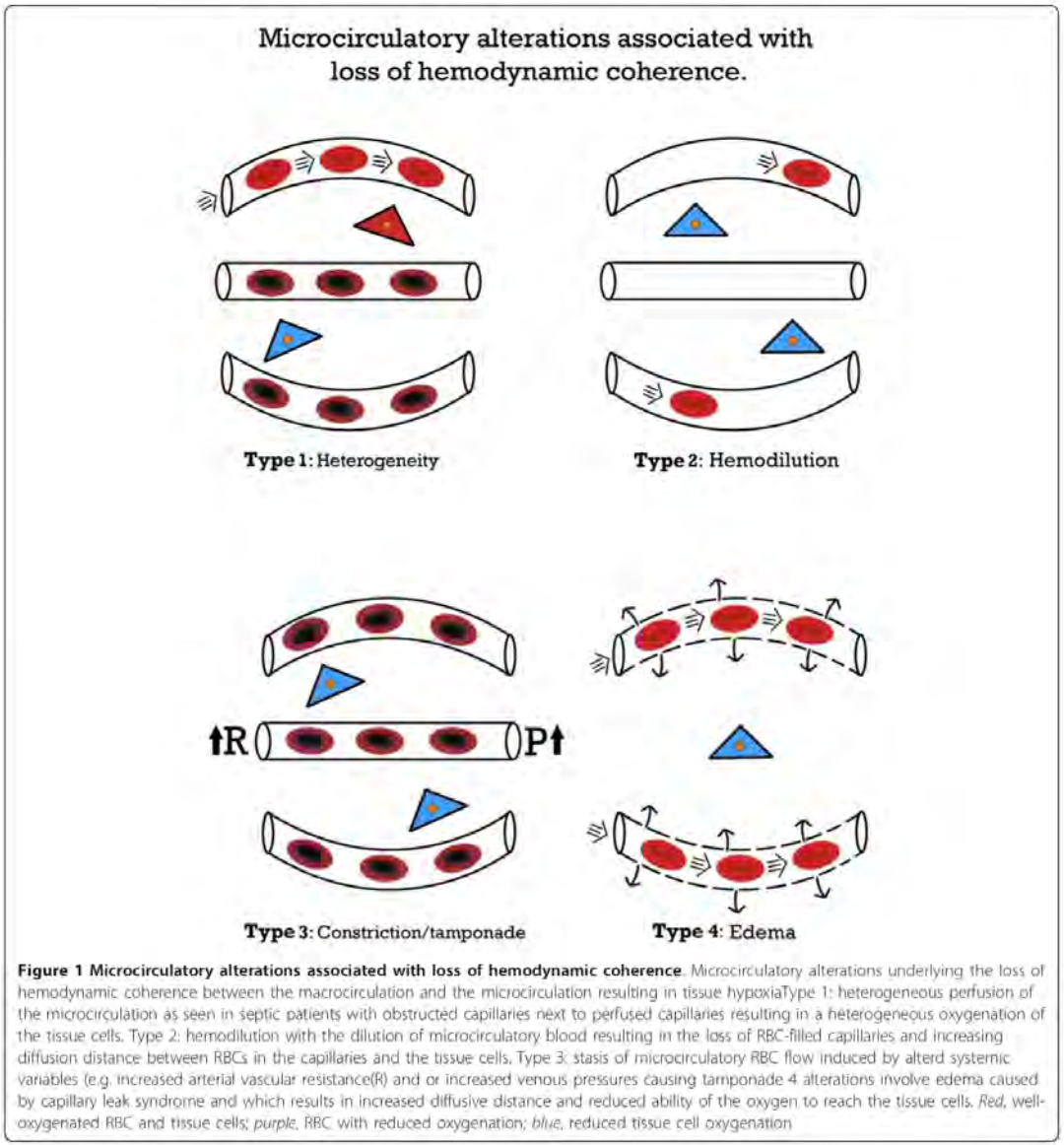


Figure 1 Microcirculatory alterations associated with loss of hemodynamic coherence. Microcirculatory alterations underlying the loss of hemodynamic coherence between the macrocirculation and the microcirculation resulting in tissue hypoxiaType 1: heterogeneous perfusion of the microcirculation as seen in septic patients with obstructed capillaries next to perfused capillaries resulting in a heterogeneous oxygenation of the tissue cells. Type 2: hemodilution with the dilution of microcirculatory blood resulting in the loss of RBC-filled capillaries and increasing diffusion distance between RBCs in the capillaries and the tissue cells. Type 3: stasis of microcirculatory RBC flow induced by alterd systemic variables (e.g. increased arterial vascular resistance(R) and or increased venous pressures causing tamponade 4 alterations involve edema caused by capillary leak syndrome and which results in increased diffusive distance and reduced ability of the oxygen to reach the tissue cells. *Red*, well-oxygenated RBC and tissue cells; *purple*, RBC with reduced oxygenation; *blue*, reduced tissue cell oxygenation

1- ¿Por qué?

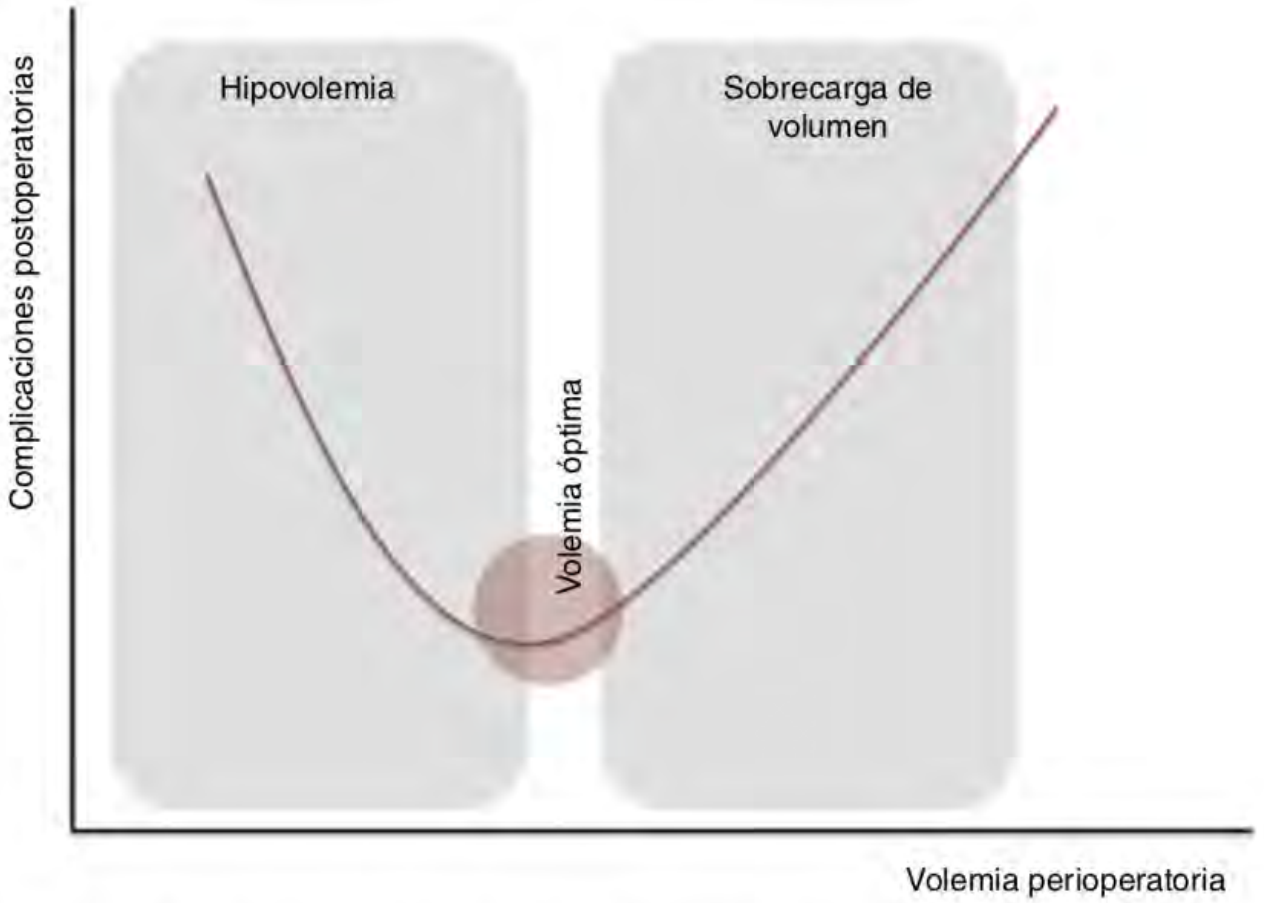


Figura 1 Asociación entre administración perioperatoria de fluidos y complicaciones postoperatorias.

1- ¿Por qué?

Fluidoterapia demasiado liberal:

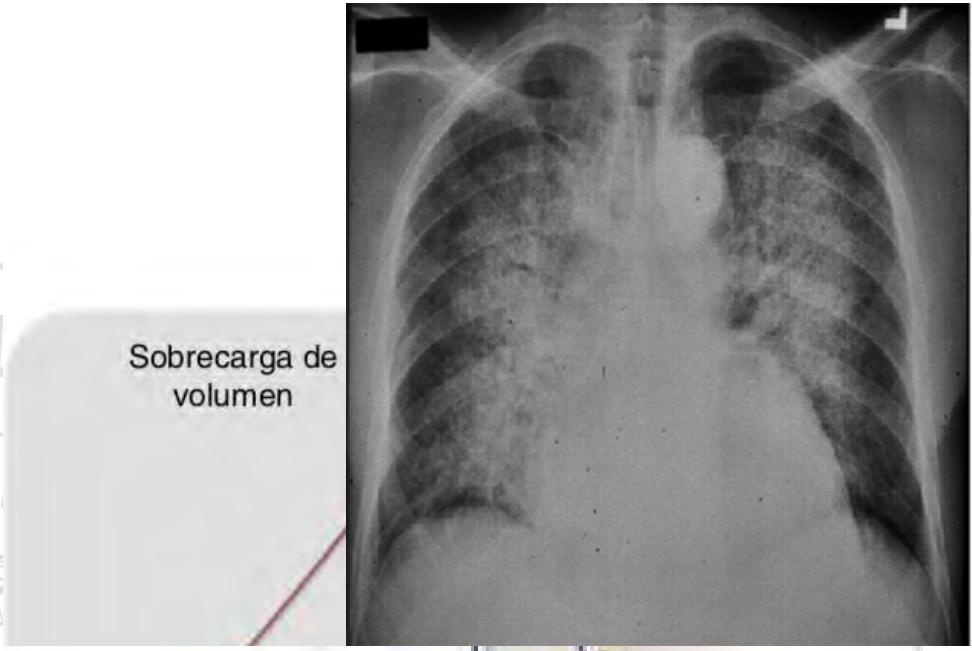
- Edema pulmonar
- Ventilación mecánica prolongada, fracasos weaning
- Disfunción Gastrointestinal:
  - Sindrome Compartimental Abdominal
  - Íleo
  - Fallo de Anastomosis
- Hemodilución y Coagulopatía

1- ¿Por qué?

Fluidoterapia demasiado liberal:

*** Disociación entre macrohemodinámica y microcirculación**

*** Rotura del glicocálix**



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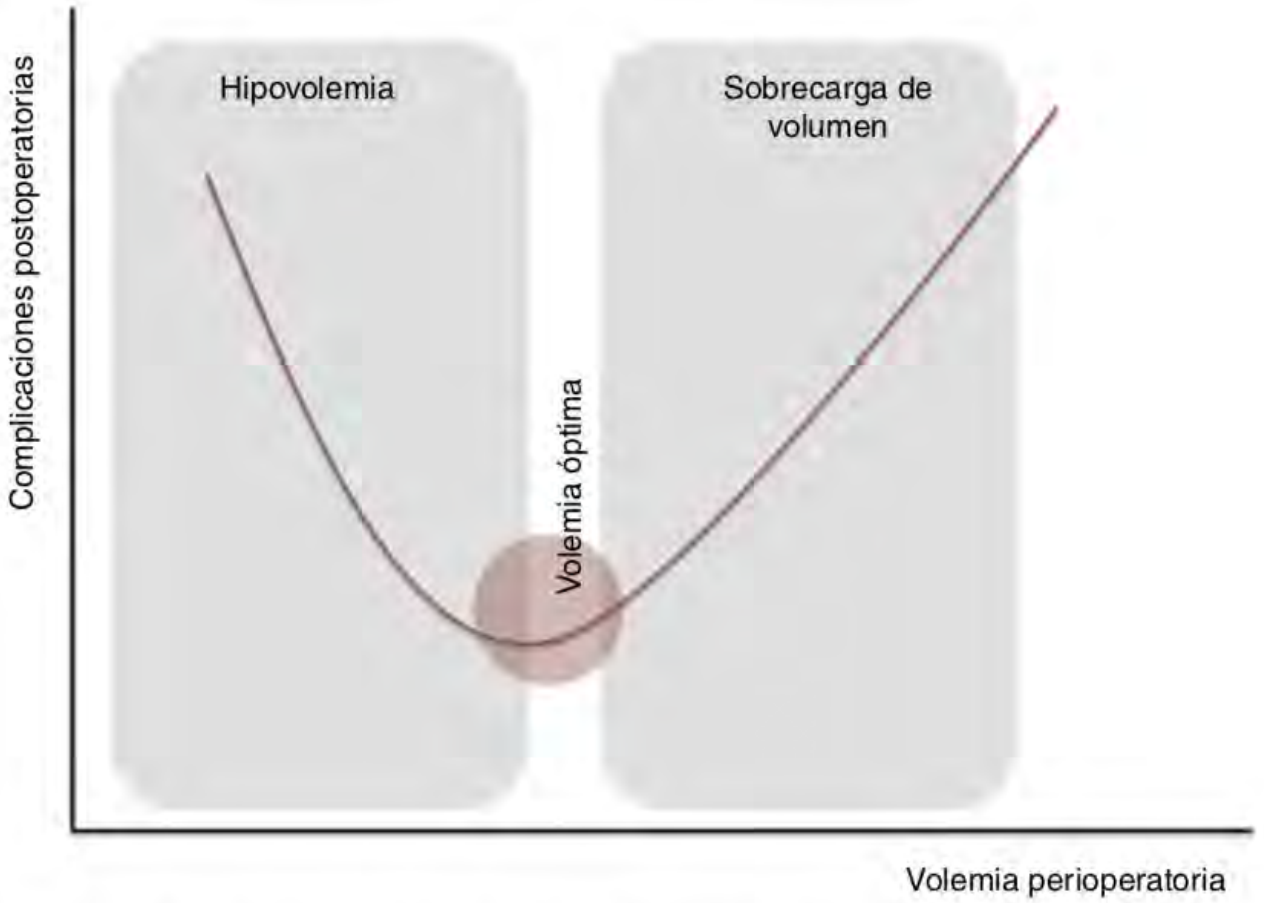

Figura 1 Asociación entre administración perioperatoria de fluidos y complicaciones postoperatorias.

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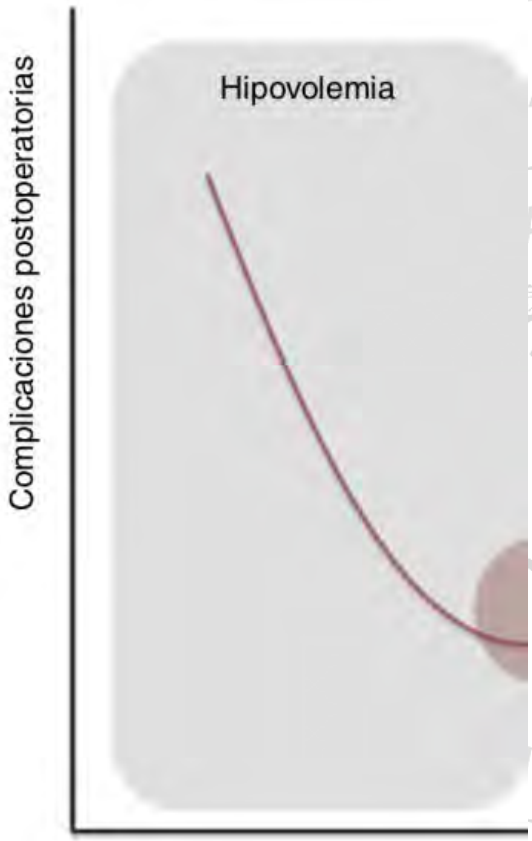


Fluidoterapia demasiado restrictiva:

- Baja precarga, bajo gasto cardiaco, baja perfusión.
- Posibilidad de Arritmias.
- Disfunción Gastrointestinal
  - Íleo postoperatorio
  - PONV
  - Fallo anastomosis
- Complicaciones infecciosas (hipoperfusión tisular)
- Insuficiencia Renal Aguda

Microcirculation follows macrocirculation in heart and gut in the acute phase of hemorrhagic shock and isovolemic autologous whole blood resuscitation in pigs

Mat van Iterson, Rick Bezemer, Michal Heger, Martin Siegemund, and Can Ince

1-Definición de Shock

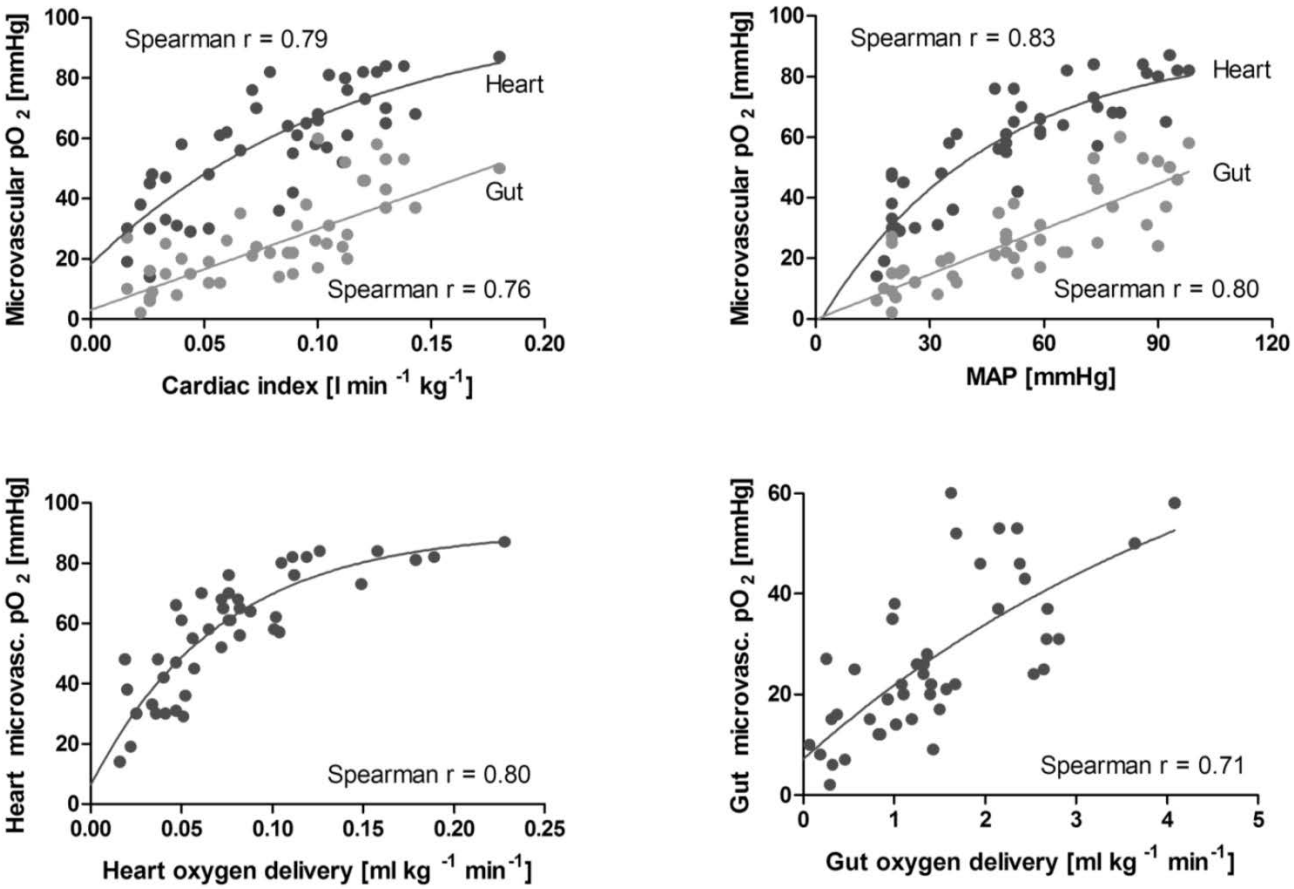
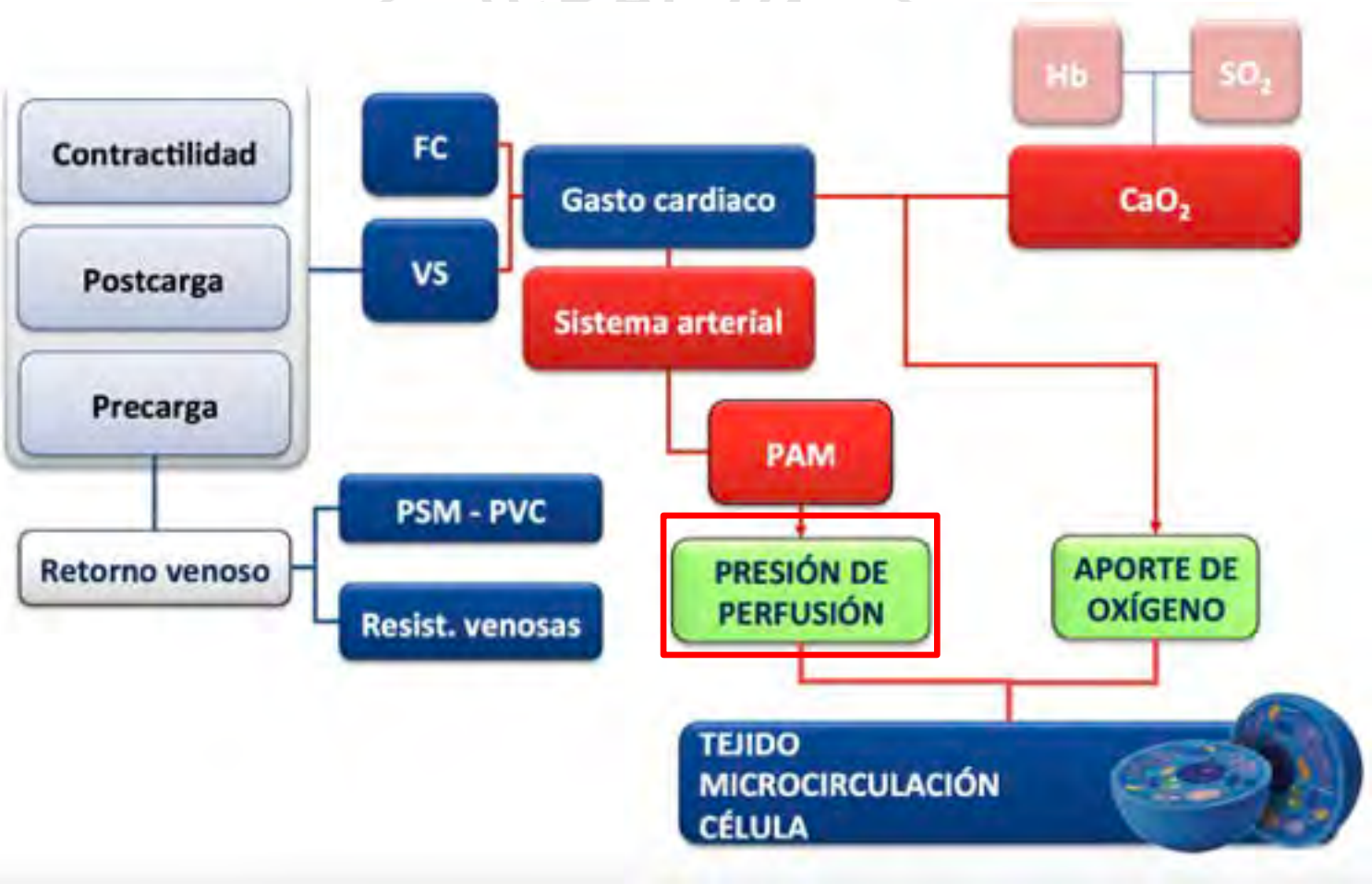


Fig. 5. Correlation analysis of microvascular pO_2 in the heart and gut versus cardiac index (top left), MAP (top right), heart and gut oxygen delivery (bottom left and bottom right, respectively) during hemorrhagic shock and resuscitation. $p < 0.001$ for all correlations.

2-Formas de corregir la hipoperfusión

2-Formas de corregir la hipoperfusión



2-Formas de corregir la hipoperfusión

Intraoperative Mean Arterial Pressure Variability and 30-day Mortality in Patients Having Noncardiac Surgery

Edward J. Mascha, Ph.D., Dongsheng Yang, M.S., Stephanie Weiss, M.D., Daniel I. Sessler, M.D.

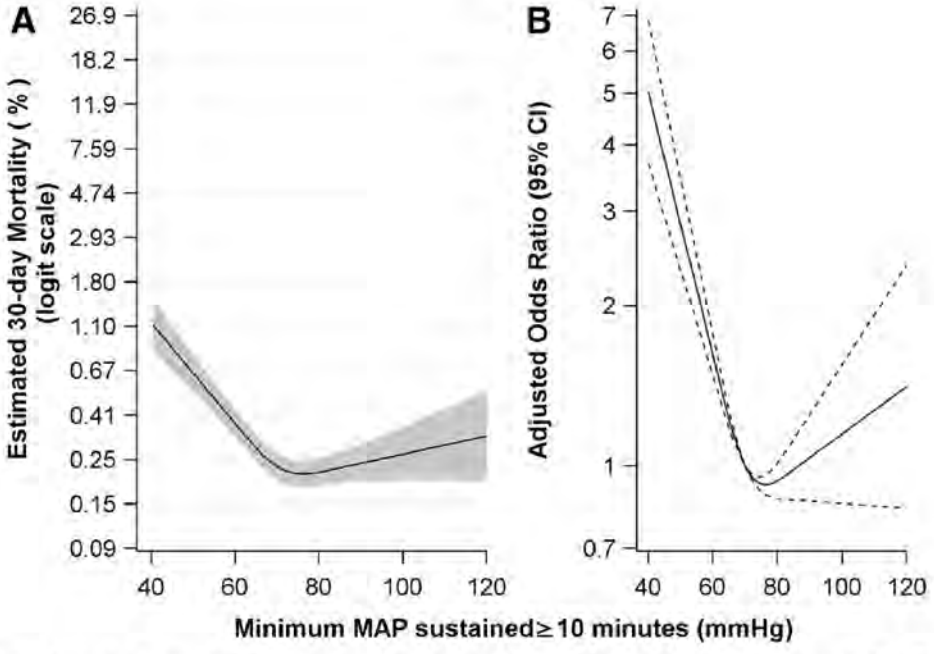


Fig. 5. Multivariable association between minimum 10-min sustained mean arterial pressure (MAP) and 30-day mortality. (*A*) Spline plot of multivariable probability of 30-day mortality as function of 10-min sustained MAP. (*B*) Spline plot of multivariable odds ratios (Y-axis) for relationship between minimum 10-min sustained MAP and 30-day mortality. The reference category for each odds ratio is the median value of the predictor (70 mmHg). There is no variability (and hence no CI) at the median, where odds ratio = 1.0. Curves derived from multivariable logistic regression smoothed by restricted cubic spline with 3 degrees of freedom using 10th, 50th, and 90th percentiles of minimum 10-min sustained MAP as knots.

2-Formas de corregir la hipoperfusión

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Individualized vs Standard Blood Pressure Management Strategies on Postoperative Organ Dysfunction Among High-Risk Patients Undergoing Major Surgery

A Randomized Clinical Trial

Emmanuel Futier, MD, PhD; Jean-Yves Lefrant, MD, PhD; Pierre-Gregoire Guinot, MD, PhD; Thomas Godet, MD, PhD; Emmanuel Lorne, MD; Philippe Cuvillon, MD, PhD; Sebastien Bertran, MD; Marc Leone, MD, PhD; Bruno Pastene, MD; Vincent Piriou, MD, PhD; Serge Molliex, MD, PhD; Jacques Albanese, MD, PhD; Jean-Michel Julia, MD; Benoit Tavernier, MD, PhD; Etienne Imhoff, MD; Jean-Etienne Bazin, MD, PhD; Jean-Michel Constantin, MD, PhD; Bruno Pereira, PhD; Samir Jaber, MD, PhD; for the INPRESS Study Group

2-Formas de corregir la hipoperfusión

JAMA | Origin

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Emmanuel Futier, M
Philippe Cuvillon, M
Jacques Albanese,
Jean-Michel Consta

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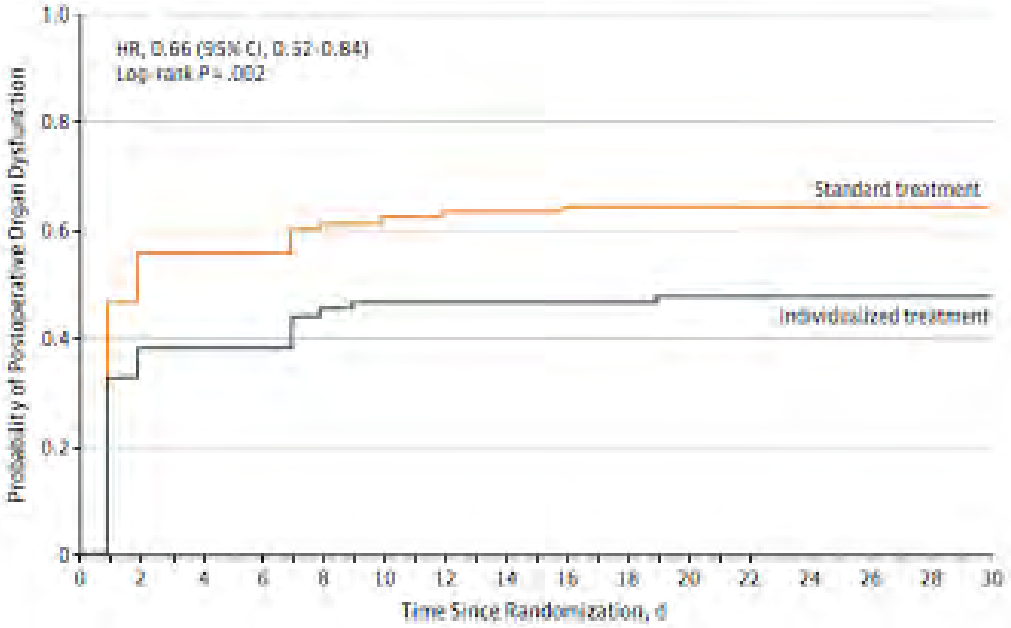
ex, MD, PhD;

Figure 3. Kaplan-Meier Estimates of the Probability of Postoperative Organ Dysfunction by Day 30 After Surgery



No. at risk

Standard treatment	145	78	65	58	54	53
Individualized treatment	147	99	91	82	80	79

2-Formas de corregir la hipoperfusión

Anesthesiology 2007; 107:213–20

Incidence of Intraoperative Hypotension as a Function of the Chosen Definition

Literature Definitions Applied to a Retrospective Cohort Using Automated Data Collection

Jilles B. Bijker, M.D., Wilton A. van Klei, M.D., Ph.D.,† Teus H. Kappen, M.D.,* Leo van Wolfswinkel, M.D., Ph.D.,‡ Karel G. M. Moons, Ph.D.,§ Cor J. Kalkman, M.D., Ph.D.‖*

Table 3. Incidence of Intraoperative Hypotension in 15,509 Adult Noncardiac Surgery Patients

	Incidence of IOH, % (Mean Number of Episodes)		
	MED = 1 min	MED = 5 min	MED = 10 min
Absolute thresholds, mmHg			
Systolic			
< 100	81.5 (3.1)	71.6 (1.8)	56.4 (1.1)
< 95	74.5 (2.7)	62.4 (1.5)	45.1 (0.8)
< 90	64.3 (2.2)	49.3 (1.1)	30.9 (0.5)
< 85	53.2 (1.6)	35.0 (0.7)	17.4 (0.3)
< 80	41.2 (1.1)	20.1 (0.3)	7.4 (0.1)
< 75	30.7 (0.6)	10.5 (0.2)	3.1 (0.04)
< 70	21.2 (0.4)	4.6 (0.1)	1.3 (0.01)
< 65	14.0 (0.2)	2.4 (0.03)	0.7 (0.01)
Mean			
< 70	77.7 (3.0)	65.9 (1.7)	48.6 (1.0)
< 65	65.2 (2.4)	49.4 (1.2)	31.3 (0.6)
< 60	50.7 (1.6)	31.1 (0.7)	16.1 (0.3)
< 55	36.3 (0.9)	15.8 (0.3)	6.6 (0.1)
< 50	24.0 (0.5)	7.1 (0.1)	2.3 (0.03)
Relative thresholds, % from baseline			
Systolic			
> 10%	98.6 (2.7)	96.9 (2.0)	92.4 (1.5)
> 15%	96.9 (3.0)	93.7 (2.1)	86.9 (1.5)
> 20%	93.3 (3.2)	88.0 (2.1)	78.3 (1.5)
> 25%	86.7 (3.1)	78.6 (2.0)	66.5 (1.3)
> 30%	76.5 (2.8)	65.6 (1.7)	52.4 (1.0)
> 40%	52.2 (1.7)	37.1 (0.8)	24.0 (0.4)
Mean			
> 10%	98.5 (2.6)	96.7 (2.0)	91.7 (1.5)
> 15%	97.0 (2.9)	93.9 (2.1)	86.6 (1.5)
> 20%	94.1 (3.1)	89.0 (2.1)	79.4 (1.5)
> 25%	88.6 (3.1)	80.7 (2.0)	68.6 (1.3)
> 30%	80.1 (2.9)	68.9 (1.8)	54.9 (1.1)
> 40%	56.1 (1.9)	40.6 (1.0)	26.6 (0.5)

IOH = intraoperative hypotension; MED = minimal episode duration.

2-Formas de corregir la hipoperfusión

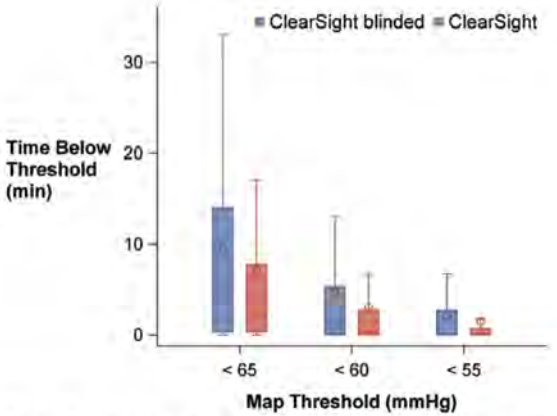
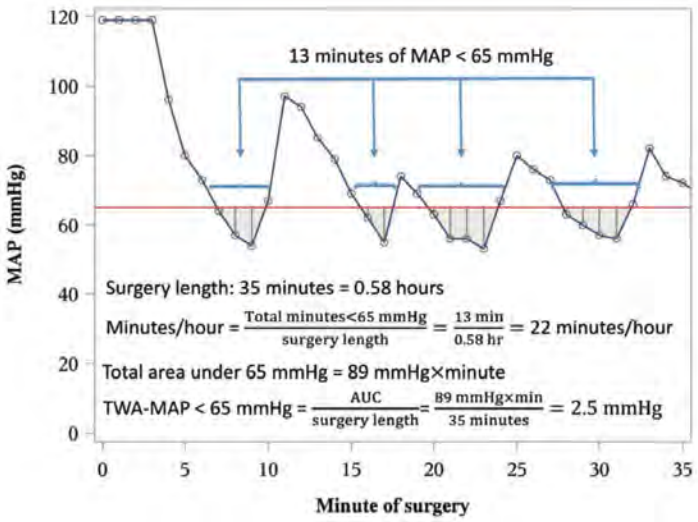
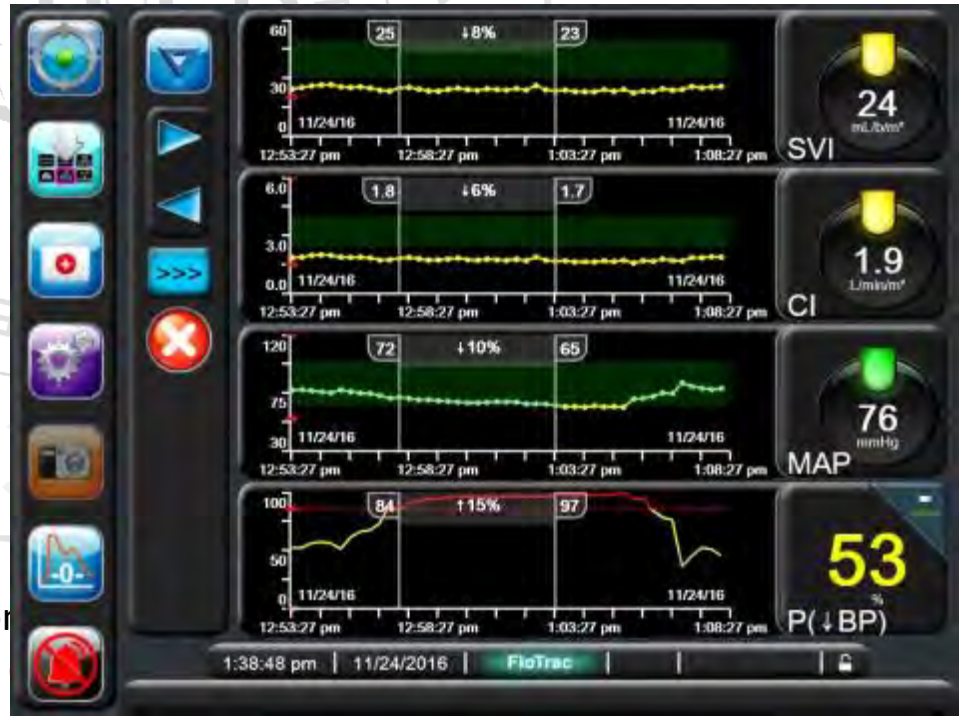
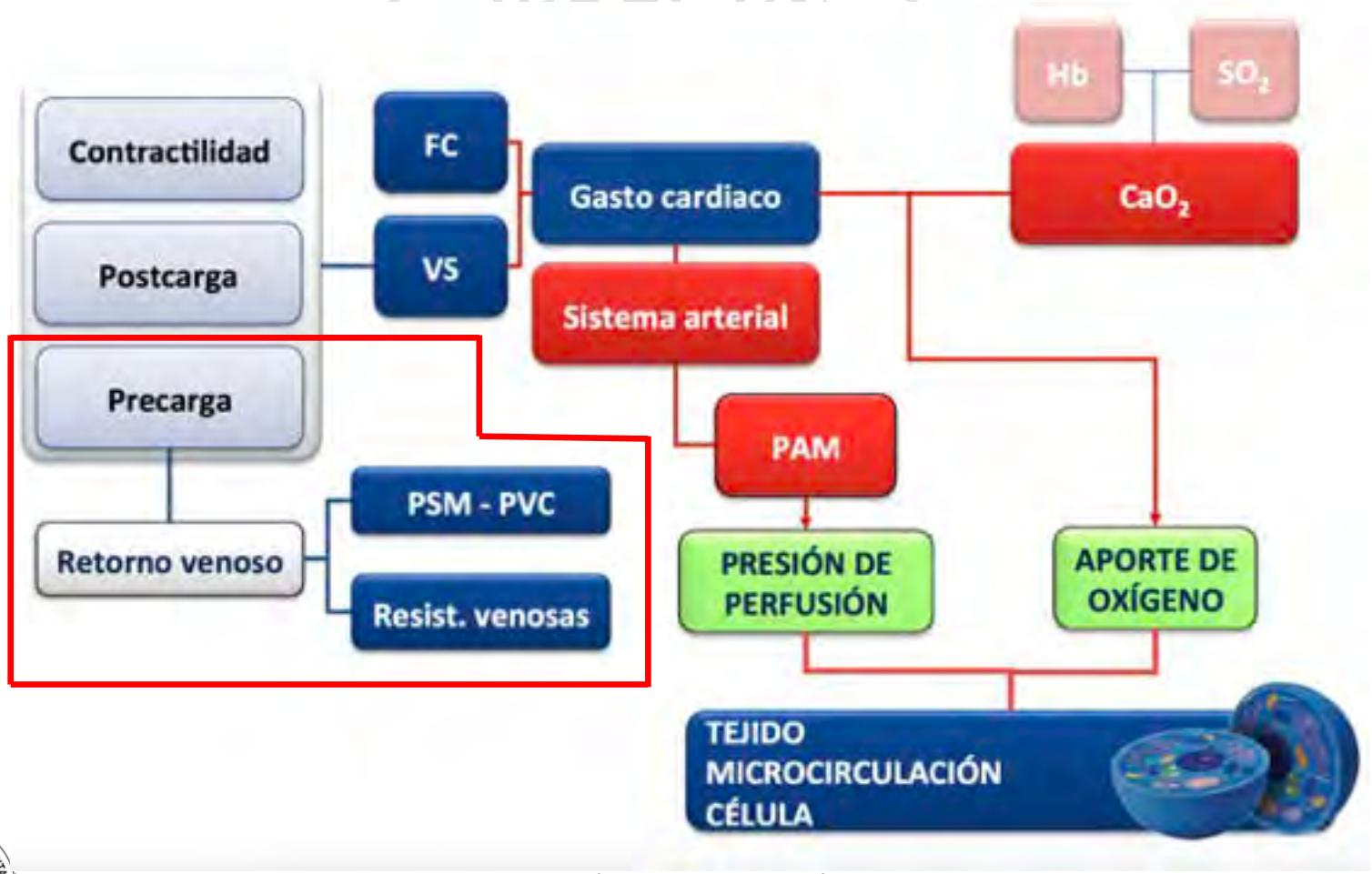


Figure 3. Intraoperative time patients spent below mean arterial pressure (MAP) thresholds of 65, 60, and 55 mm Hg.





2-Formas de corregir la hipoperfusión



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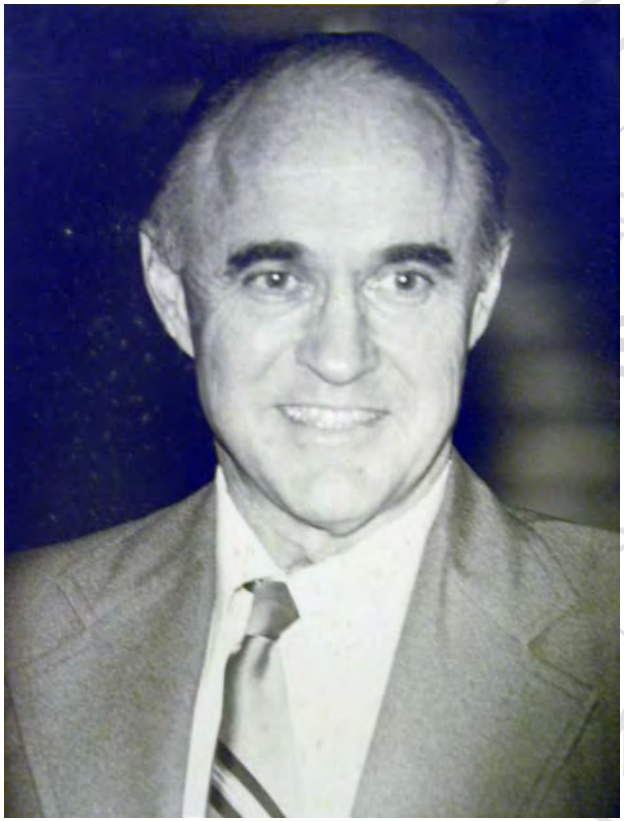
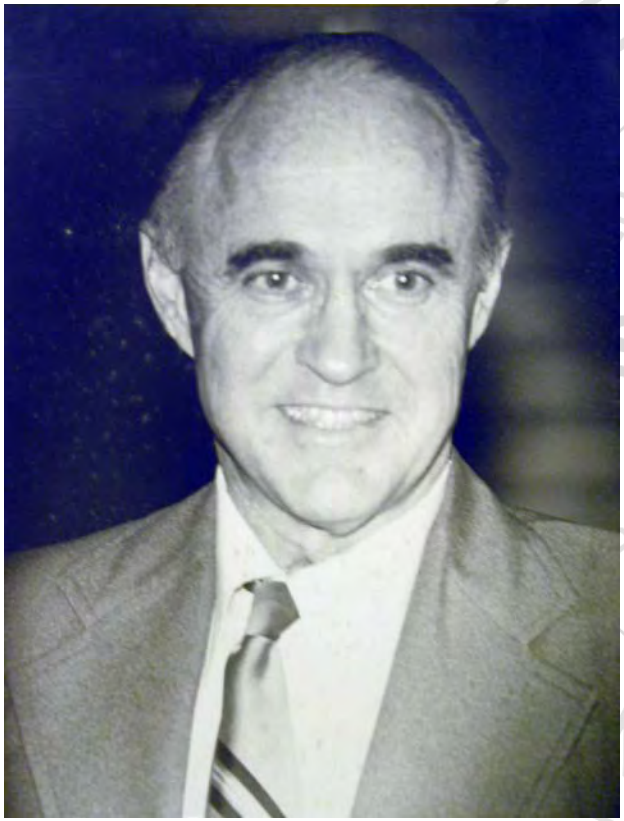


- **Retorno venoso:**

$$\frac{P_{sm} - P_{AD}}{\text{Resistencia venosa}}$$

2-Formas de corregir la hipoperfusión



- **Retorno venoso:**

$$\frac{P_{sm} - P_{AD}}{\text{Resistencia venosa}}$$

2-Formas de corregir la hipoperfusión

Retorno venoso = (Psm - PVC) / Rv

2-Formas de corregir la hipoperfusión

Retorno venoso ↑ = (Psm ↑ - PVC) / Rv

2-Formas de corregir la hipoperfusión

1-¿A quien?

2-¿Cuándo?

3-¿Con qué?

4-¿Hasta cuando?

2-Formas de corregir la hipoperfusión

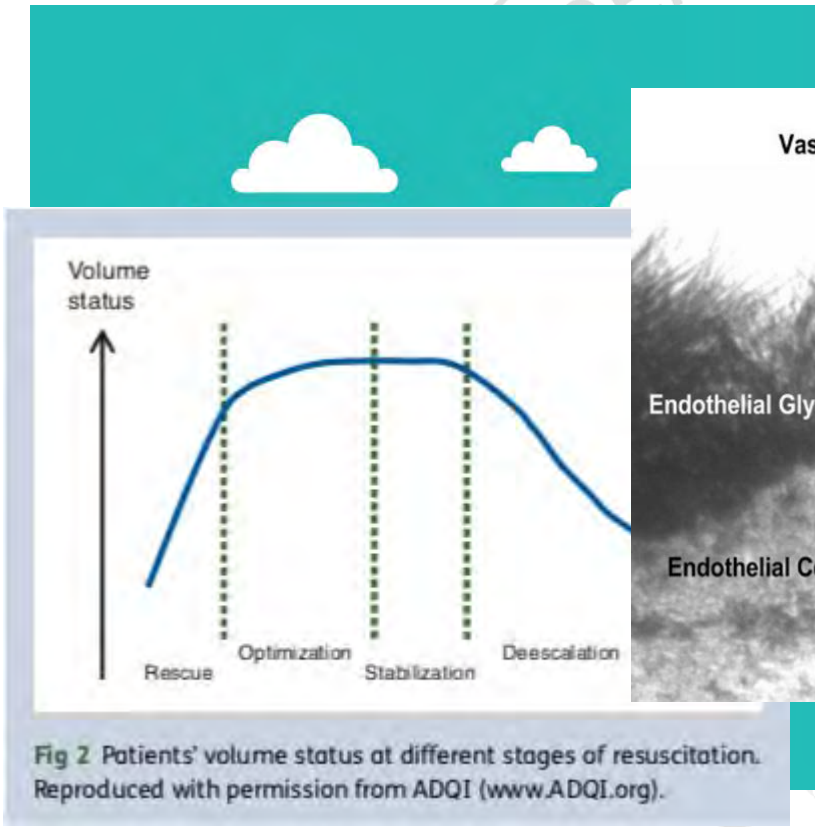
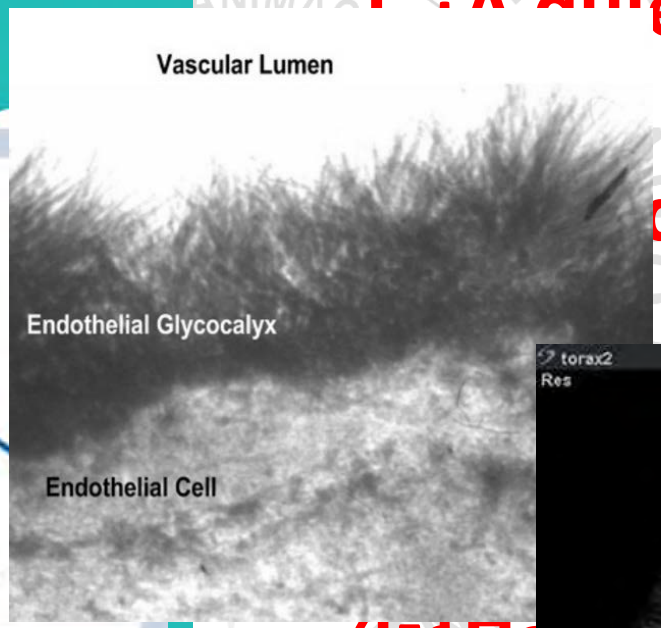


Fig 2 Patients' volume status at different stages of resuscitation. Reproduced with permission from ADQI (www.ADQI.org).



2-Formas de corregir la hipoperfusión

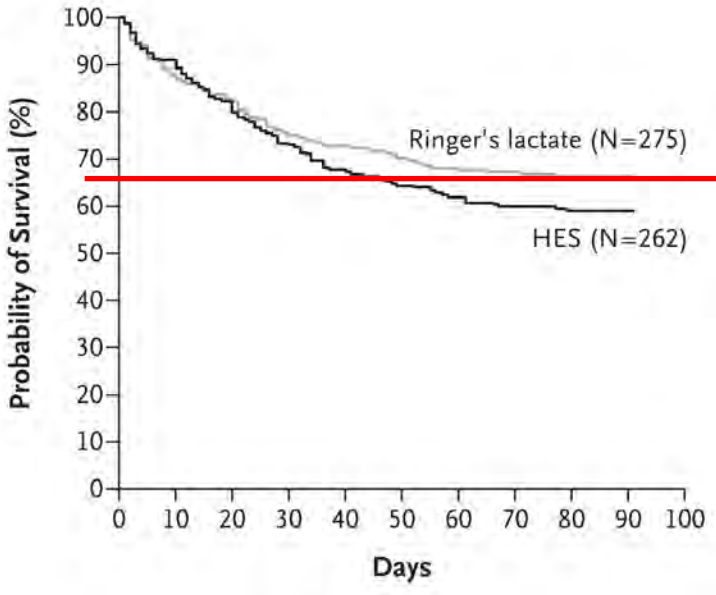
The NEW ENGLAND JOURNAL of MEDICINE

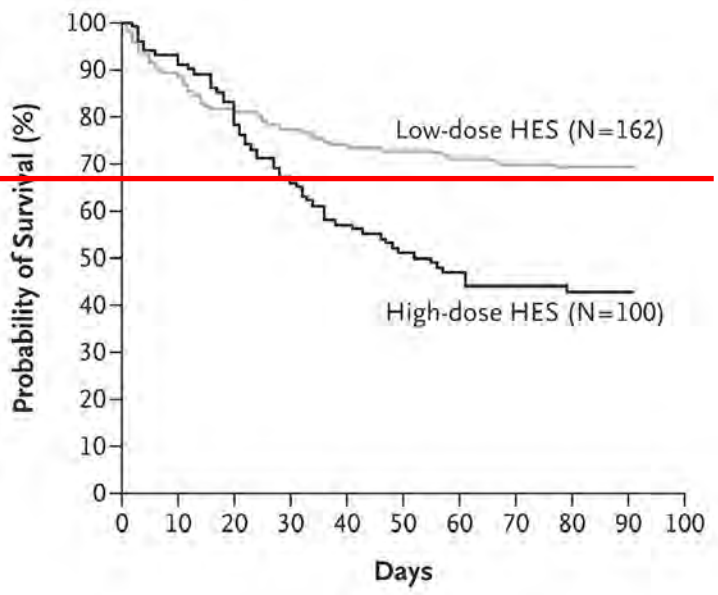
ORIGINAL ARTICLE

Intensive Insulin Therapy and Pentastarch Resuscitation in Severe Sepsis

Frank M. Brunkhorst, M.D., Christoph Engel, M.D., Frank Bloos, M.D., Ph.D., Andreas Meier-Hellmann, M.D., Max Ragaller, M.D., Norbert Weiler, M.D., Onnen Moerer, M.D., Matthias Gruendling, M.D., Michael Oppert, M.D., Stefan Grond, M.D., Derk Olthoff, M.D., Ulrich Jaschinski, M.D., Stefan John, M.D., Rolf Rossaint, M.D., Tobias Welte, M.D., Martin Schaefer, M.D., Peter Kern, M.D., Evelyn Kuhnt, M.Sc., Michael Kiehntopf, M.D., Christiane Hartog, M.D., Charles Natanson, M.D., Markus Loeffler, M.D., Ph.D., and Konrad Reinhart, M.D., for the German Competence Network Sepsis (SepNet)

HES KILLS PATIENTS!!





mac

2-Formas de corregir la hipoperfusión

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

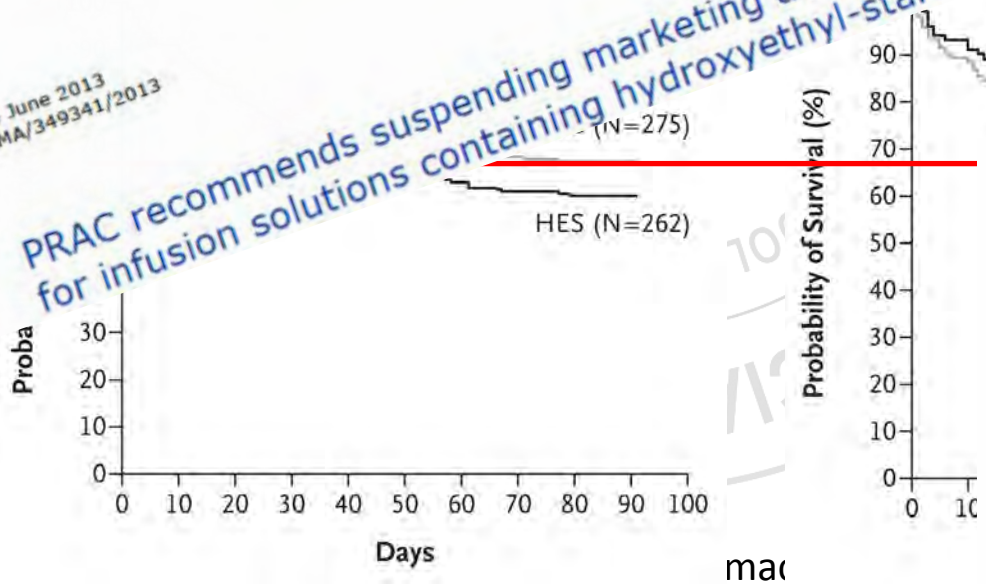
Intensive Insulin Therapy and Pentastarch Resuscitation in Severe Sepsis

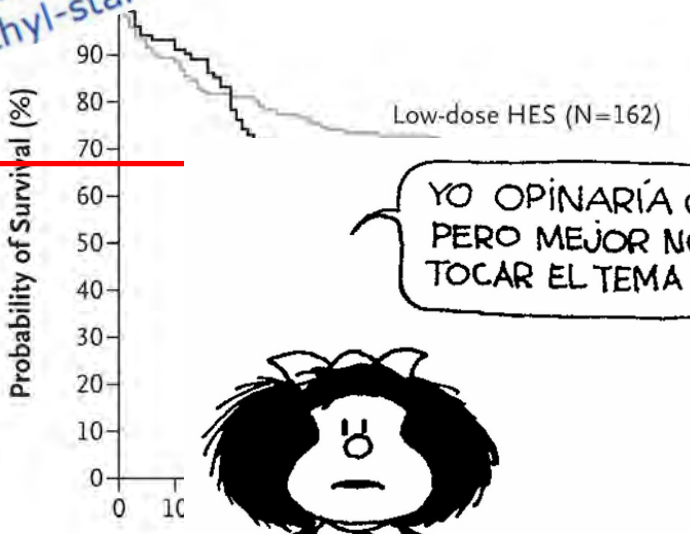
Frank M. Brunkhorst, M.D., Christoph Engel, Andreas Meier-Hellmann, M.D., Onnen Moerer, M.D., Matth... Stefan Grond, M.D., Rolf Rossaint, Cha...

EUROPEAN MEDICINES AGENCY
SCIENCE MEDICINES HEALTH

14 June 2013
EMA/349341/2013

PRAC recommends suspending marketing authorisations for infusion solutions containing hydroxyethyl-starch





S PATIENTS!!

mac

Valencia 11 de Noviembre de 2019

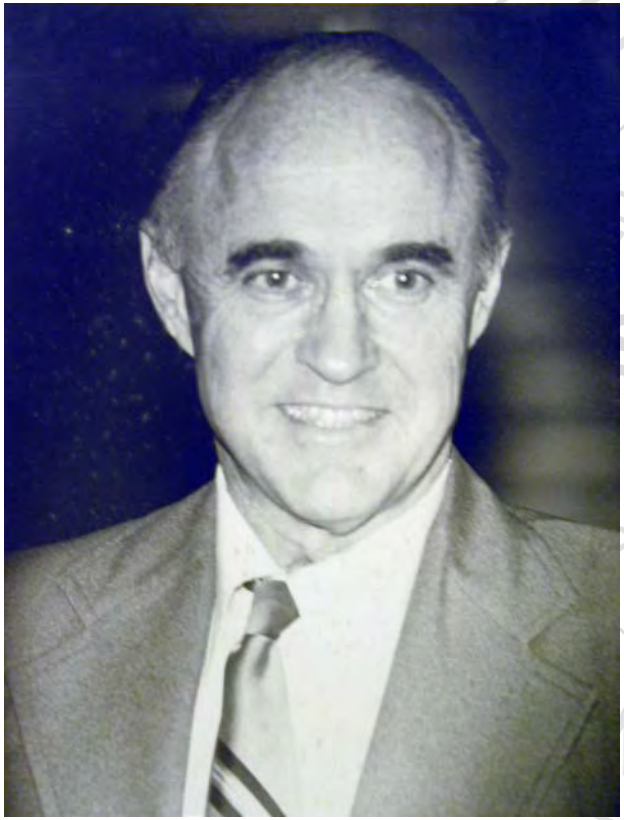
2-Formas de corregir la hipoperfusión

Retorno venoso = (Psm - PVC) / Rv

2-Formas de corregir la hipoperfusión

Retorno venoso ↑ = (Psm ↑ - PVC) / Rv

2-Formas de corregir la hipoperfusión



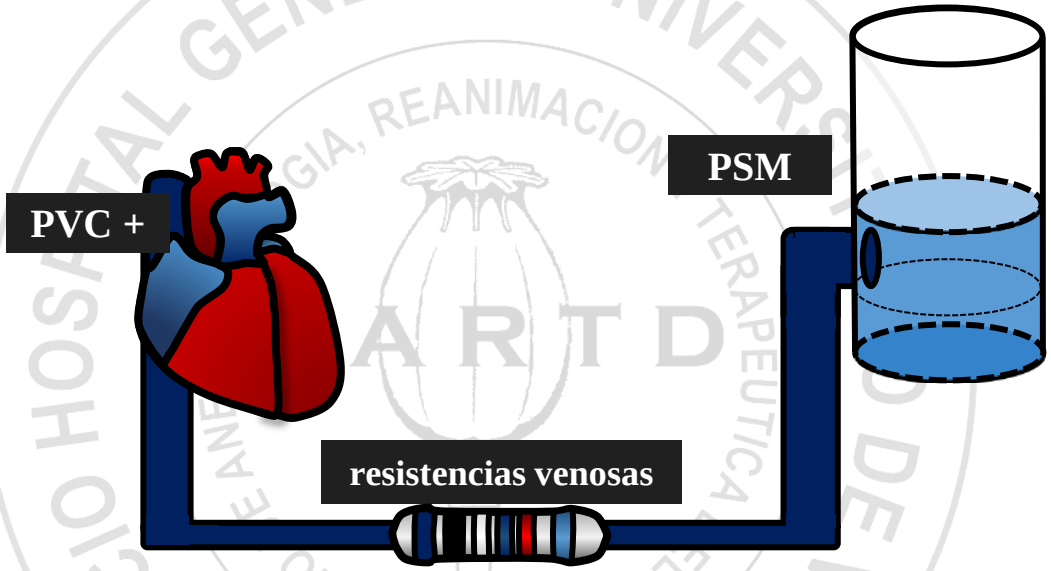
- **Retorno venoso:**

$$\frac{P_{sm} - P_{AD}}{\text{Resistencia venosa}}$$

2-Formas de corregir la hipoperfusión

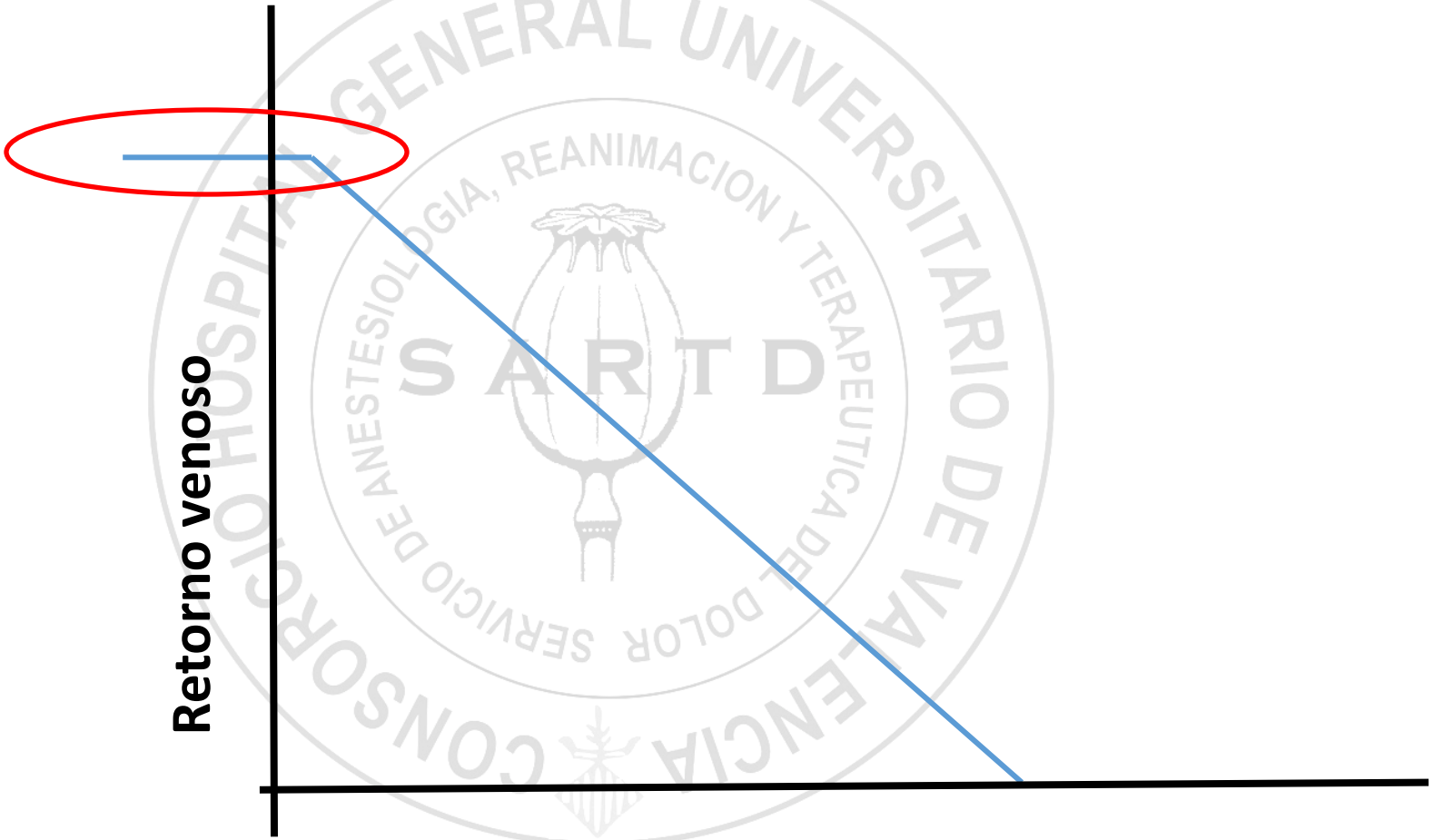
Retorno venoso = (Psm - PVC) / Rv

2-Formas de corregir la hipoperfusión

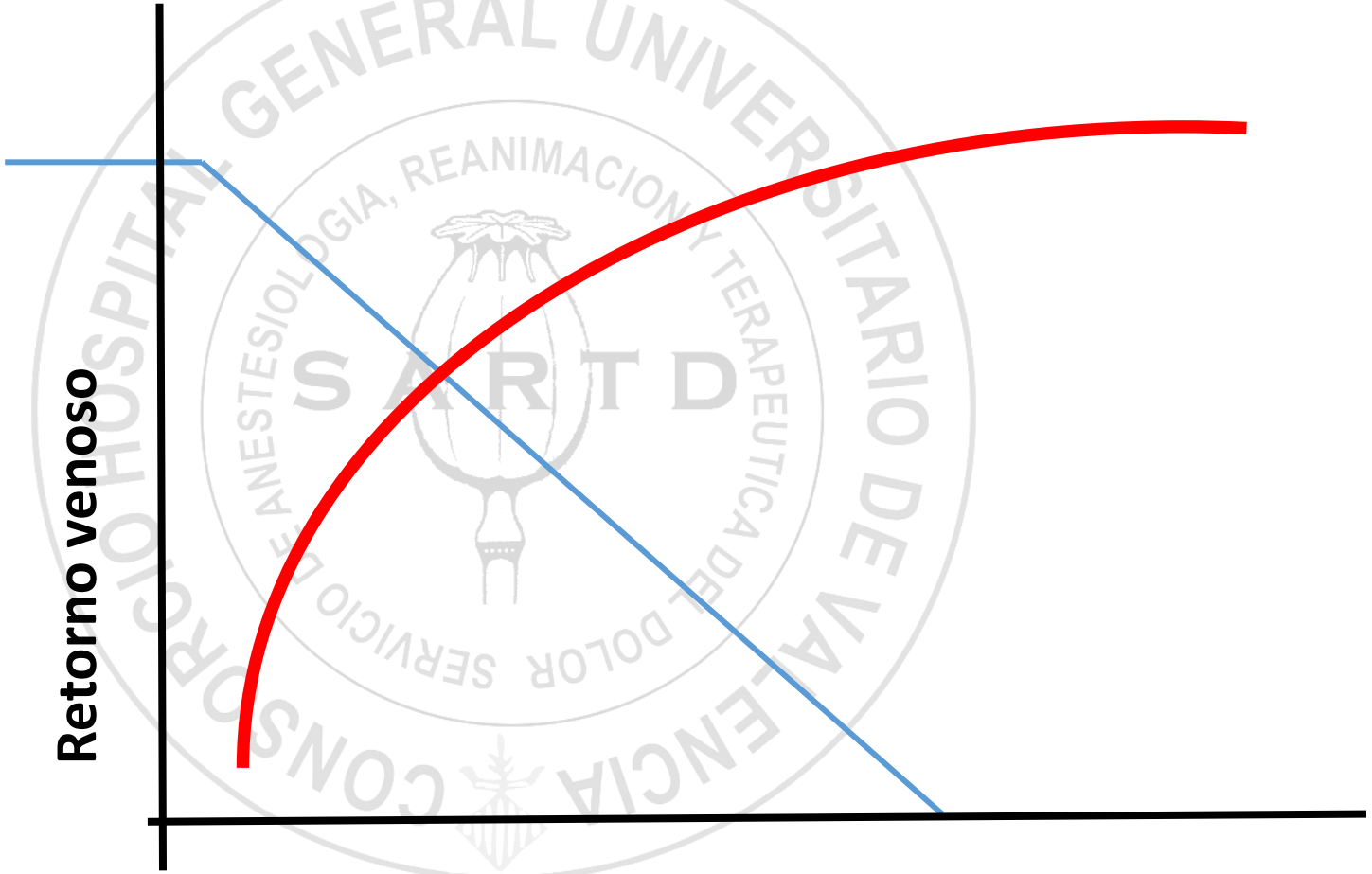


Retorno venoso ↓ = (Psm - PVC ↑) / Rv

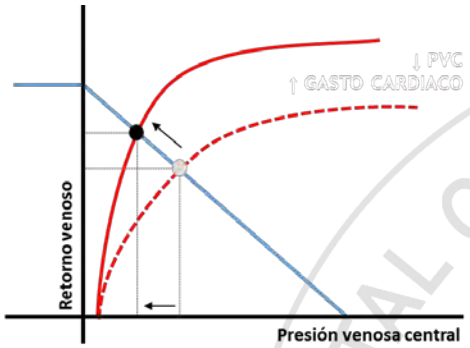
2-Formas de corregir la hipoperfusión

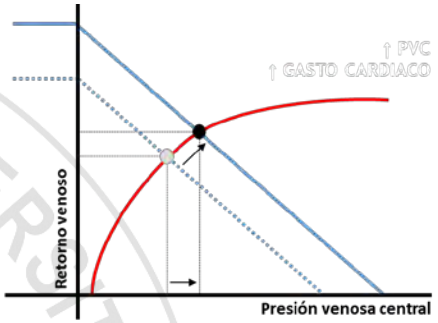


2-Formas de corregir la hipoperfusión

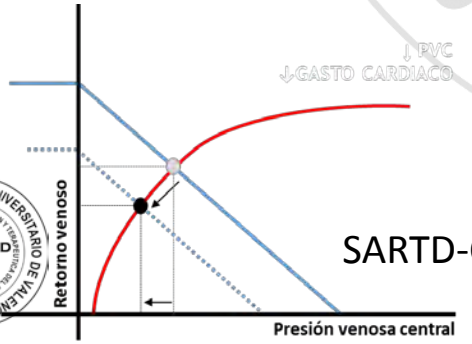


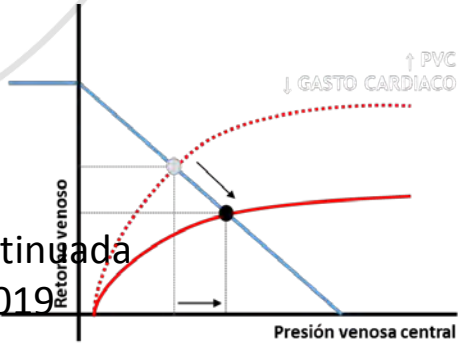
2-Formas de corregir la hipoperfusión



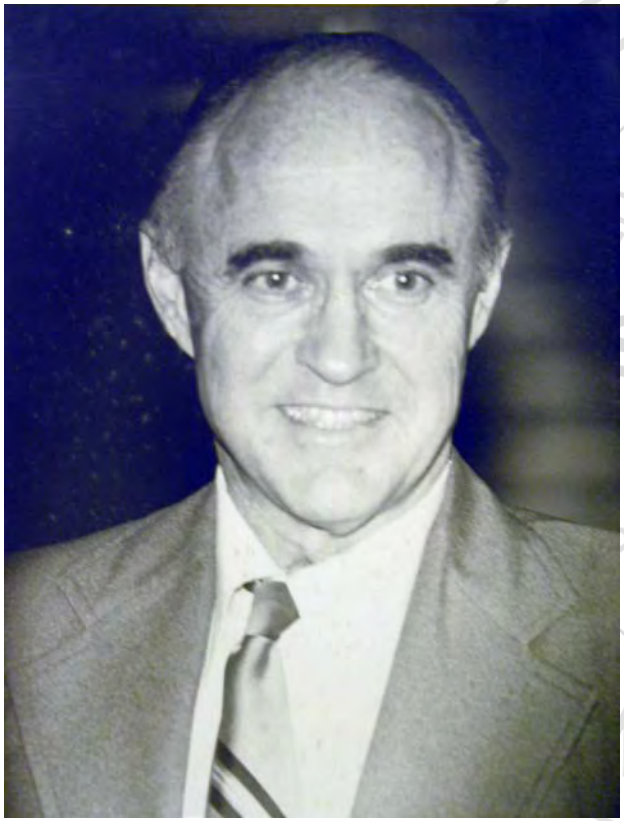


	PVC ↓	PVC ↑
GASTO CARDIACO ↑	Mejoría de la función cardiaca	Mejoría del retorno venoso
GASTO CARDIACO ↓	Deterioro del retorno venoso	Deterioro de la función cardiaca





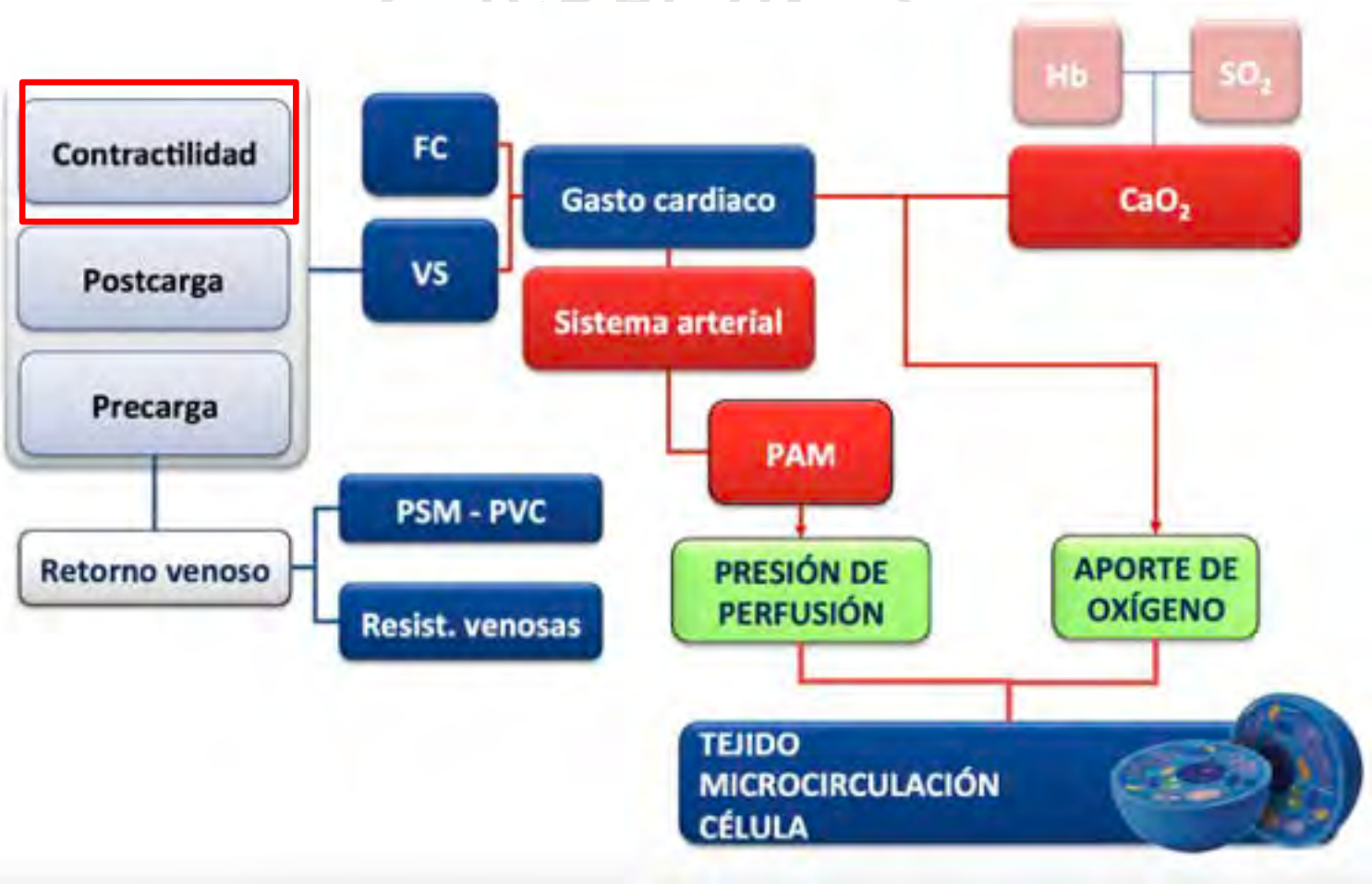
2-Formas de corregir la hipoperfusión



- **Retorno venoso:**

$$\frac{P_{vs} - P_{AD}}{\text{Resistencias venosas}}$$

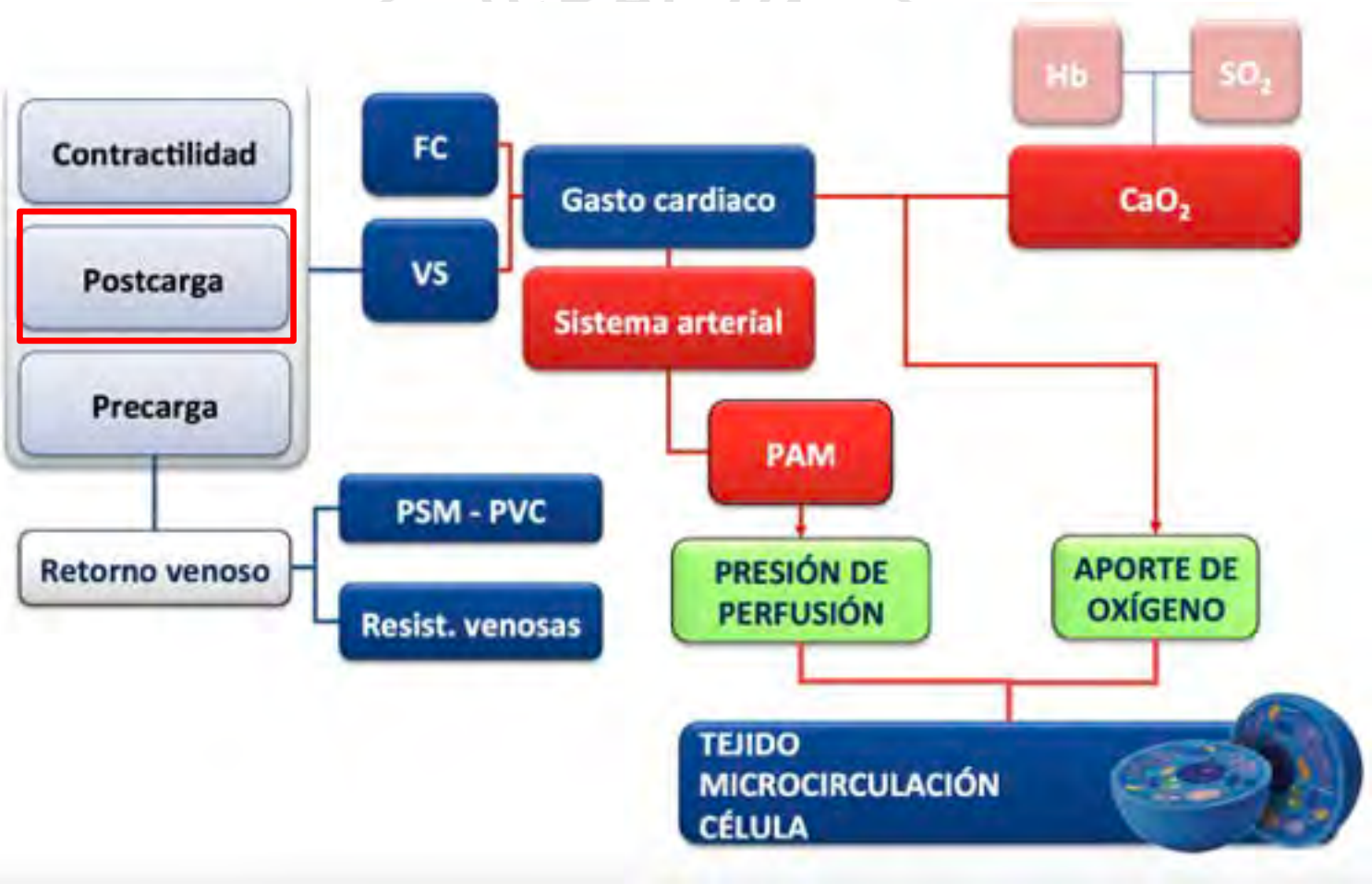
2-Formas de corregir la hipoperfusión



2-Formas de corregir la hipoperfusión

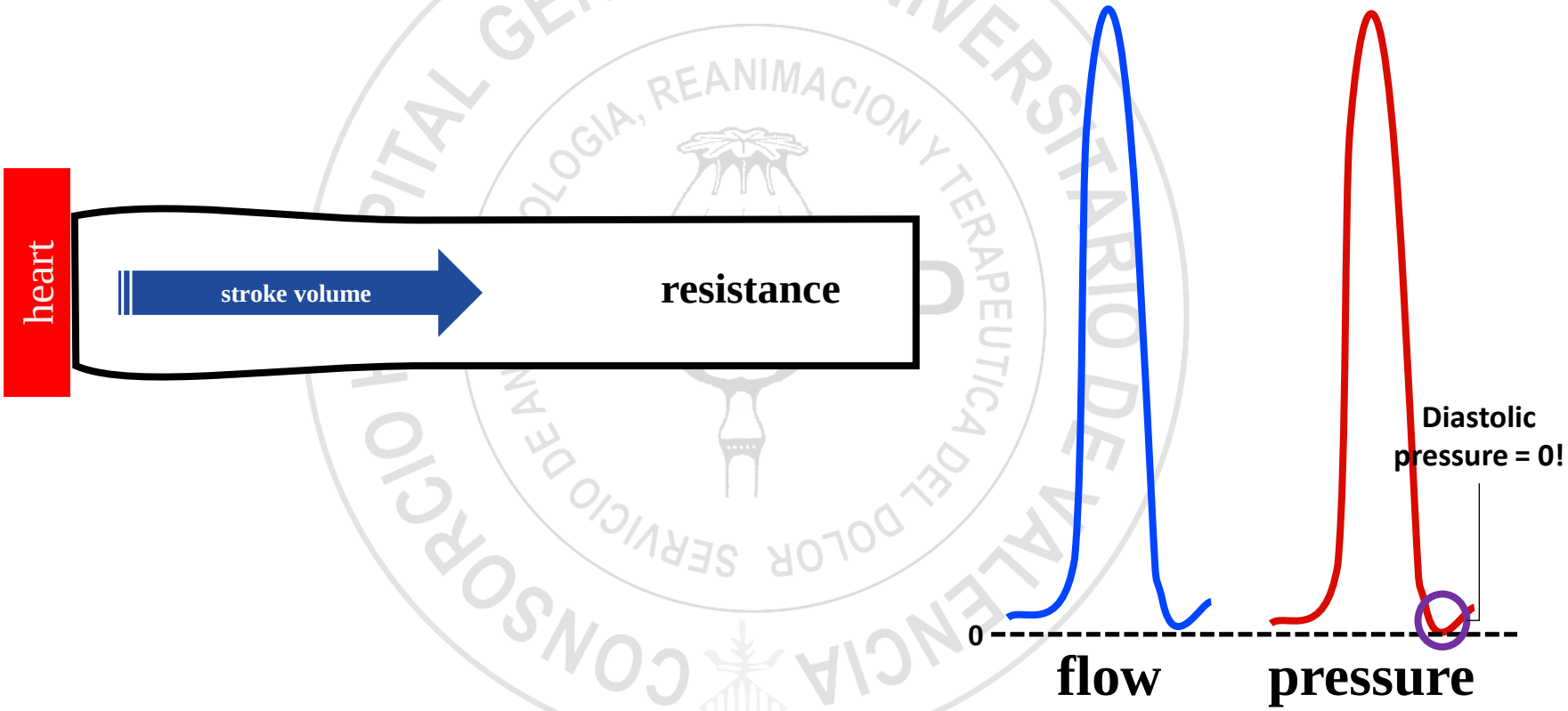
- La FE no es un parámetro de función ventricular, sino más bien un parámetro integrador de rendimiento cardiovascular.
- Una FE del 60% indica la integridad del sistema cardiovascular para compensar cambios de postcarga, precarga y contractilidad.
- En presencia de un tono arterial disminuido (vasoplegia, shock séptico), una fracción de eyección normal puede enmascarar una función ventricular izquierda deprimida.
- **En pacientes sépticos, una FE > 70% se ha asociado a una mayor mortalidad.**

2-Formas de corregir la hipoperfusión



2-Formas de corregir la hipoperfusión

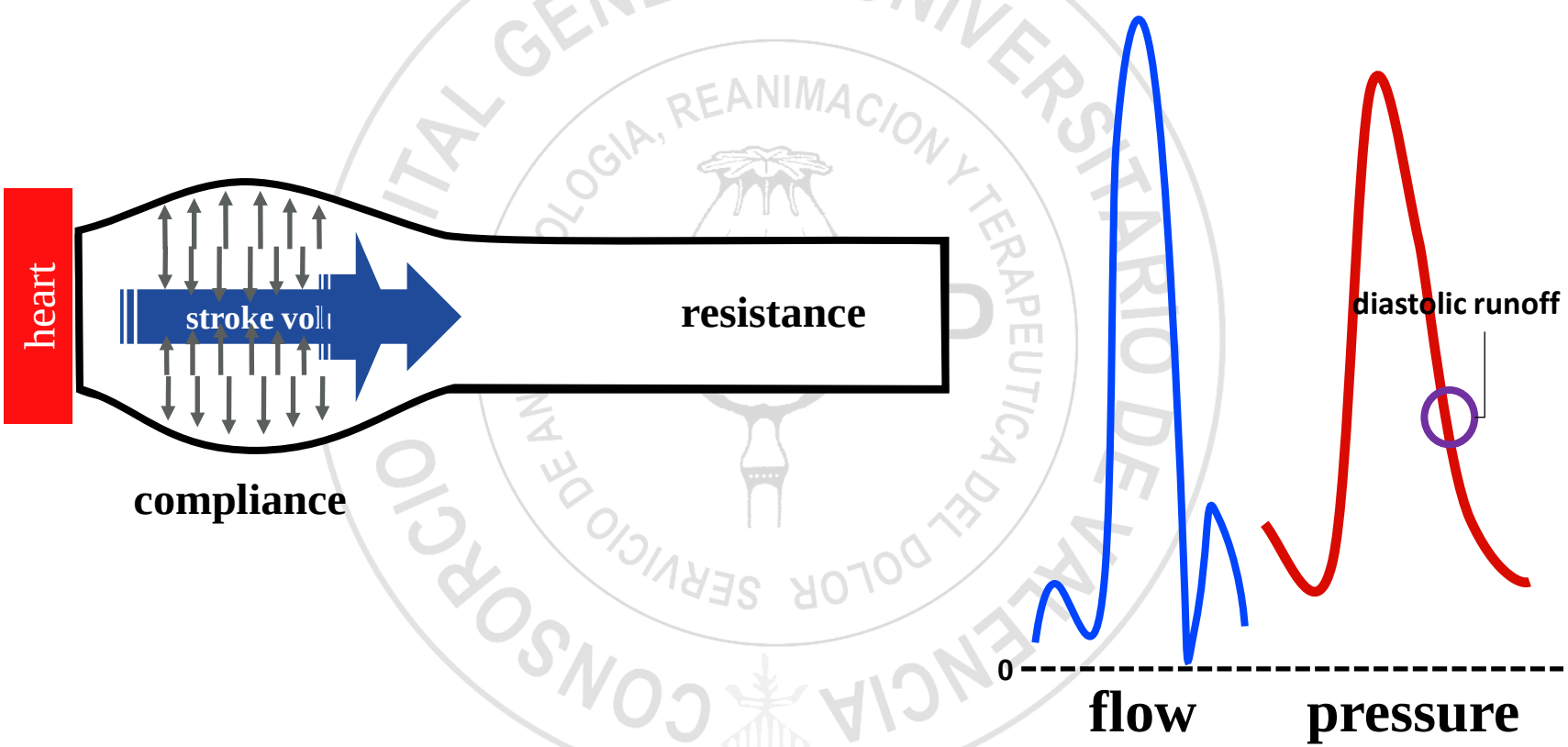
Resistance as sole descriptor of arterial system



2-Formas de corregir la hipoperfusión

Resistance + Compliance

(2-element Windkessel model)



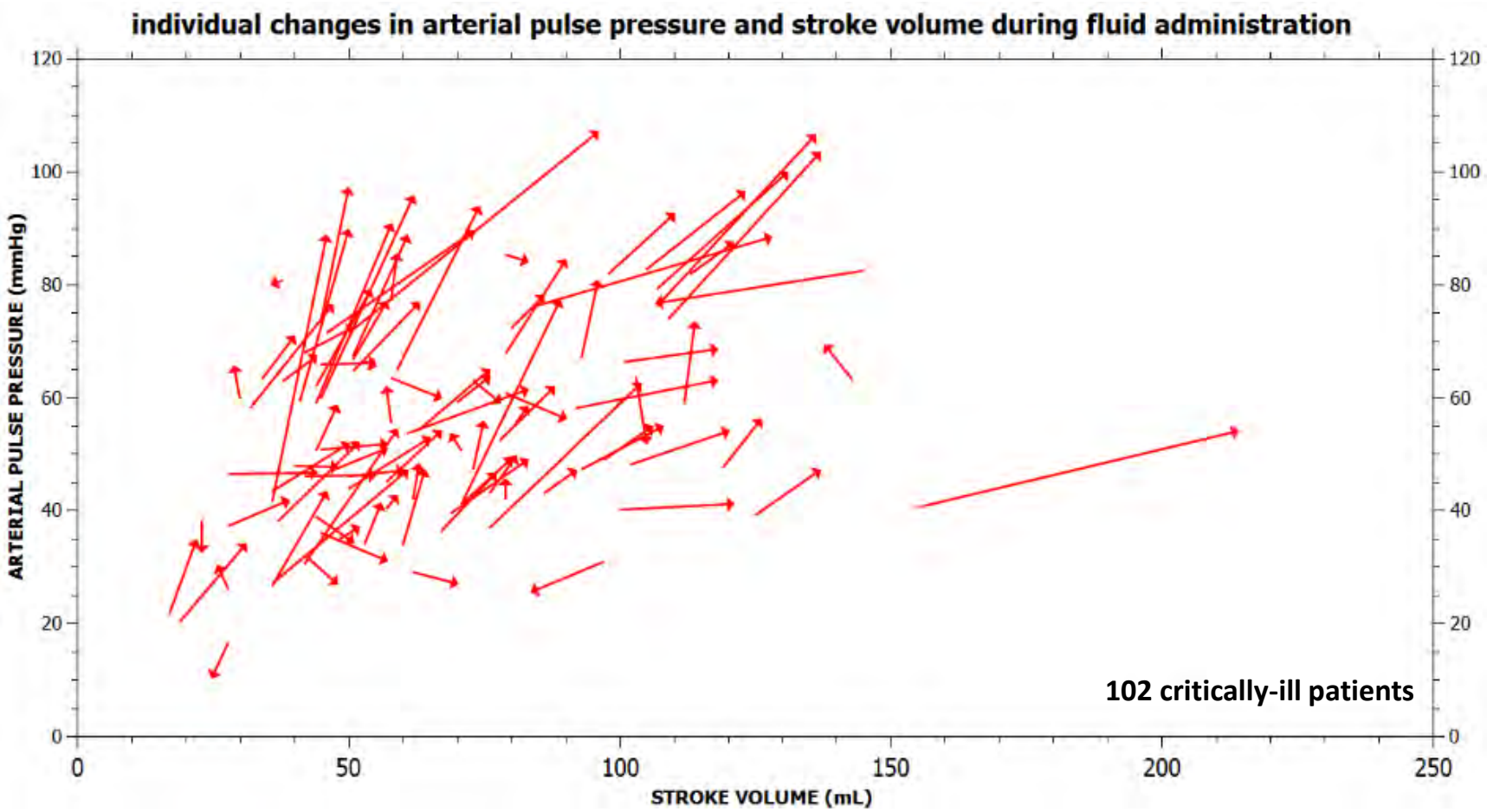
2-Formas de corregir la hipoperfusión

arterial pressure

≈

arterial blood flow

2-Formas de corregir la hipoperfusión



2-Formas de corregir la hipoperfusión

Fluid challenges in intensive care: the FENICE study

A global inception cohort study

Table 3 Indications and variables used to predict fluid responsiveness ($N = 2213$)

Indication	*n* (%)
Hypotension	1211 (58.7 [56.7–60.8])
Weaning vasopressor	146 (7.1 [6.0–8.2])
Cardiac output	62 (3.0) [2.3–3.7]
Oliguria	372 (18.0 [16.4–19.6])
Skin mottling	36 (1.7 [1.2–2.2])
Lactate	128 (6.2 [5.2–7.2])
$SvO_2/ScvO_2$	10 (0.5 [0.2–0.8])
SVV/PPV	37 (1.8 [1.3–2.4])
CVP/PAOP	60 (2.9 [2.2–3.6])

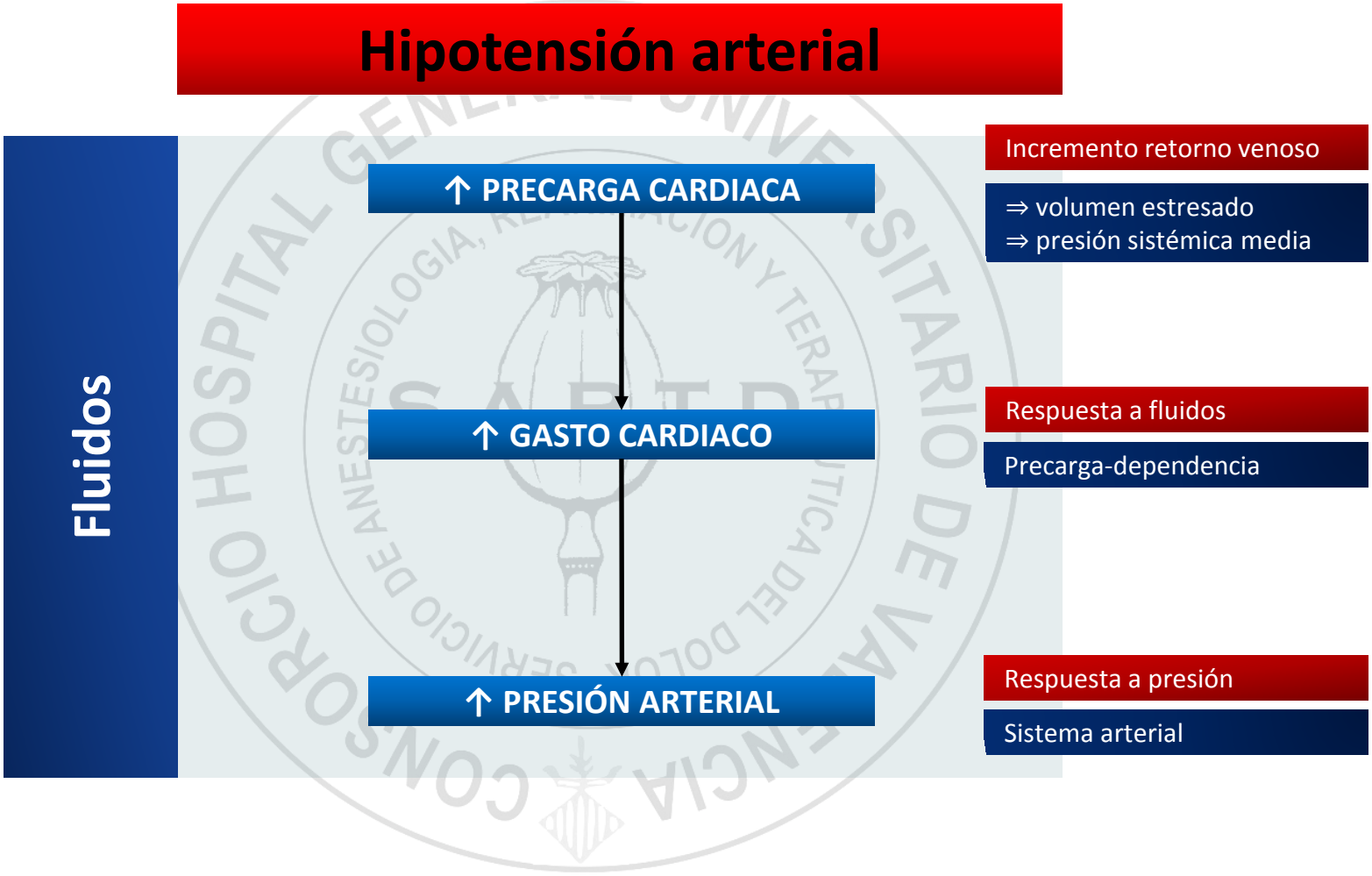
2-Formas de corregir la hipoperfusión

Response classification [no. (%) of 2162]	
Negative response	429 (19.8 [18.1–21.5])
Positive response	1544 (71.4 [69.5–71.4])
Uncertain	189 (8.7 [7.5–9.9])
Variable use to evaluate response [no. (%) of 1544 with positive response]	
Increase in BP	1039 (67.3 [65.0–69.7])
Decrease vasopressors	56 (3.6 [2.7–4.5])
Increase in CO	174 (11.3 [9.7–12.9])
Increase in SV	100 (6.5 [5.3–7.7])
Decrease in HR	374 (24.2 [22.1–26.3])
Urine output	590 (38.2 [35.8–40.6])
Lactate	281 (18.2 [16.3–20.1])
Skin perfusion	128 (8.3 [6.9–9.7])
Mental state	40 (2.6 [1.8–3.4])
EVLWI	28 (4.9 [3.1–6.7])
SpO_2/SaO_2	105 (18.2 [15.1–21.35])
CO	8 (1.4 [0.4–2.4])
SVV/PPV	80 (13.9 [11.1–16.7])
Other	120 (20.8 [17.5–24.1])

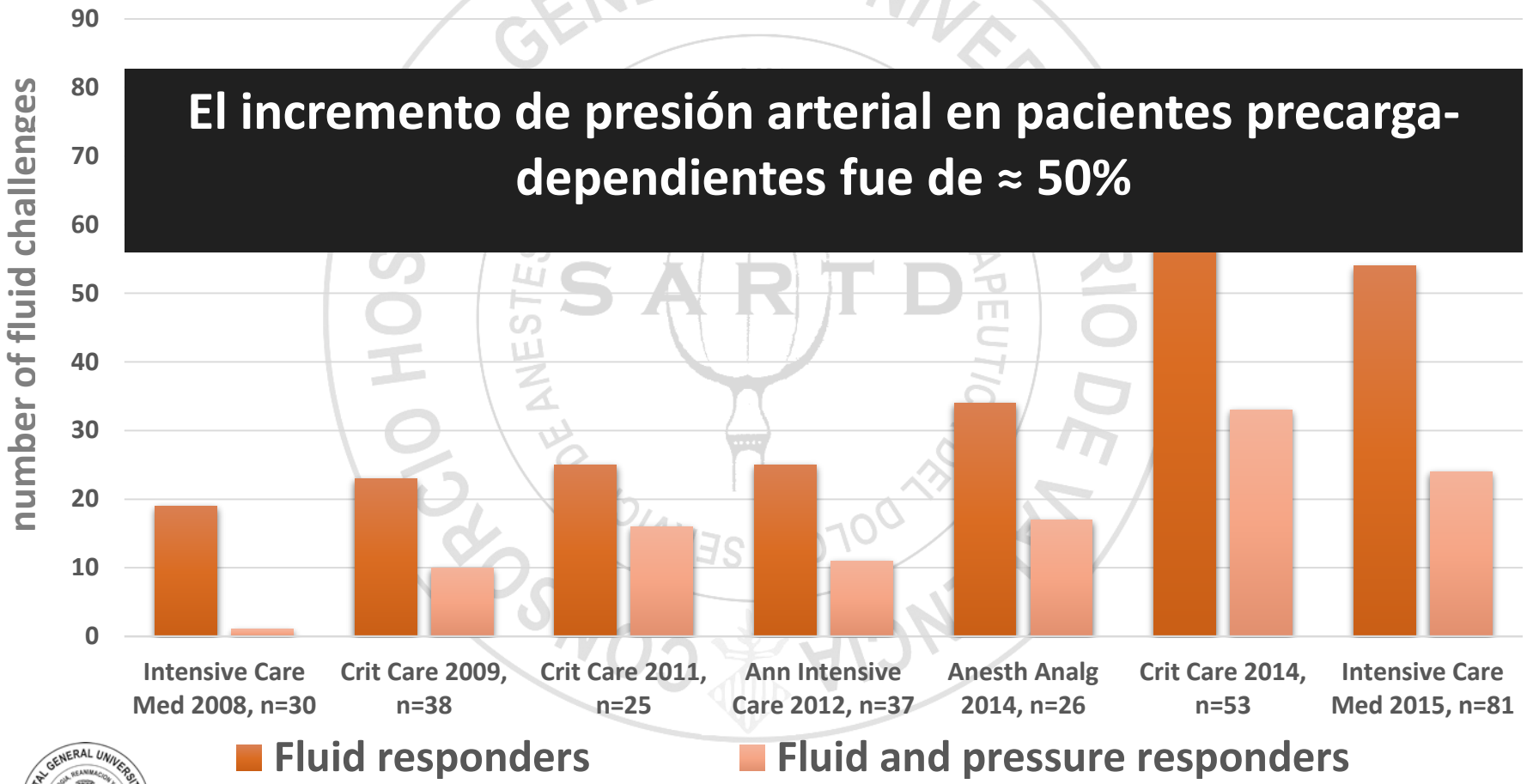
La presión arterial es frecuentemente empleada para evaluar la respuesta a fluidos

BP blood pressure, *CO* cardiac output, *SV* stroke volume, *HR* heart rate, SvO_2 mixed venous oxygen saturation, $ScvO_2$ central venous oxygen saturation, *SVV* stroke volume variation, *PPV* pulse pressure variation, *CVP* central venous pressure, *PAOP* pulmonary artery occlusion pressure, *GEDVI* global end diastolic volume, *EVLWI* extravascular lung water index

2-Formas de corregir la hipoperfusión



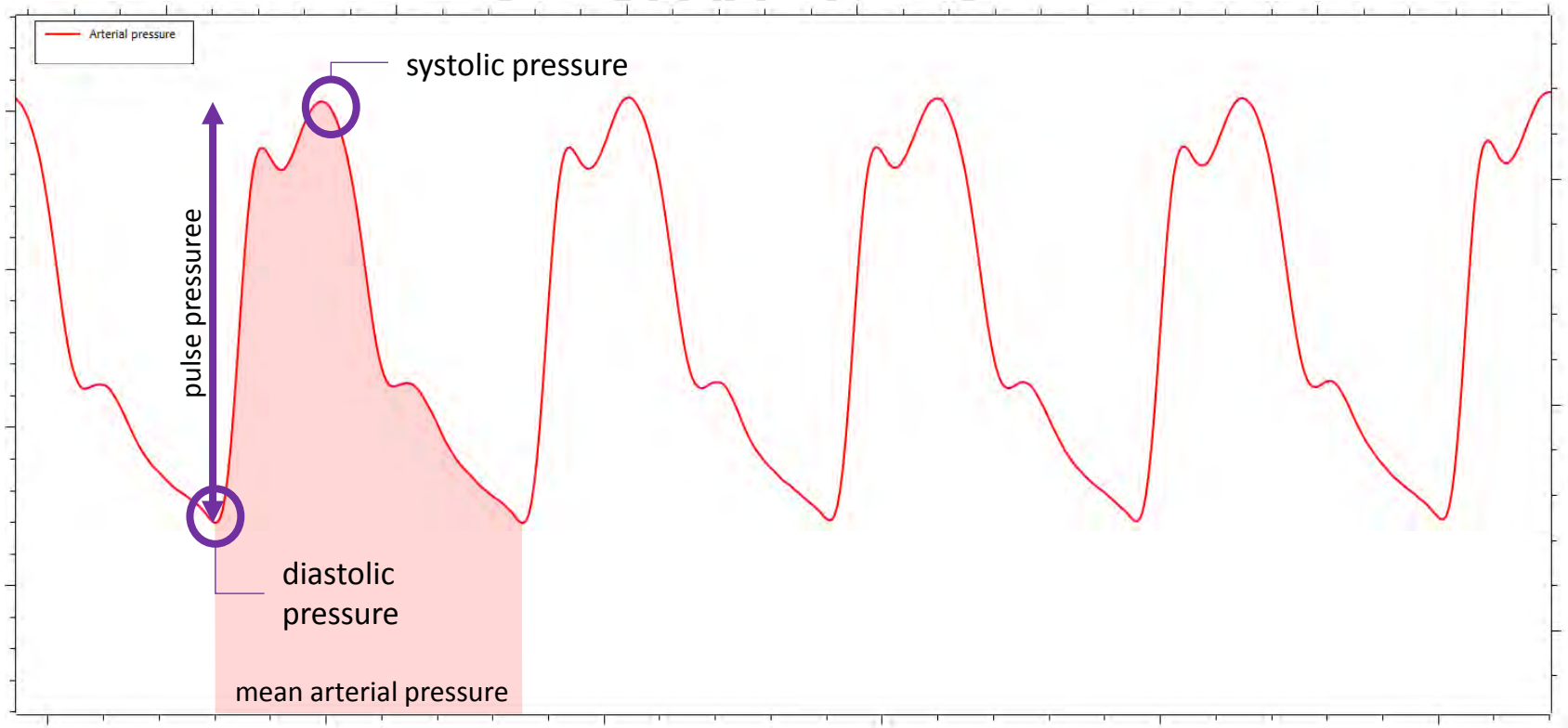
2-Formas de corregir la hipoperfusión



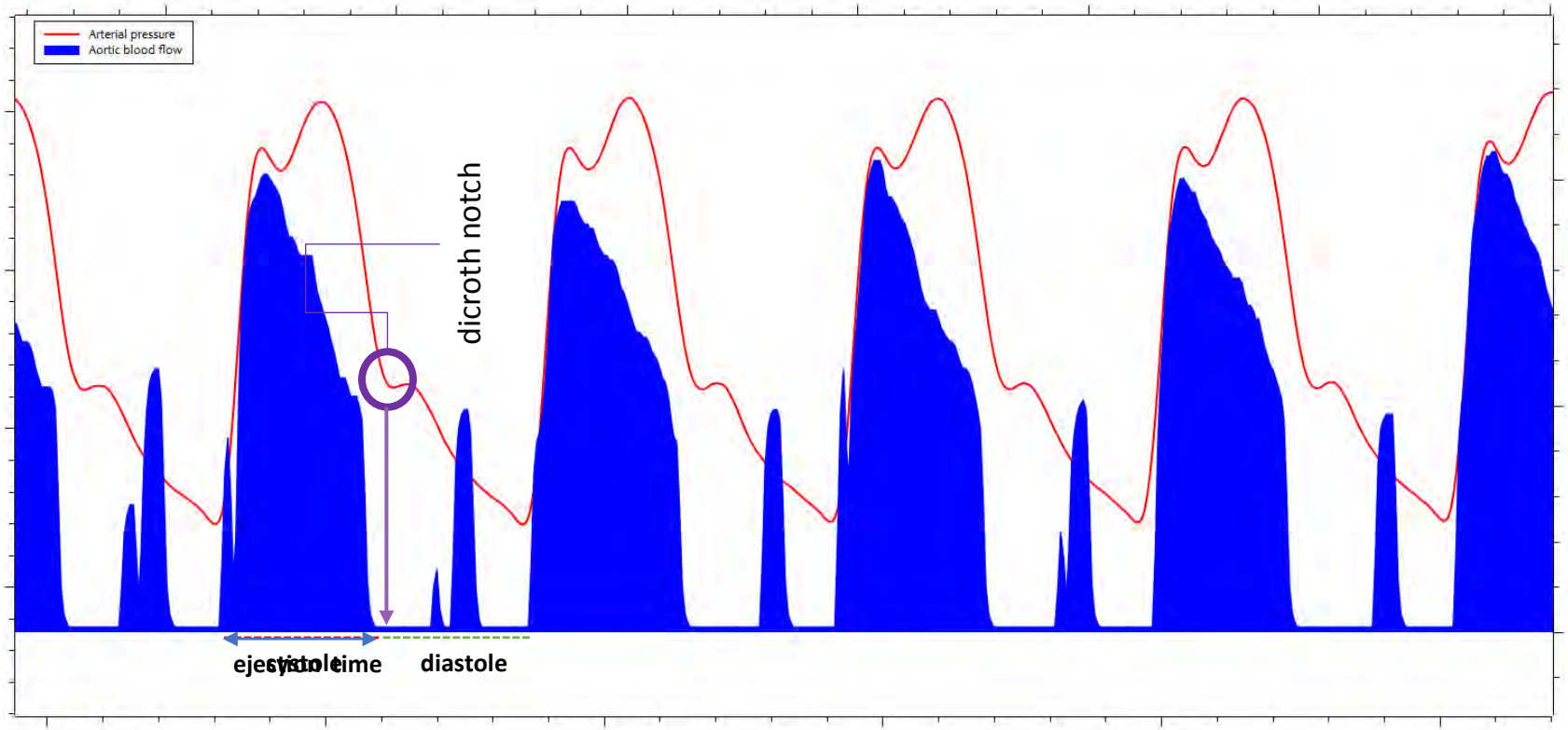
2-Formas de corregir la hipoperfusión

arterial pressure waveform analysis

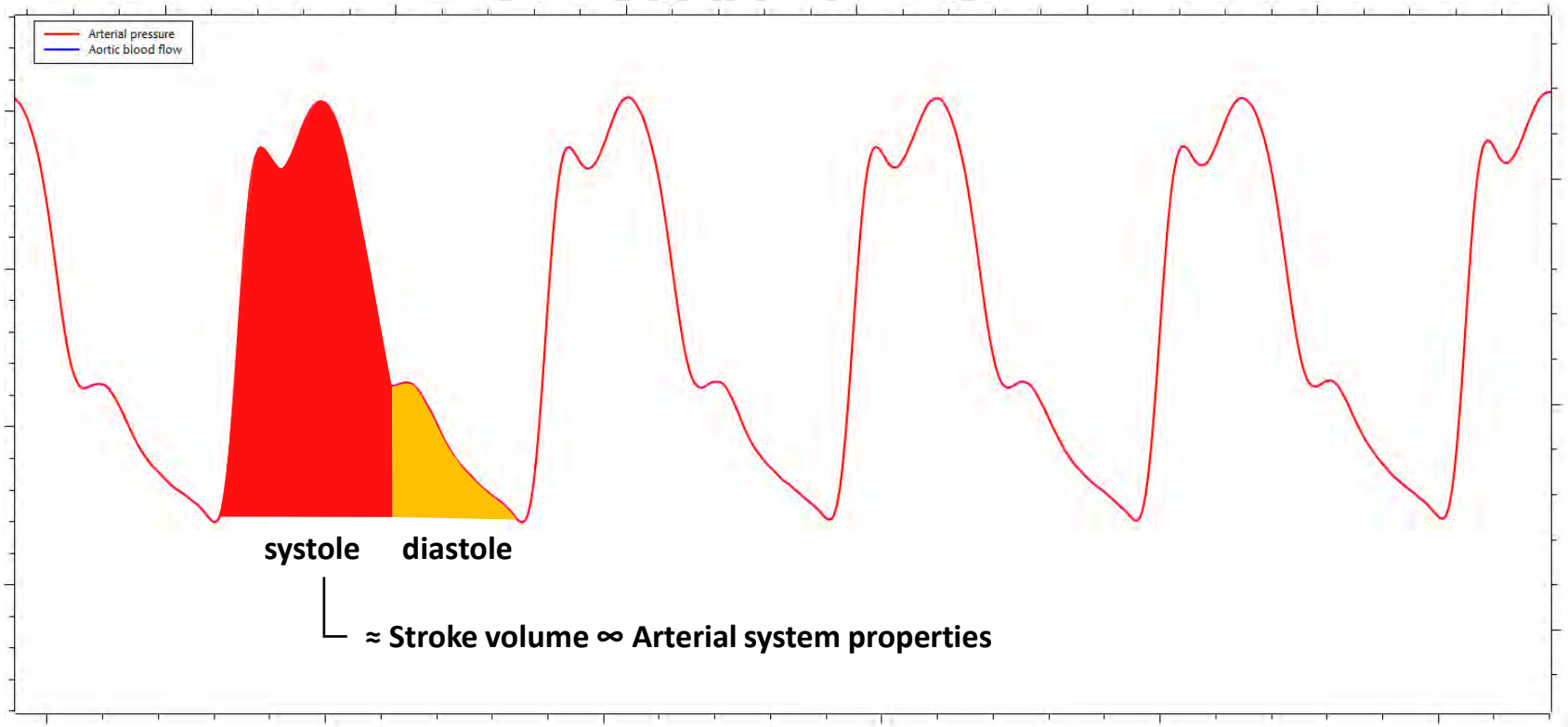
2-Formas de corregir la hipoperfusión



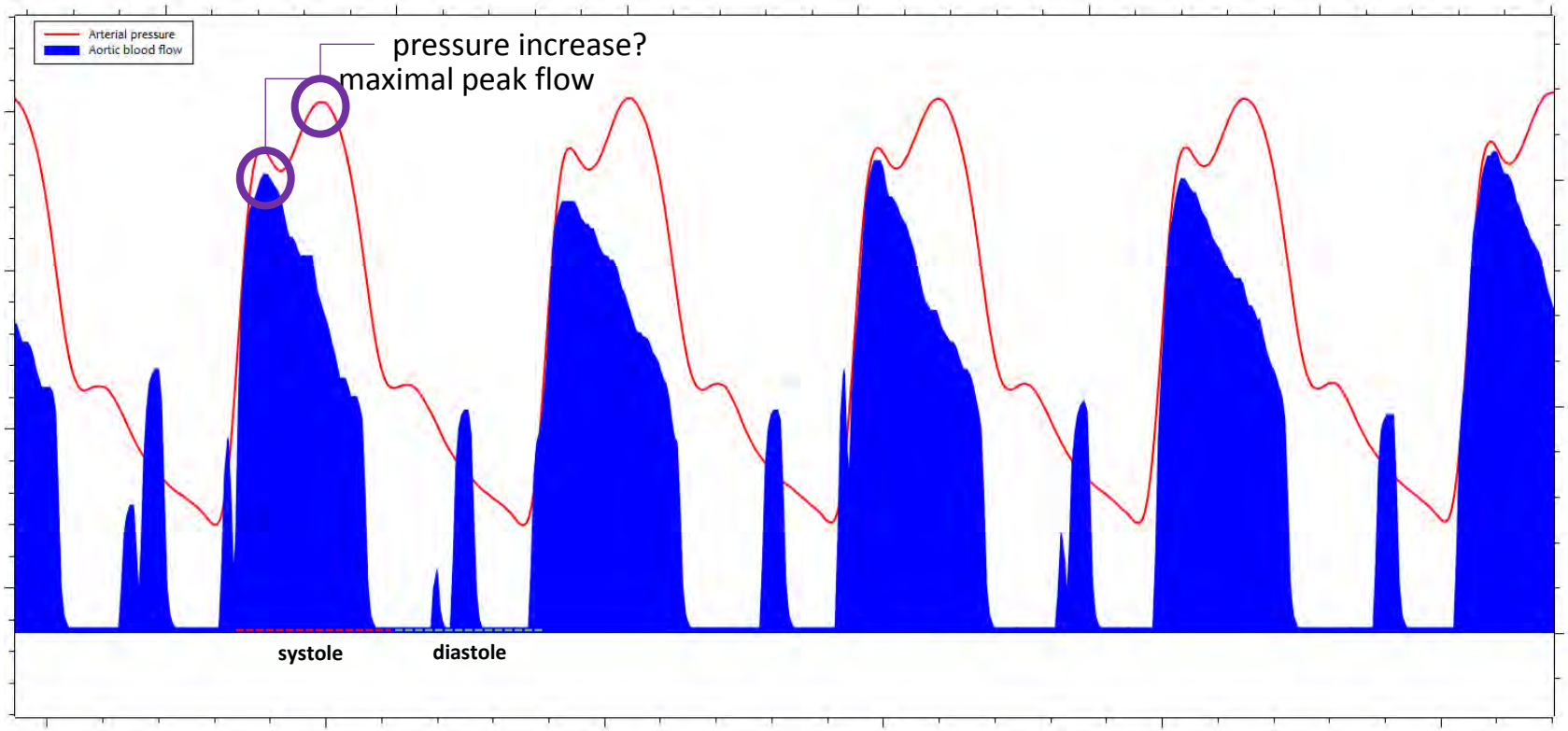
2-Formas de corregir la hipoperfusión



2-Formas de corregir la hipoperfusión

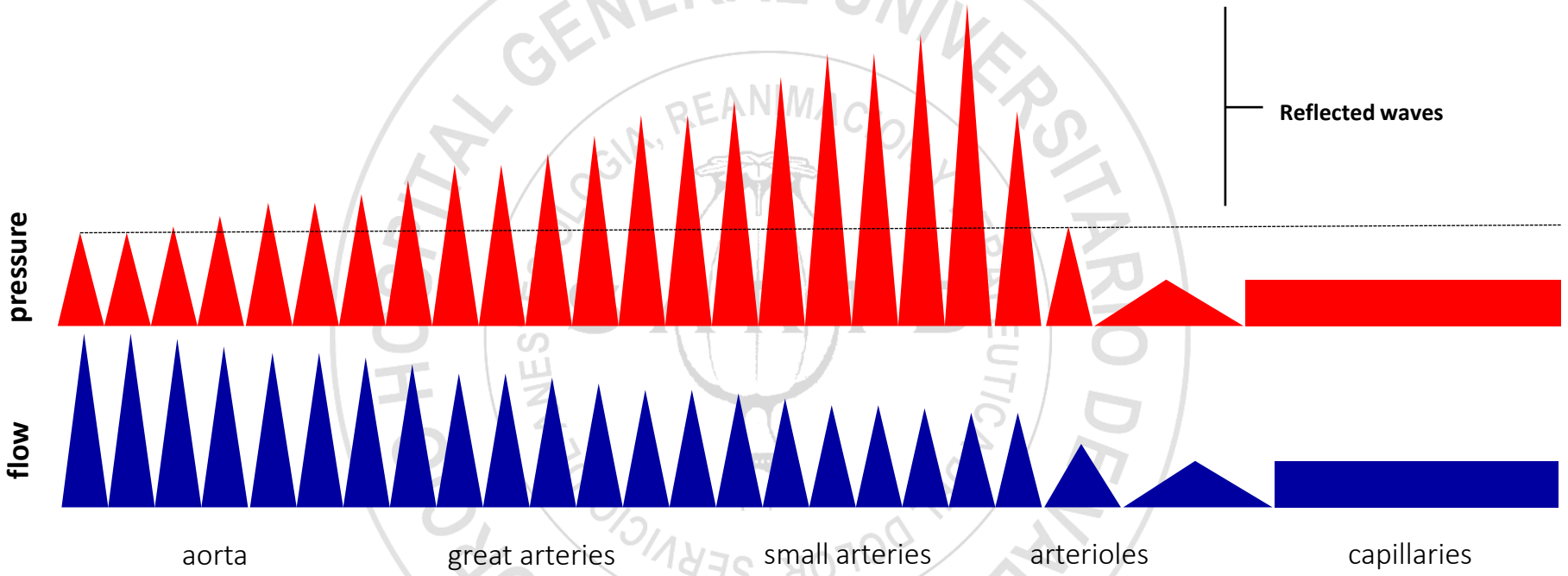


2-Formas de corregir la hipoperfusión



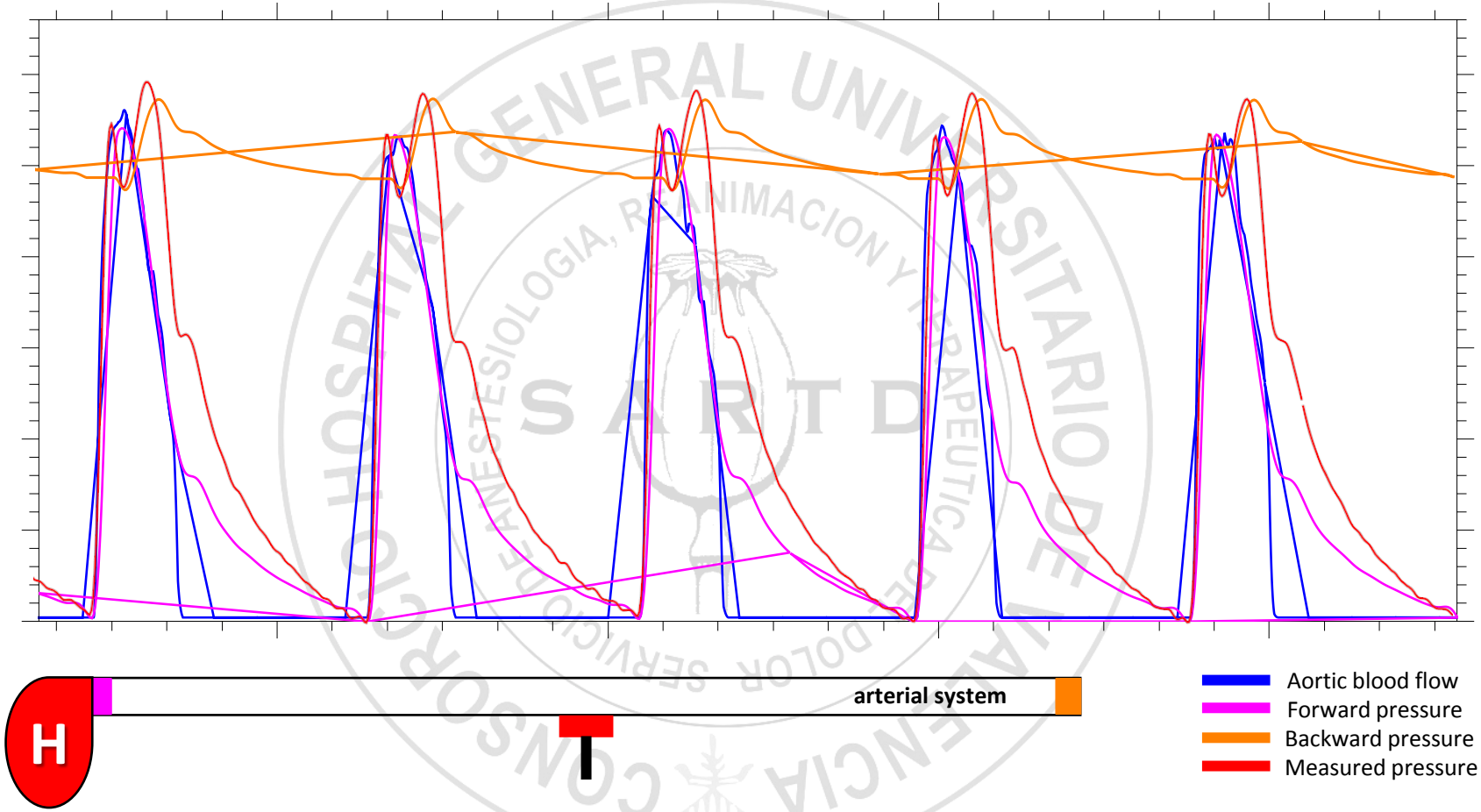
2-Formas de corregir la hipoperfusión

Flow and pressure distribution along the arterial tree



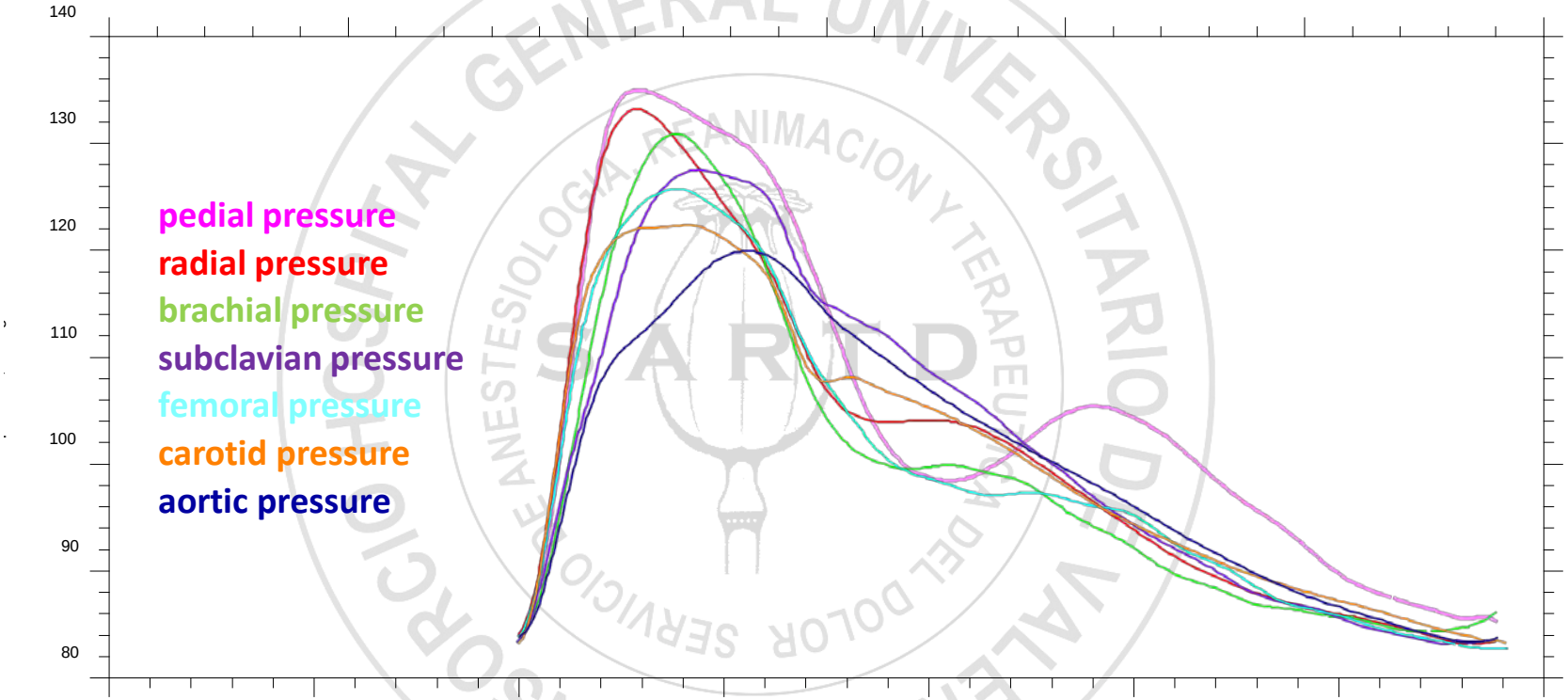
2-Formas de corregir la hipoperfusión

deconstructing arterial pressure waveform



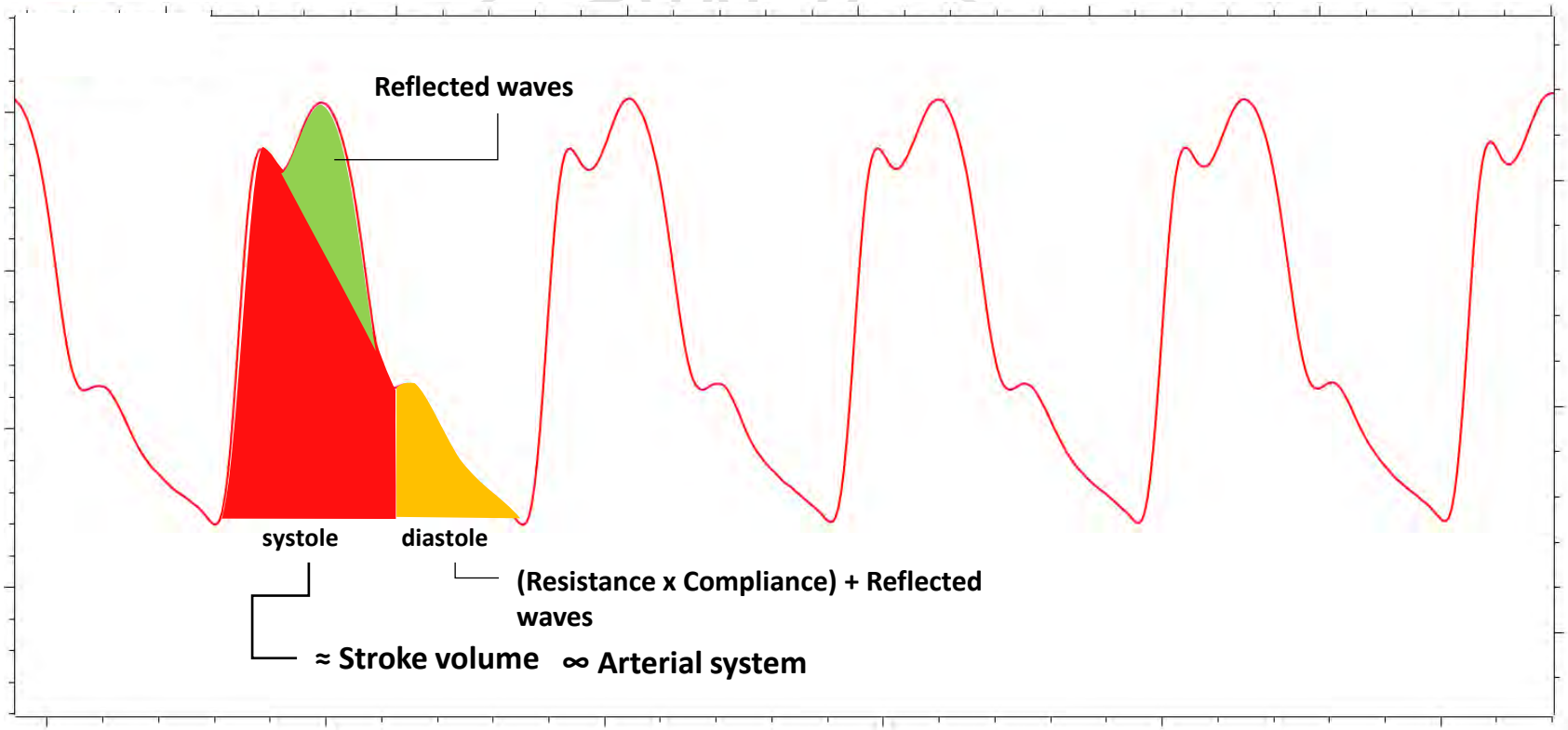
2-Formas de corregir la hipoperfusión

arterial pressure contour on different arteries

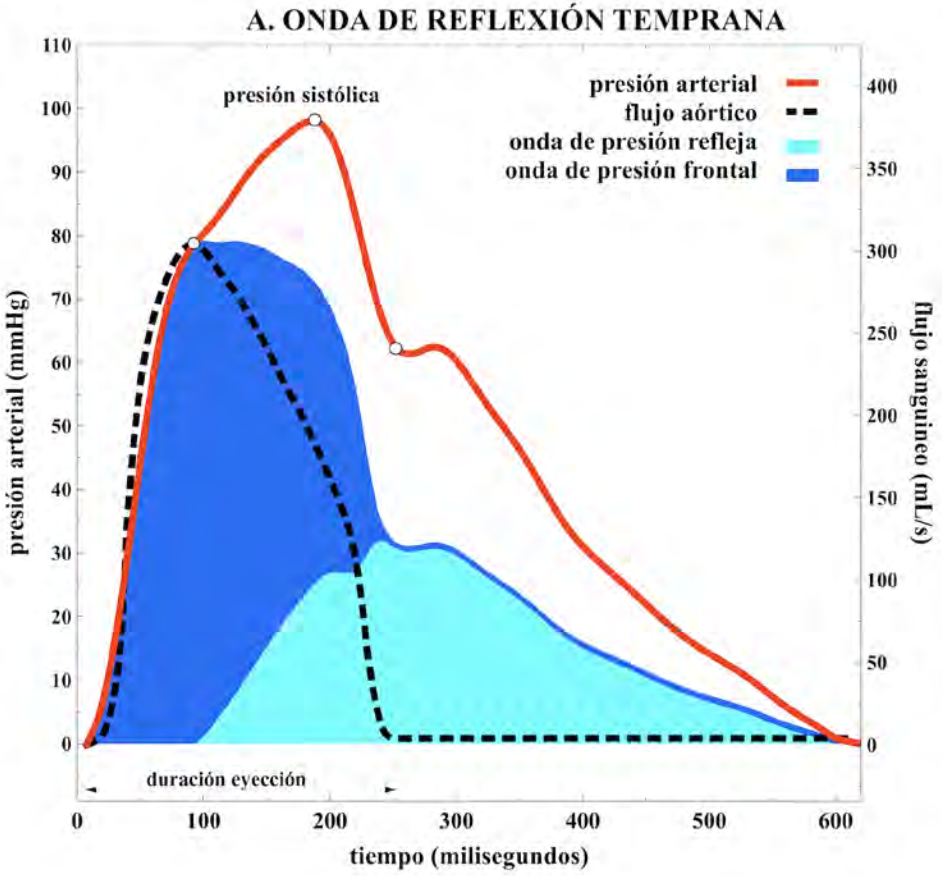


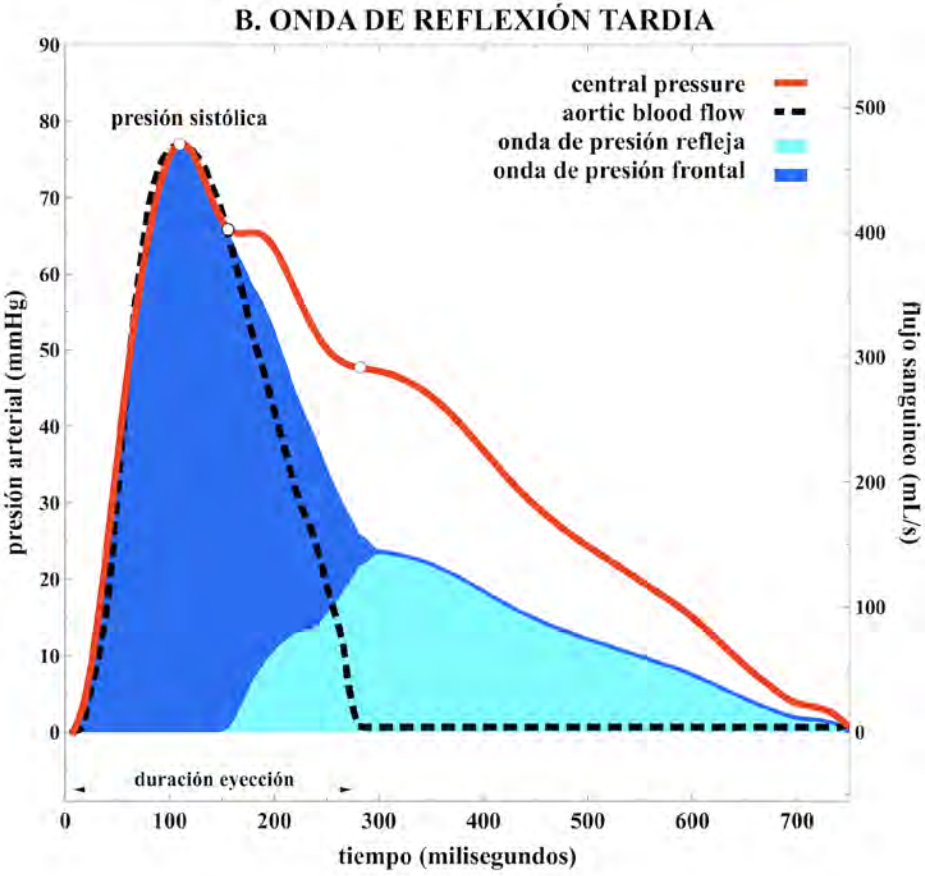
2-Formas de corregir la hipoperfusión

arterial waveform analysis



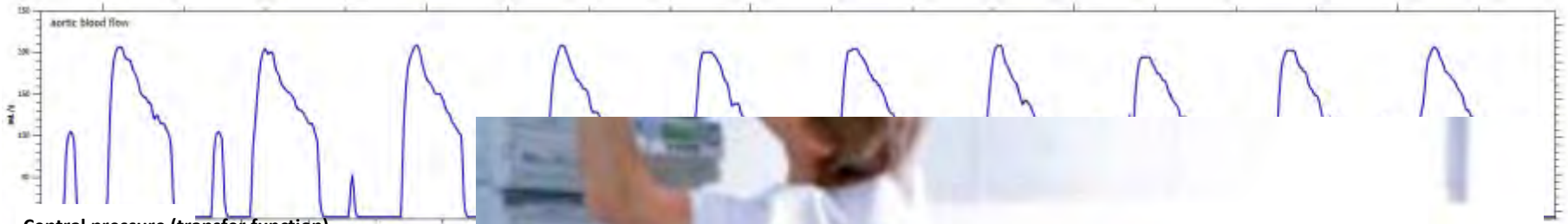
2-Formas de corregir la hipoperfusión





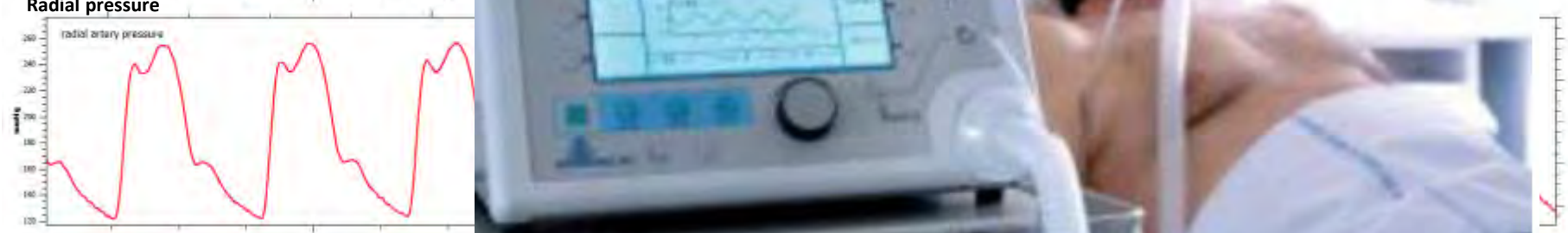
2-Formas de corregir la hipoperfusión

aortic blood flow



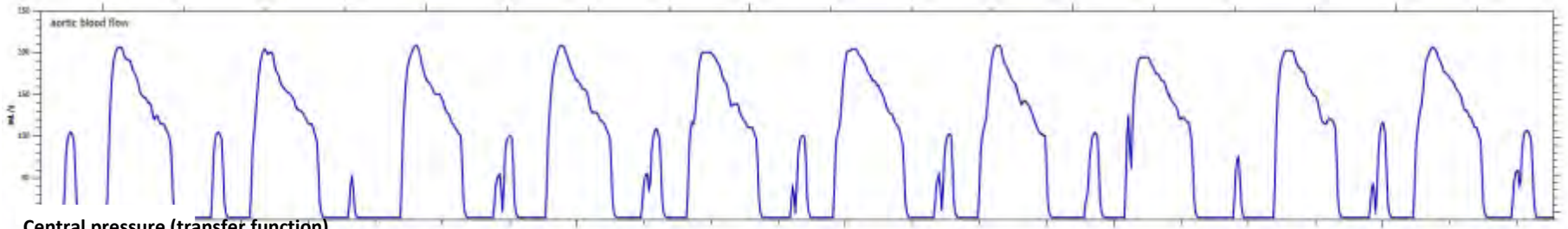
Central pressure (transfer function)

Radial pressure

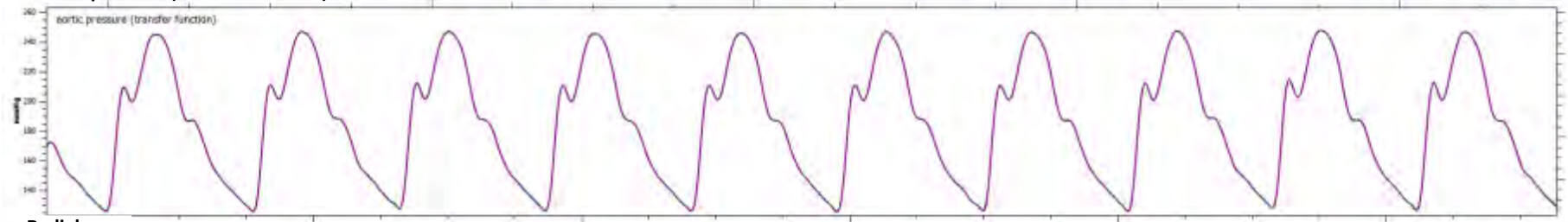


2-Formas de corregir la hipoperfusión

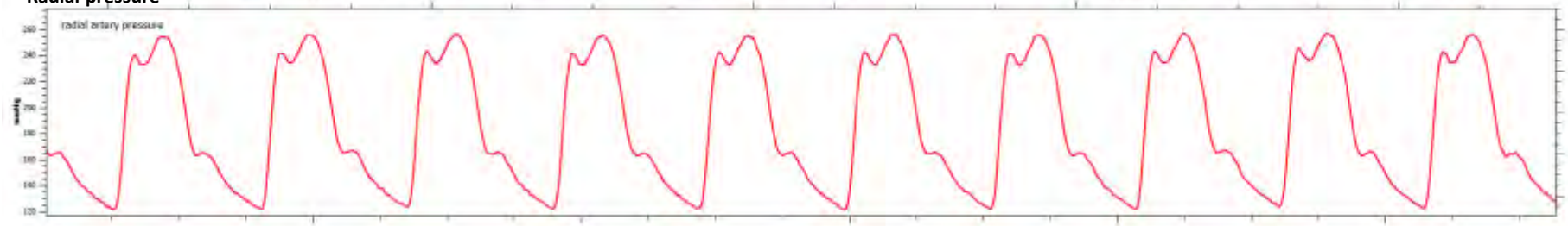
aortic blood flow



Central pressure (transfer function)

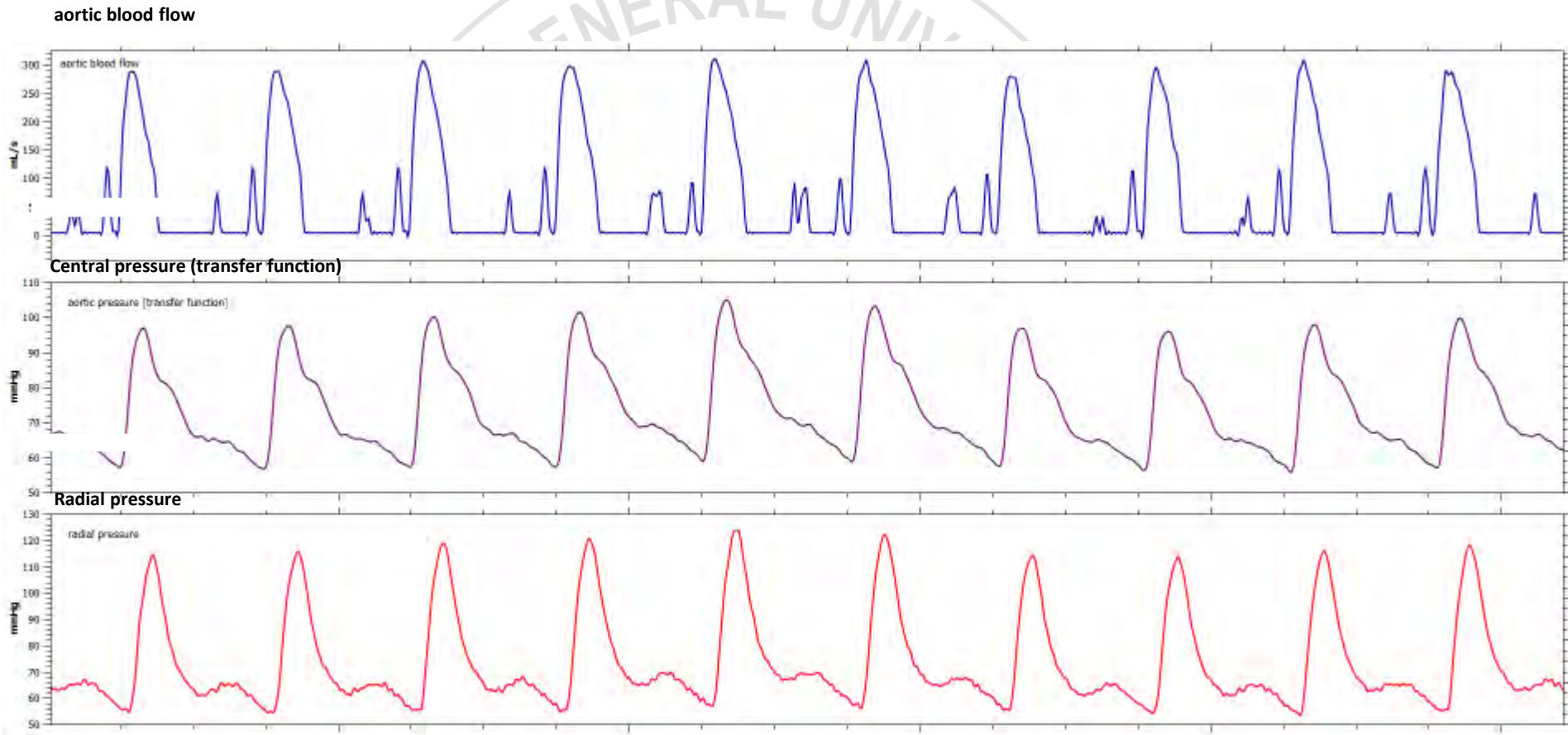


Radial pressure



2-Formas de corregir la hipoperfusión

after nitroprusside infusion

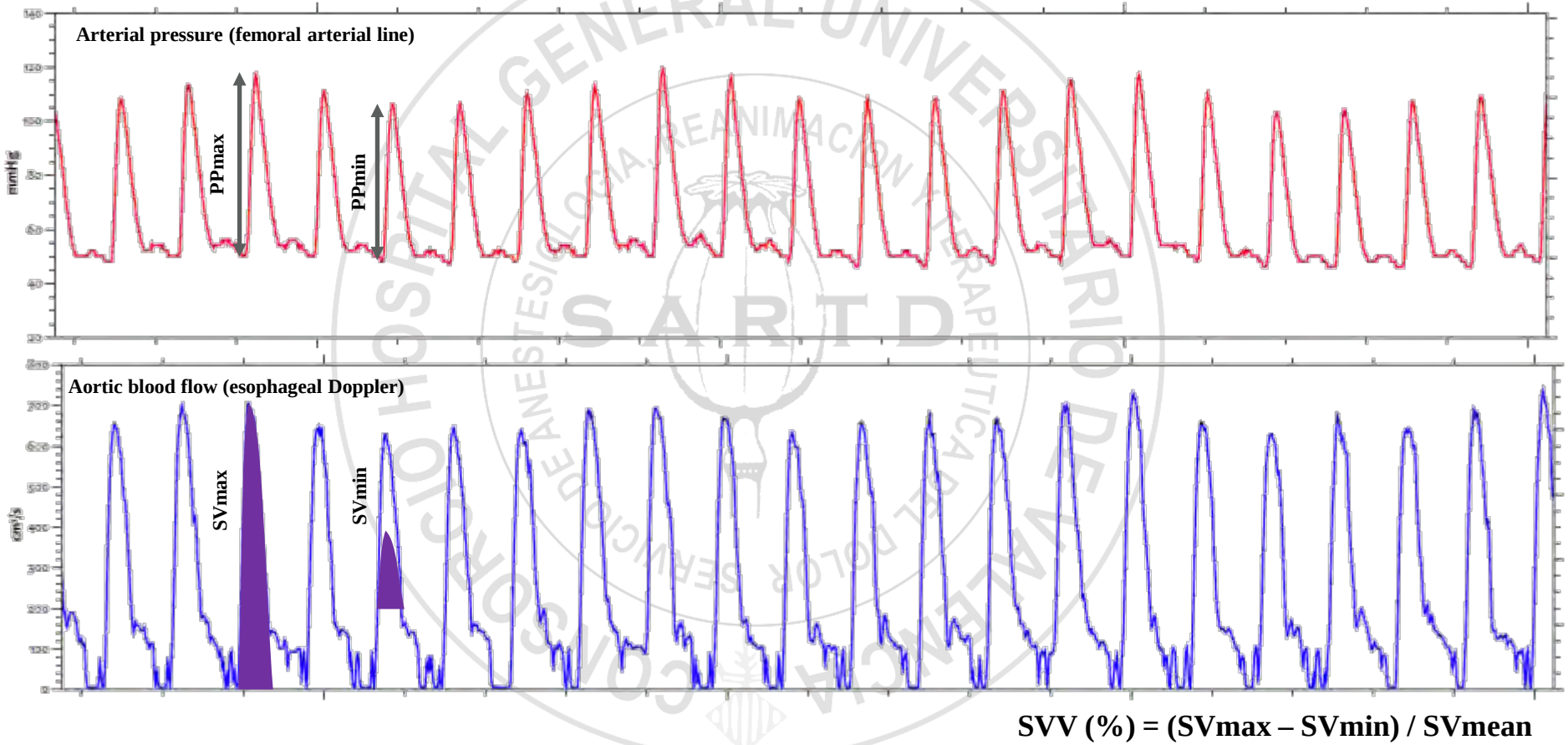


2-Formas de corregir la hipoperfusión

Dinamic arterial elastance (Ea_{dyn})

2-Formas de corregir la hipoperfusión

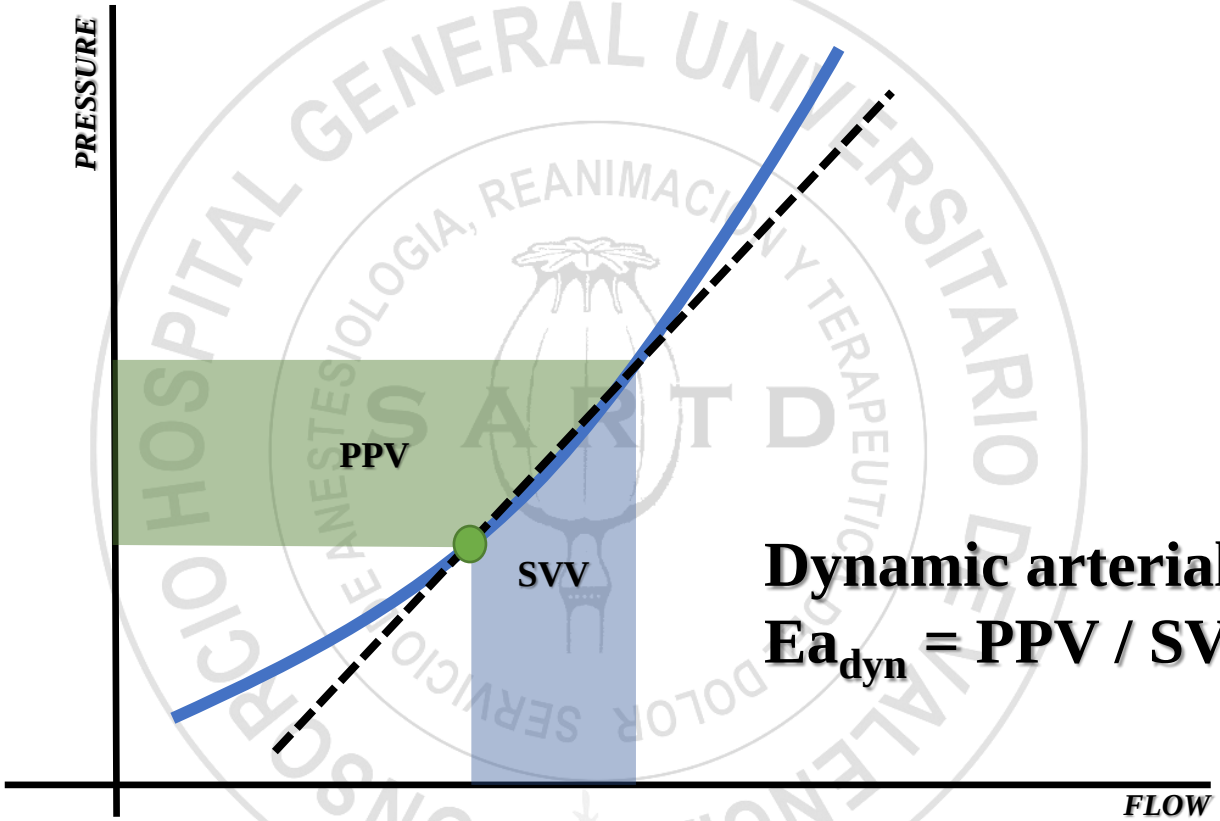
PPV (%) = (PPmax – PPmin) / PPmean



SVV (%) = (SVmax – SVmin) / SVmean

2-Formas de corregir la hipoperfusión

functional assessment of arterial load



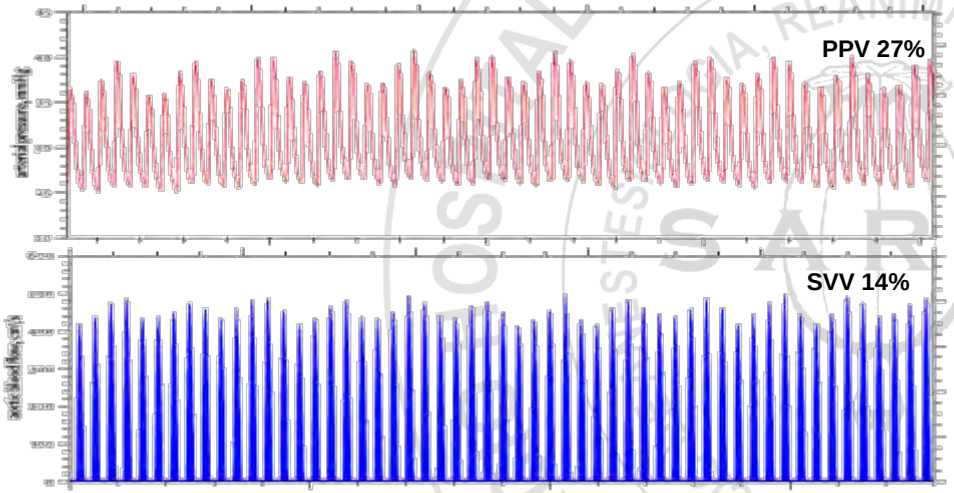
Dynamic arterial elastance

$$Ea_{dyn} = PPV / SVV$$

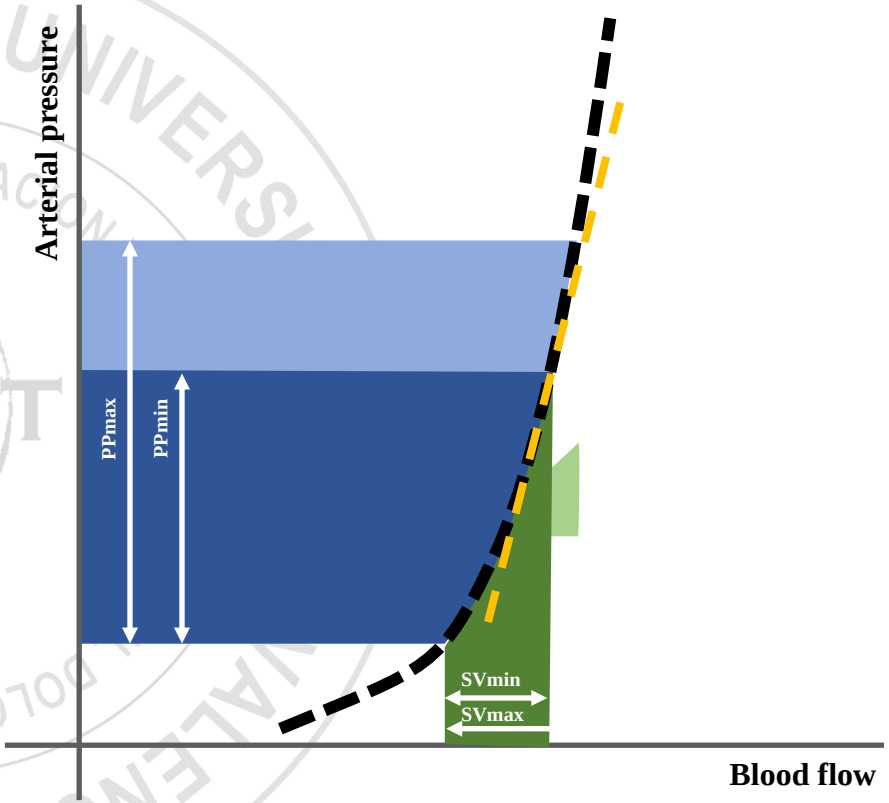
Pinsky MR. Protocolized cardiovascular management based on ventricular-arterial coupling. In: Functional hemodynamic monitoring 2006.

2-Formas de corregir la hipoperfusión

high dynamic arterial elastance

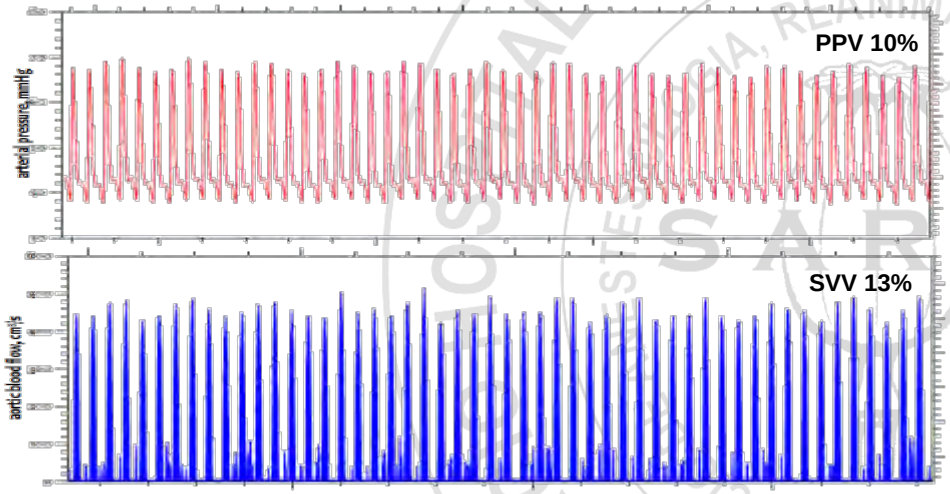


EAdyn = 27 / 14 = 1.93

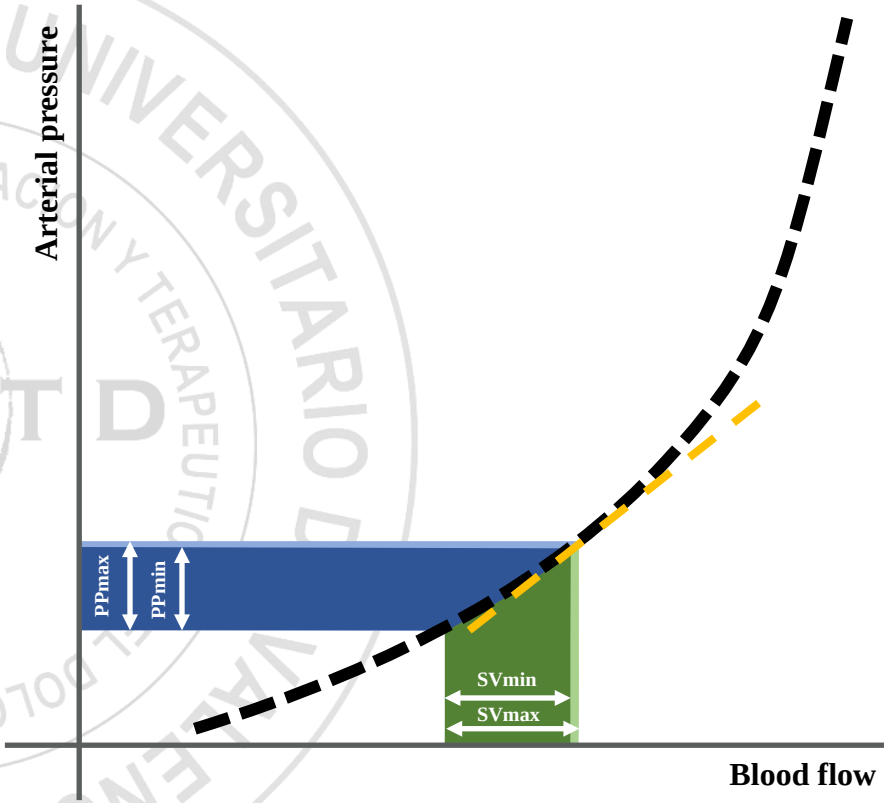


2-Formas de corregir la hipoperfusión

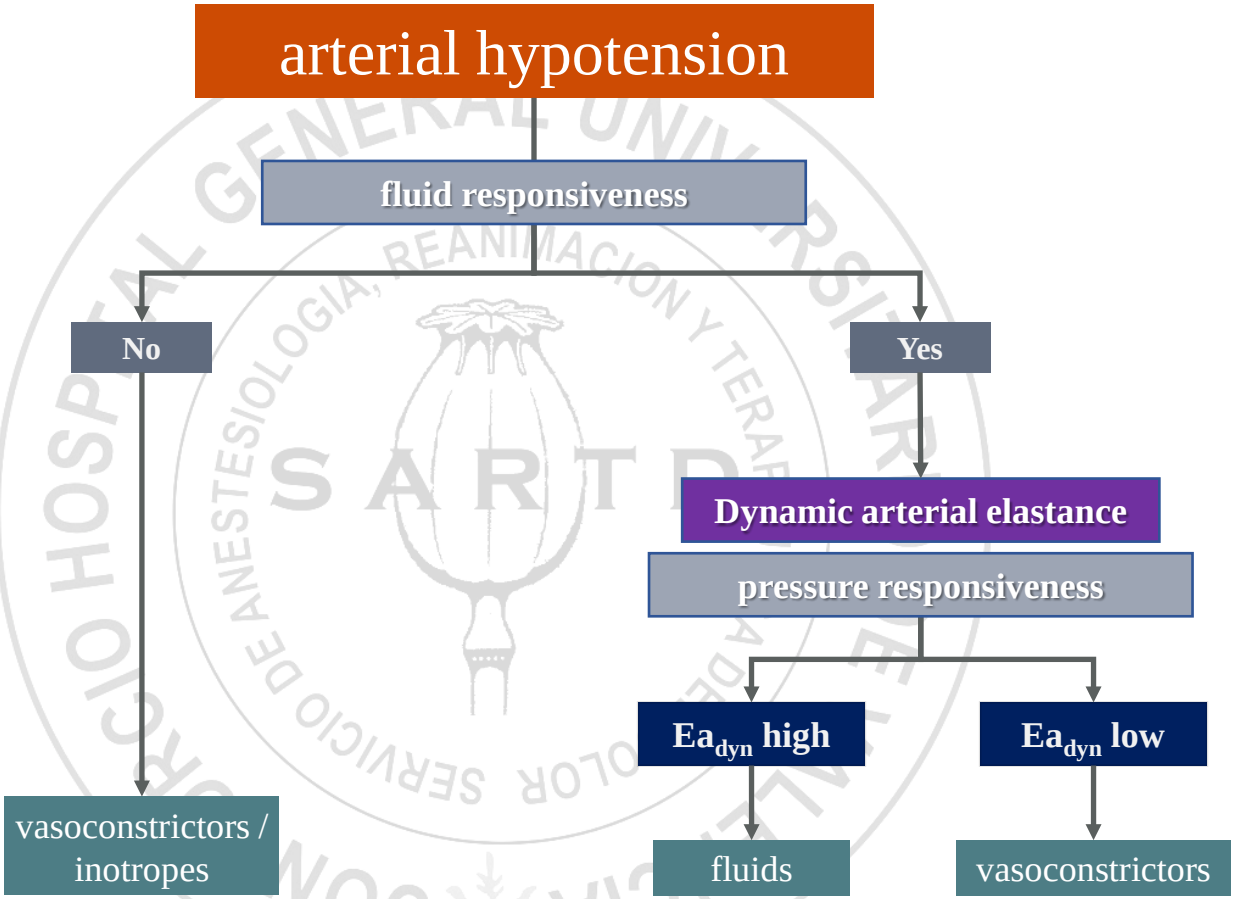
low dynamic arterial elastance



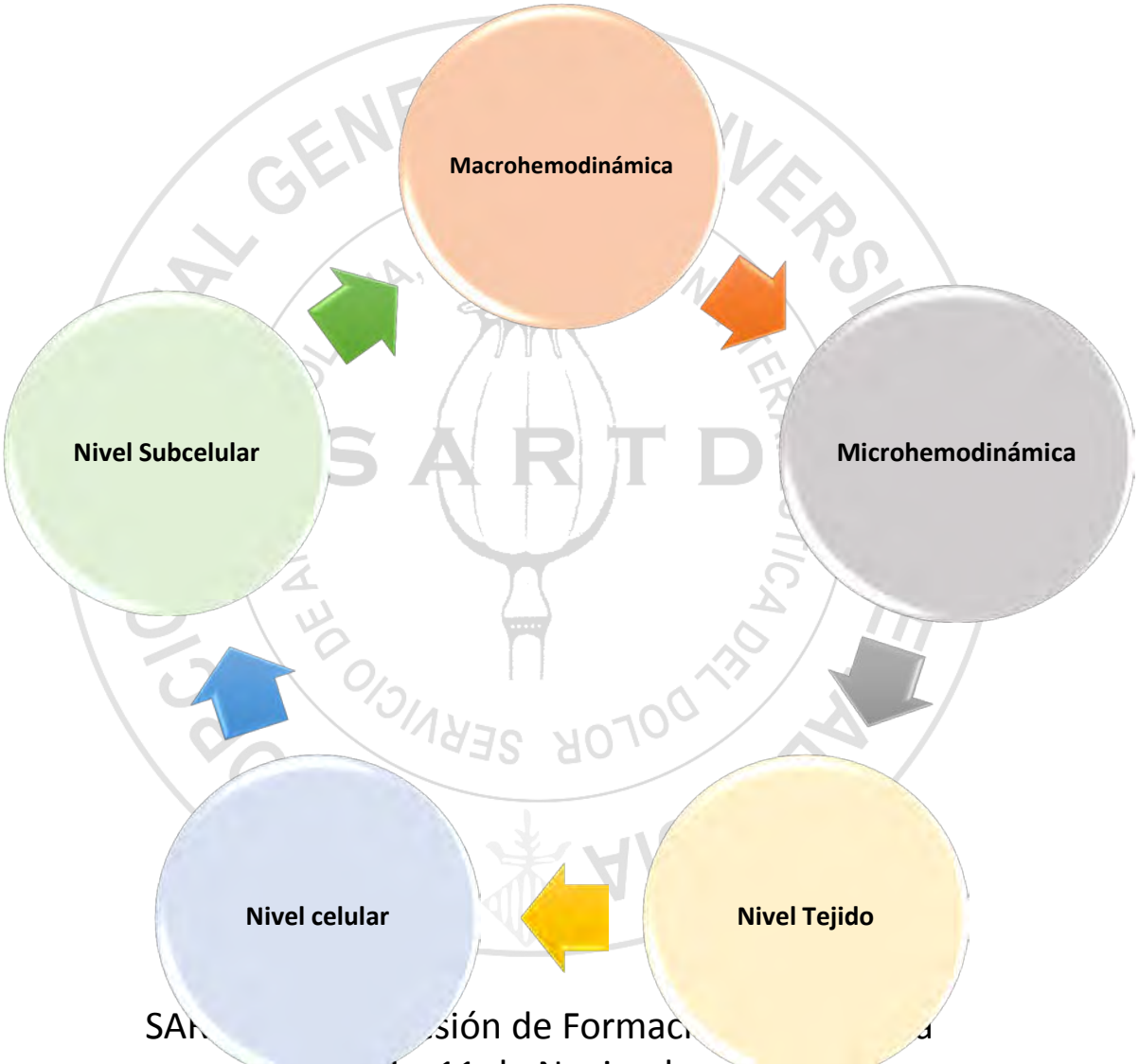
EAdyn = 10 / 13 = 0.77



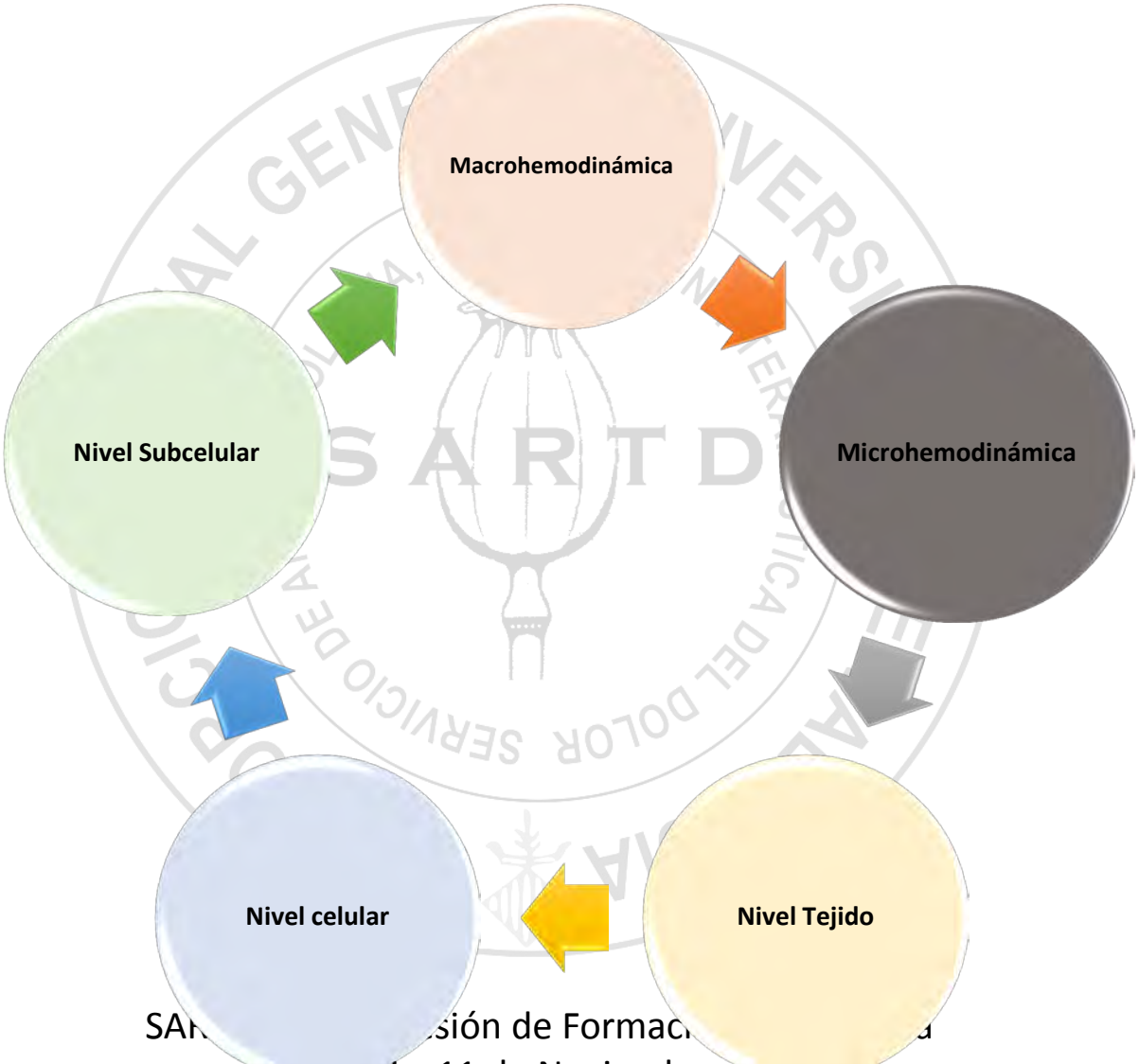
2-Formas de corregir la hipoperfusión



3-Monitorización de la microcirculación



3-Monitorización de la microcirculación

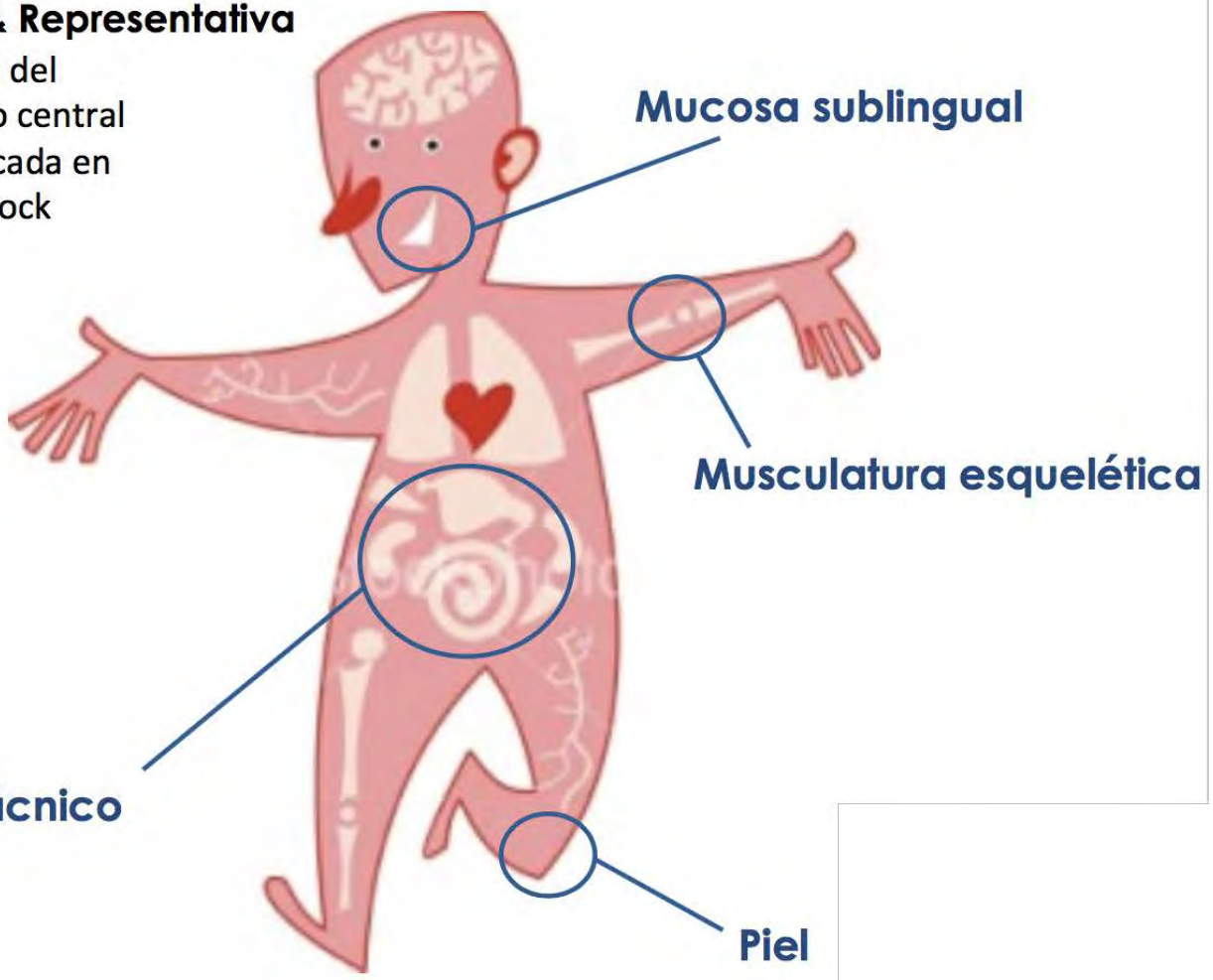


3-Monitorización de la microcirculación

Área "no-vital" & Representativa

- Representativa del compartimento central
- Primera sacrificada en situación de shock
- Fácil Acceso

TERRITORIOS "CANARIO"



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3-Monitorización de la microcirculación

Intensive Care Med (2011) 37:801–807
DOI 10.1007/s00134-011-2163-y

ORIGINAL

H. Ait-Oufella
S. Lemoinne
P. Y. Boelle
A. Galbois
J. L. Baudel
J. Lemant
J. Joffre
D. Margetis
B. Guidet
E. Maury
G. Offenstadt

Mottling score predicts survival in septic shock

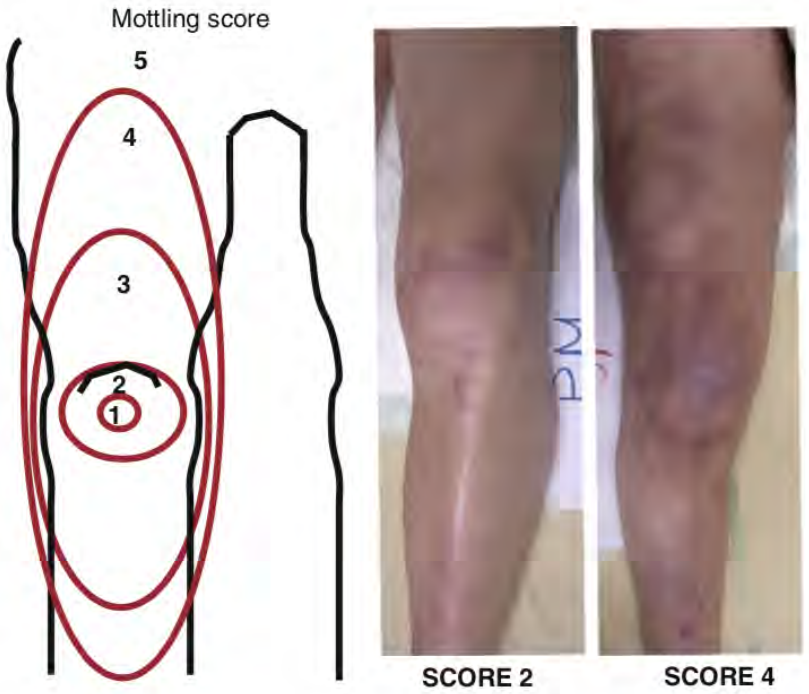

Fig. 1 *Left*: the mottling score is based on a mottling area extension on the legs. Score 0 indicates no mottling; score 1, a modest mottling area (coin size) localized to the center of the knee; score 2, a moderate mottling area that does not exceed the superior edge of the kneecap; score 3, a mild mottling area that does not exceed the middle thigh; score 4, a severe mottling area that does not go beyond the fold of the groin; score 5, an extremely severe mottling area that goes beyond the fold of the groin. *Right*: Examples of the mottling score

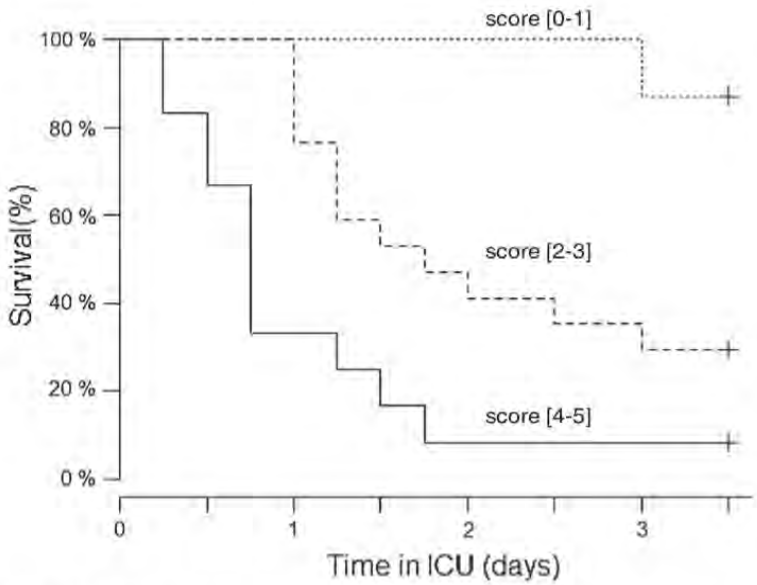

Fig. 2 Kaplan-Meier survival estimates according to the H6 mottling score. Larger mottling scores were associated with earlier death ($p < 0.0001$)

Table 3 Impact of mottling score changes during resuscitation (between H0 and H6) on prognosis

	14-day survivors ($n = 13$)	14-day non-survivors ($n = 25$)
Mottling score decrease ($n = 13$)	10	3*
Mottling score did not decrease ($n = 25$)	3	22*
		*$p = 0.0005$

Patients with moderate and extensive mottling at admission were studied (score 2–5, $n = 38$). A decrease in mottling score was associated with reduced 14-day mortality ($p = 0.0005$)

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3-Monitorización de la microcirculación

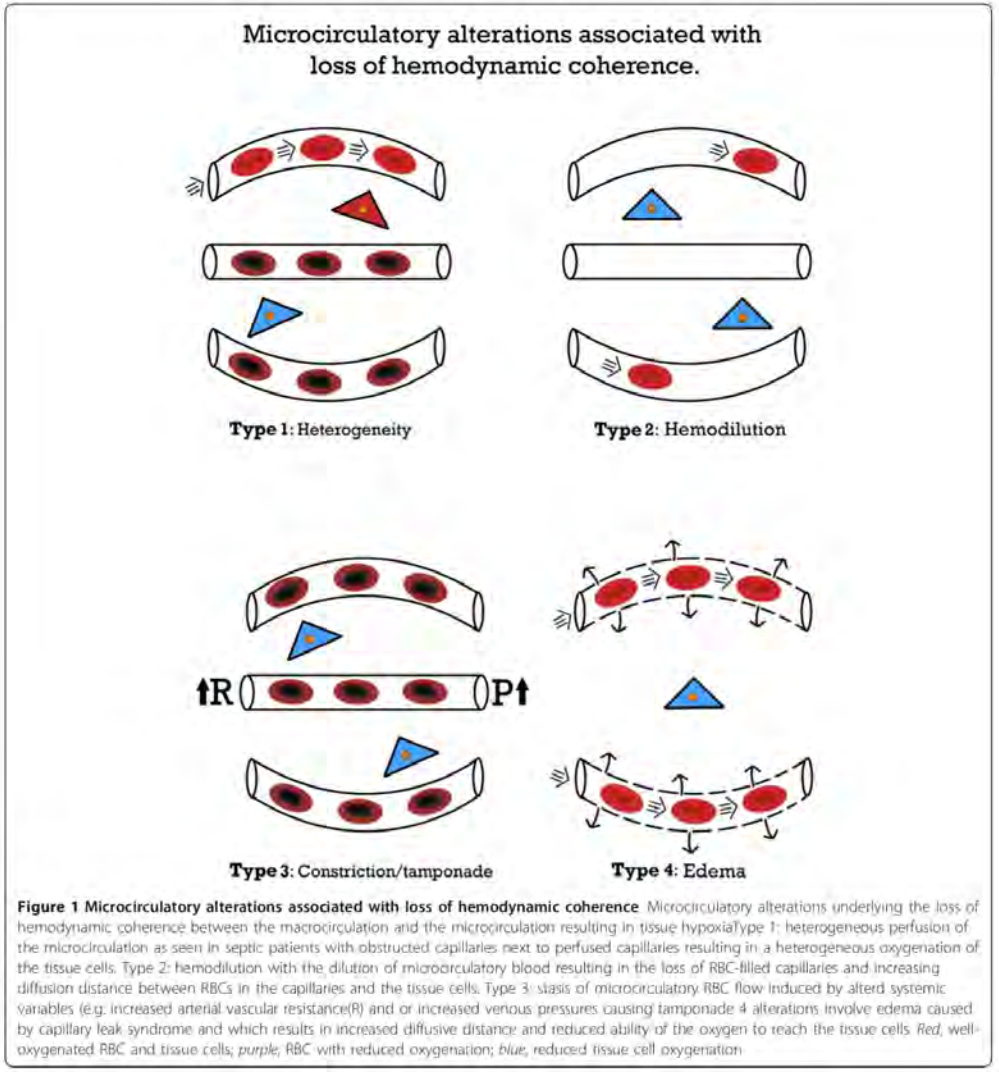
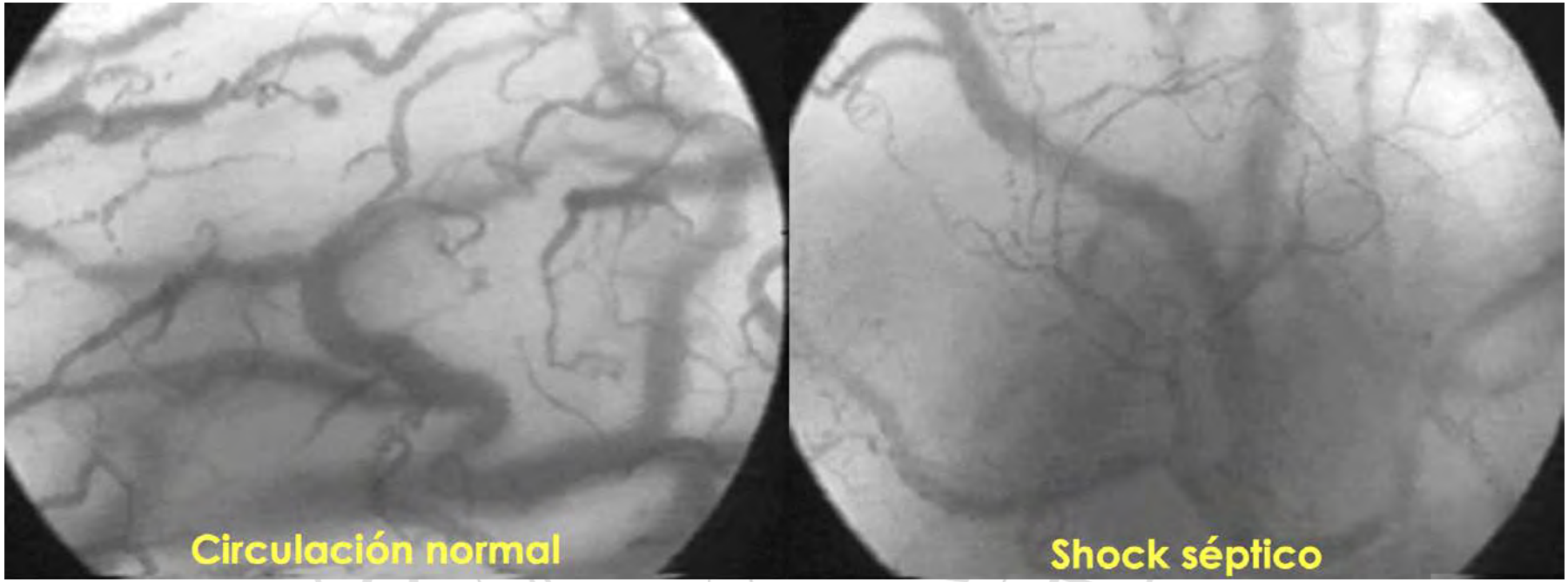


Figure 1 Microcirculatory alterations associated with loss of hemodynamic coherence Microcirculatory alterations underlying the loss of hemodynamic coherence between the macrocirculation and the microcirculation resulting in tissue hypoxiaType 1: heterogeneous perfusion of the microcirculation as seen in septic patients with obstructed capillaries next to perfused capillaries resulting in a heterogeneous oxygenation of the tissue cells. Type 2: hemodilution with the dilution of microcirculatory blood resulting in the loss of RBC-filled capillaries and increasing diffusion distance between RBCs in the capillaries and the tissue cells. Type 3: stasis of microcirculatory RBC flow induced by alterd systemic variables (e.g. increased arterial vascular resistance(R) and or increased venous pressures causing tamponade 4 alterations involve edema caused by capillary leak syndrome and which results in increased diffusive distance and reduced ability of the oxygen to reach the tissue cells. *Red*, well-oxygenated RBC and tissue cells; *purple*, RBC with reduced oxygenation; *blue*, reduced tissue cell oxygenation

3-Monitorización de la microcirculación



Effect of pneumoperitoneum and steep reverse-Trendelenburg position on mean systemic filling pressure, venous return, and microcirculation during esophagectomy

Huaiwu He[1], Guillem Gruartmoner[2], Yilmaz Ince[3], Mark I. van Berge Henegouwen[4], Suzanne S. Gisbertz[4], Bart F. Geerts[5], Can Ince[3,5], Markus W. Hollmann[5], Dawei Liu[1], Denise P. Veelo[5]

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Online version at http://www.minervamedica.it
Minerva Anestesiologica 2018 January;84(1):68-80
DOI: 10.23736/S0375-9393.17.12106-1

REVIEW

Mucosal and cutaneous capnometry for the assessment of tissue hypoperfusion

Jihad MALLAT [1]*, Benoit VALLET [2]

[1]Service of Réanimation, Department of Anesthesiology and Critical Care Medicine, Dr. Schaffner Hospital, Lens, France; [2]Department of Anesthesiology and Critical Care Medicine, Lille University Hospital, Lille, France

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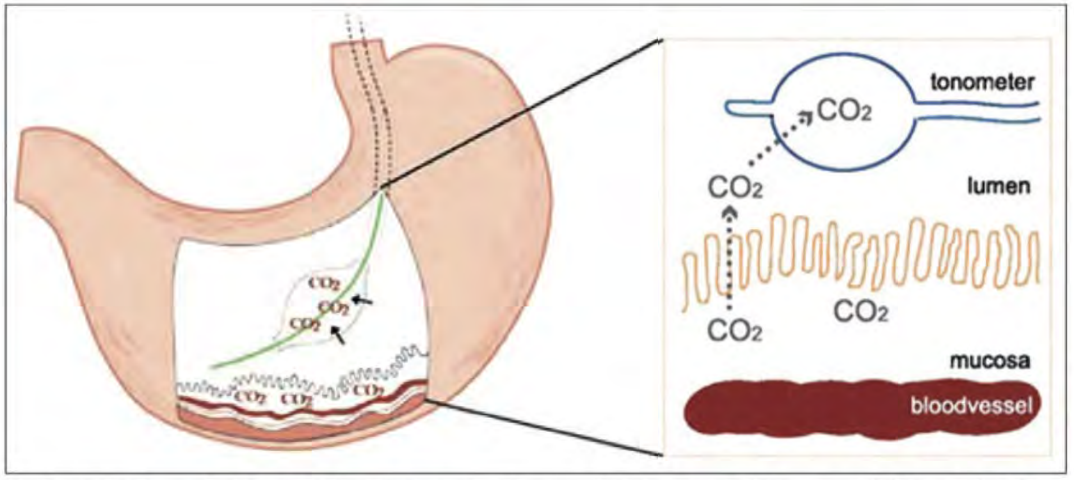
3-Monitorización de la microcirculación



Supplementary Figure 1.—Principle of gastric tonometry (from van Wijck K, Lenaerts K, Grootjans J, Wijnands KA, Poeze M, van Loon LJ, *et al.* Physiology and pathophysiology of splanchnic hypoperfusion and intestinal injury during exercise: strategies for evaluation and prevention. Am J Physiol Gastrointest Liver Physiol 2012;303:G155-68).

Interpretación PCO_2 tejidos:

→ **Depende de :**

- -Flujo sanguíneo regional
- -Contenido CO_2 arterial
- -Producción CO_2 por el tejido

→ **Aumenta por dos mecanismos:**

- -Metabolismo AEROBIO
- -Bicarbonato para tamponar Met. ANAEROBIO

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3-Monitorización de la microcirculación

Xu et al. Ann. Intensive Care (2017) 7:56
DOI 10.1186/s13613-017-0279-0

Annals of Intensive Care

RESEARCH Open Access

Fluid responsiveness predicted by transcutaneous partial pressure of oxygen in patients with circulatory failure: a prospective study

Jingyuan Xu, Xiao Peng, Chun Pan, Shixia Cai, Xiwen Zhang, Ming Xue, Yi Yang and Haibo Qiu*

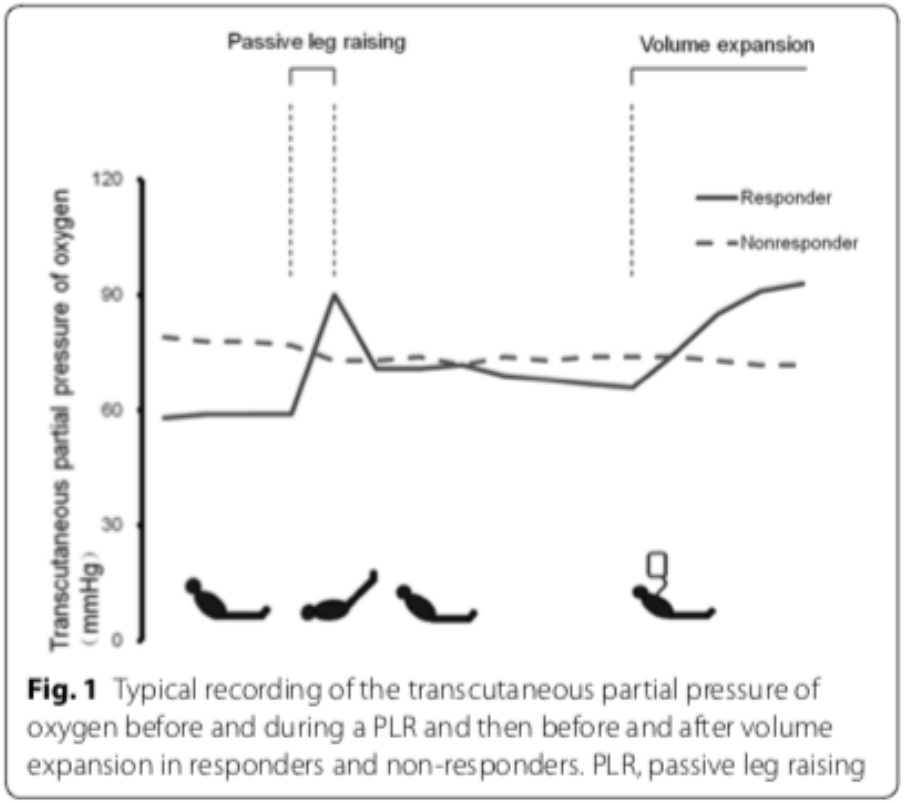

Fig. 1 Typical recording of the transcutaneous partial pressure of oxygen before and during a PLR and then before and after volume expansion in responders and non-responders. PLR, passive leg raising

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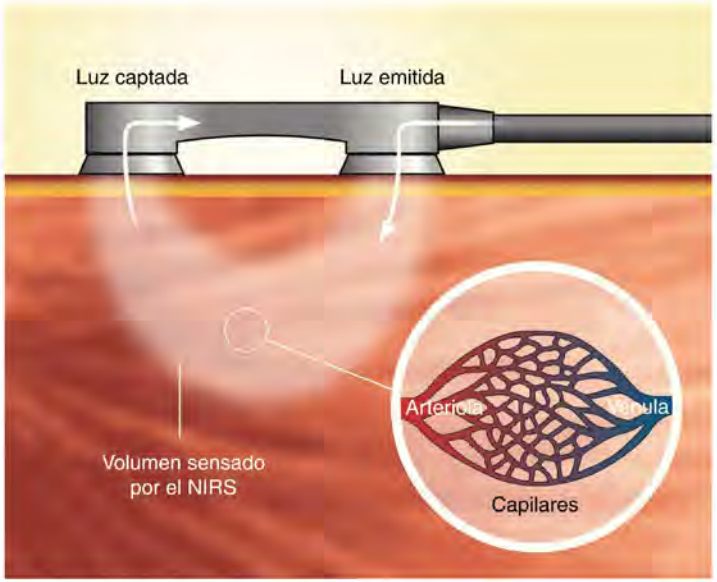
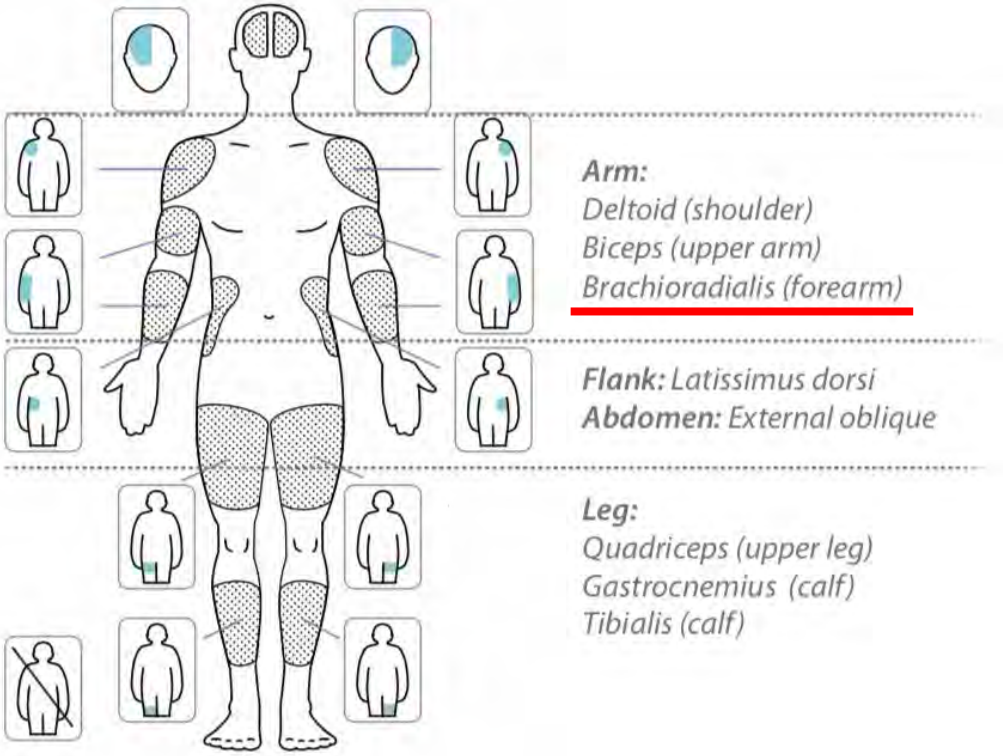


Figura 1 Representación del funcionamiento de la tecnología de la espectroscopia de luz en el espectro cercano al infrarrojo. El sistema consta de una fuente de luz NIRS (habitualmente emitiendo 4 longitudes de onda diferentes), sensores de fibra óptica (optrodos) emisores y receptores, y un procesador que detecta y cuantifica la entrada de fotones en la señal recuperada. La distancia entre los optrodos emisor y receptor determinará la profundidad y el área de sensado del sistema.

ig. 2 Probe positioning. Example of forearm probe positionin
Here additionally fixated with a transparent adhesive



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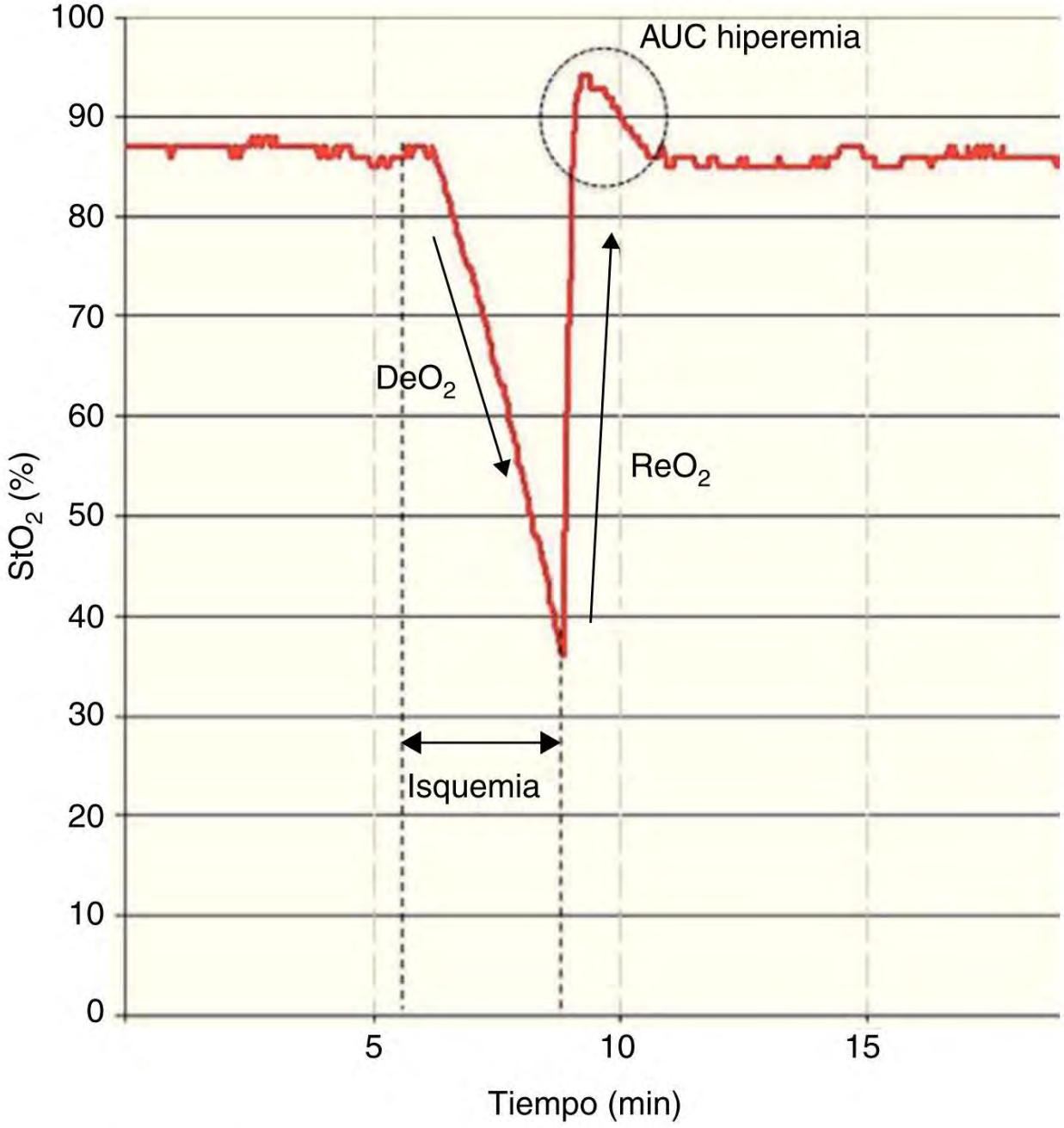


Figura 2 Test de oclusión vascular.

3-Monitorización de la microcirculación

RESEARCH ARTICLE Open Access

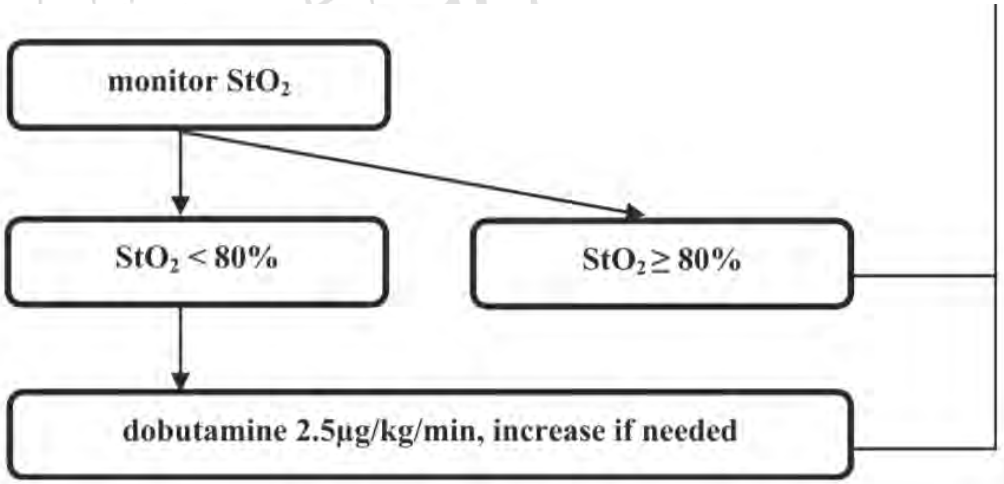
Tissue oxygenation as a target for goal-directed therapy in high-risk surgery: a pilot study

Paul A van Beest*, Jaap Jan Vos, Marieke Poterman, Alain F Kalmar and Thomas WL Scheeren

Patients

Eligible patients were ASA III and IV patients of 65 years and older who were scheduled to undergo elective major surgery under general anesthesia combined with epidural analgesia.

Exclusion criteria were patients undergoing emergency surgery, refusal, neurosurgical patients, and patients with disseminated malignancy or receiving palliative treatment only. Patients undergoing extensive liver surgery requiring low central venous pressure (CVP) management and patients scheduled for a fast track protocol were excluded as well.



3-Monitorización de la microcirculación

Int J Clin Exp Med 2014;7(3):631-639
www.ijcem.com /ISSN:1940-5901/IJCEM1401019

Original Article

Effects of different types of hydroxyethyl starch (HES) on microcirculation perfusion and tissue oxygenation in patients undergoing liver surgery

Yinghua Cui, Bo Sun, Changsong Wang, Shujuan Liu, Peng Li, Jinghui Shi, Enyou Li

Department of Anesthesiology, The First Affiliated Hospital of Harbin Medical University, Harbin, China

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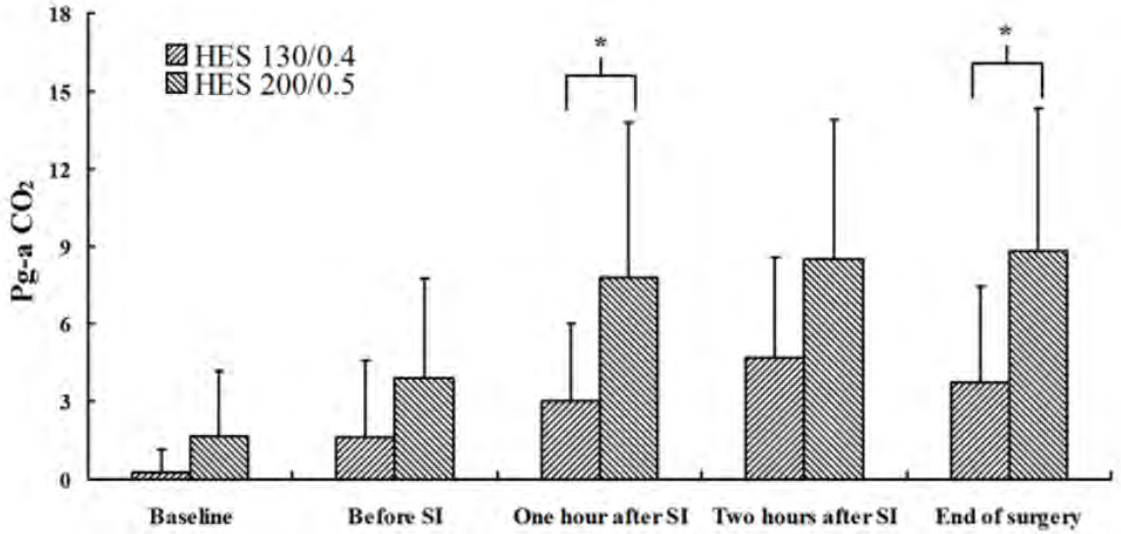

Figure 3. $P_{g\text{-}a}CO_2$. Mean ± SD. *P<0.05 (difference between groups). (Repeated-measures ANOVA showed significant differences in the effects of the two volume expanders on indicators of $P_{g\text{-}a}CO_2$. The spherical symmetry test criteria were not met, and after correction with the Greenhouse-Geisser method, comparisons of repeated measurement data at various time points within each group showed statistical significance (P<0.05).

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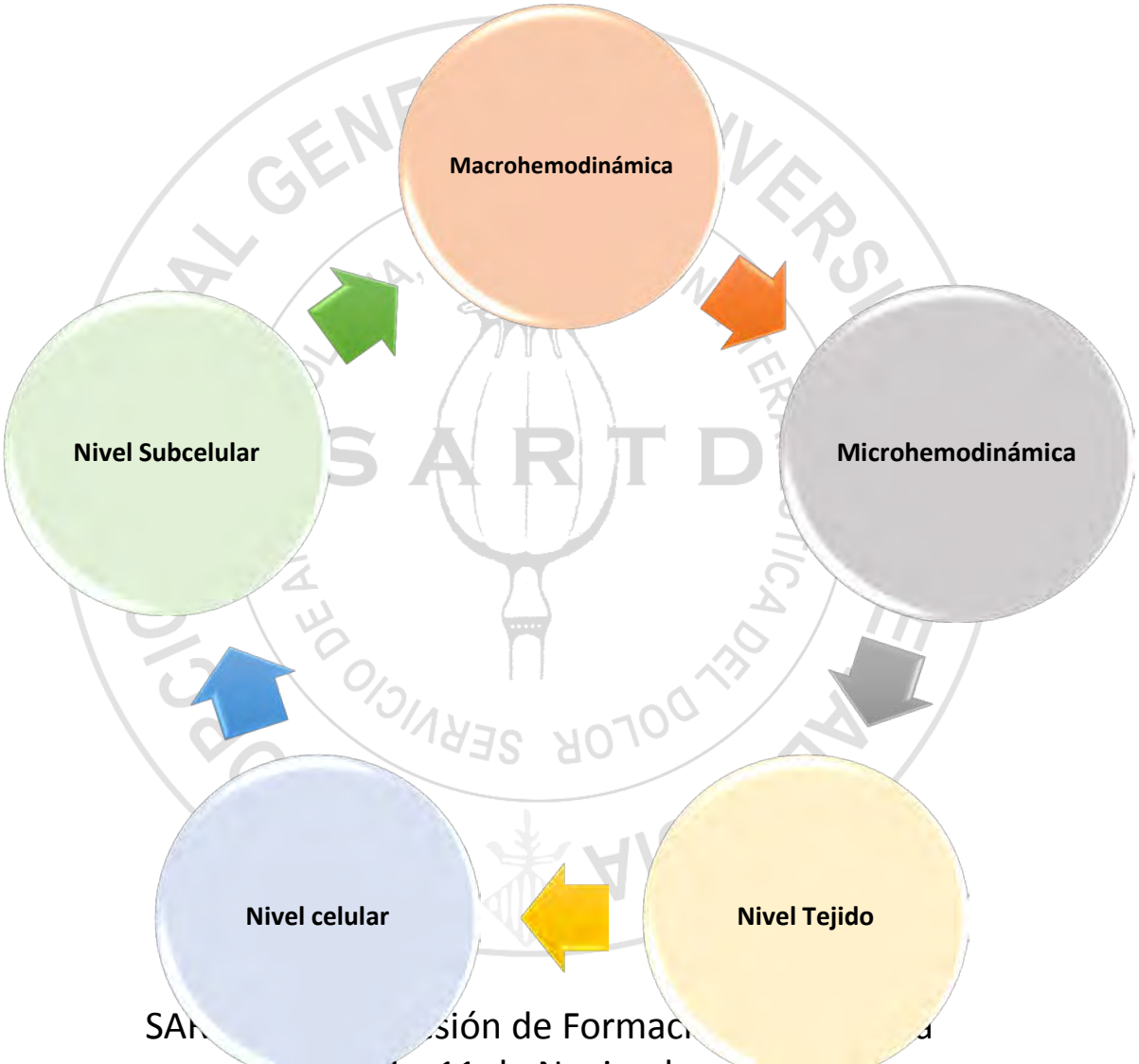
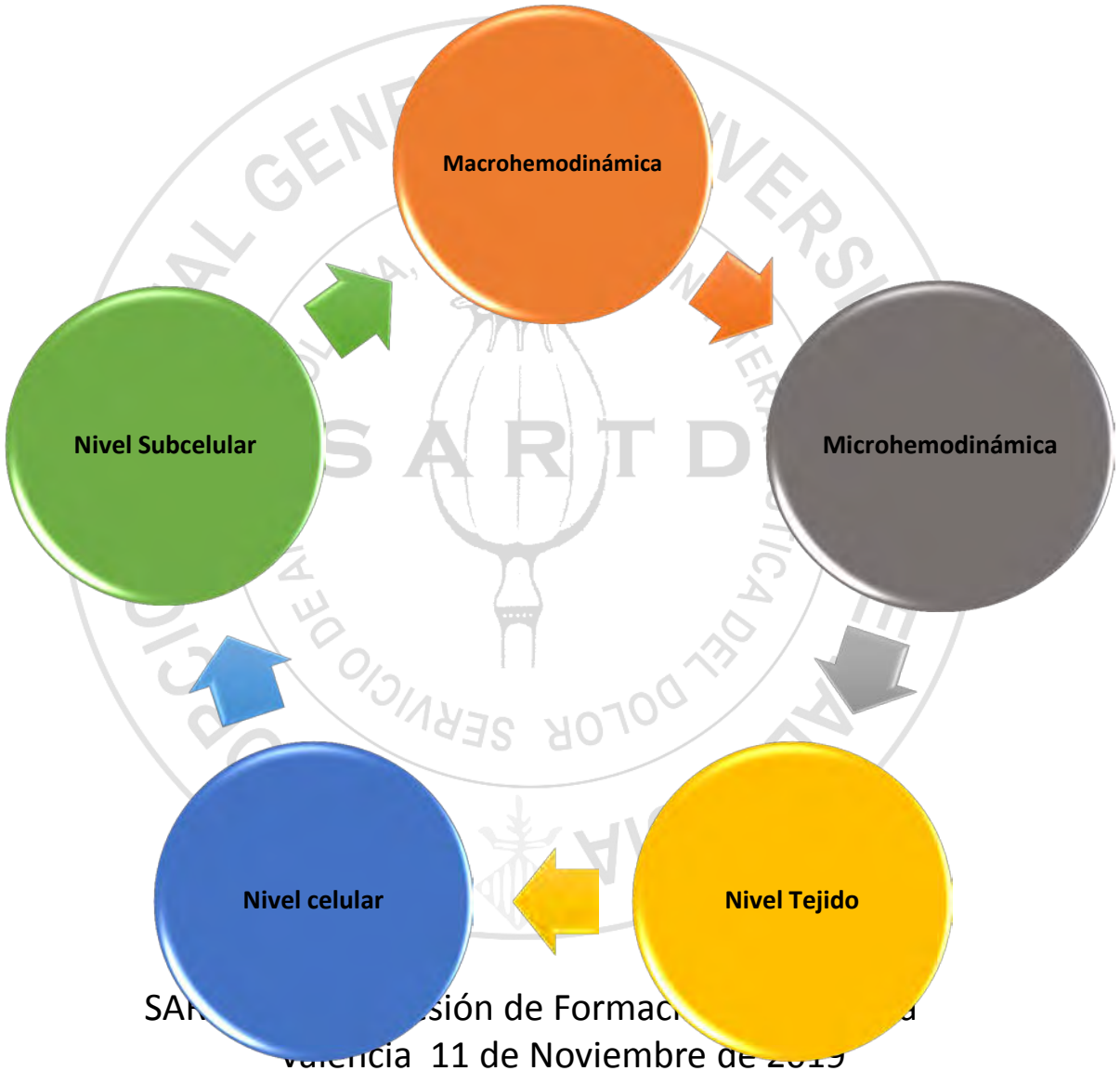
3-Monitorización de la microcirculación



3-Monitorización de la microcirculación



3-Monitorización de la microcirculación

Fig 2 Patients' volume status at different stages of resuscitation. Reproduced with permission from ADQI (www.ADQI.org).

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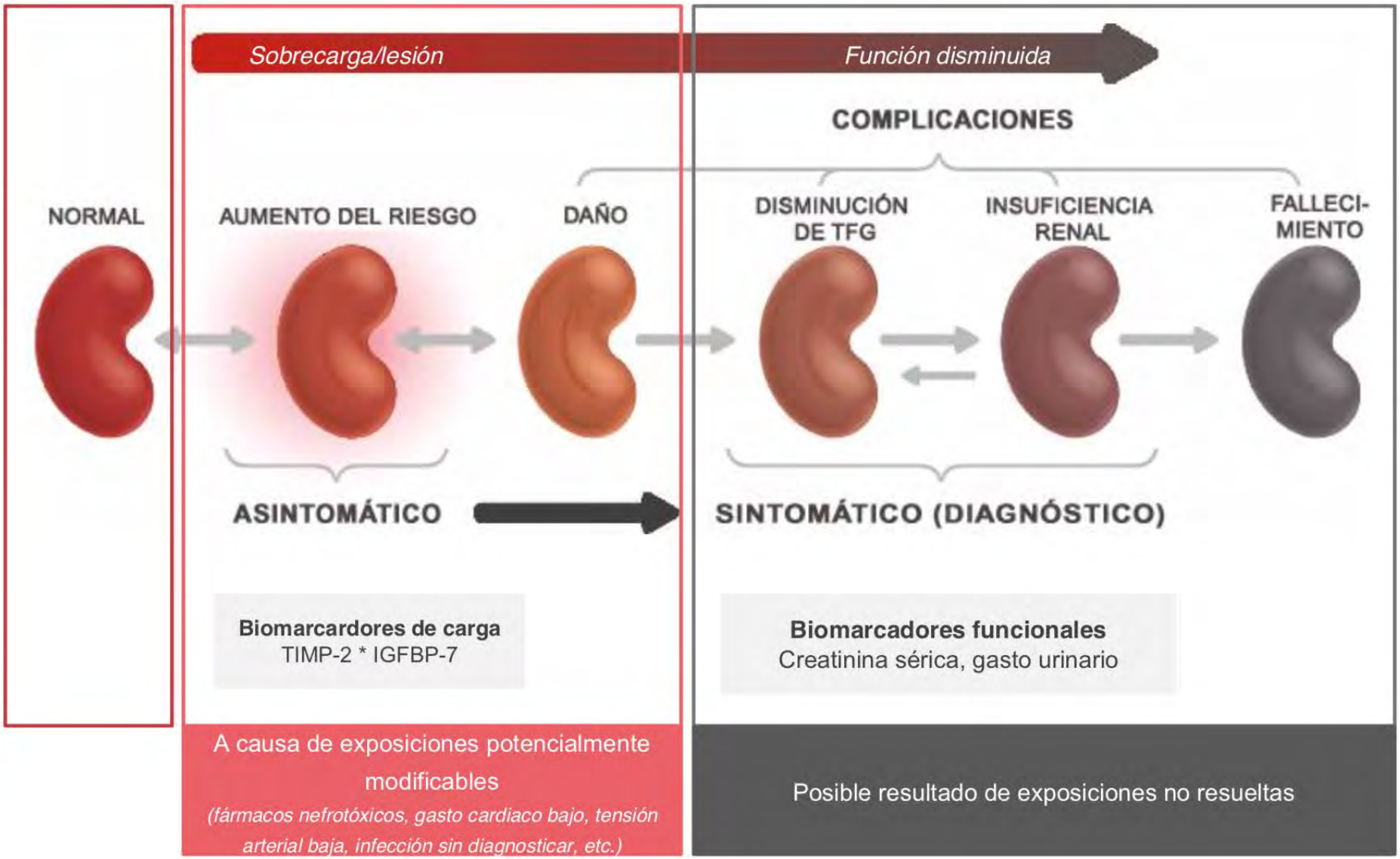
3-Monitorización de la microcirculación



3-Monitorización de la microcirculación

Biomarker-guided Intervention to Prevent Acute Kidney Injury After Major Surgery

The Prospective Randomized BigpAK Study

Ivan Göcze, MD, Dominik Jauch, MD,† Markus Götz, MD,* Pascal Kennedy,* Bettina Jung, MD,‡ Florian Zeman,§ Carsten Gnewuch, MD,¶ Bernhard M. Graf, MD,|| Wolfgang Gnann,** Bernhard Banas, MD,‡ Thomas Bein, MD,|| Hans J. Schlitt, MD,* and Tobias Bergler, MD‡*

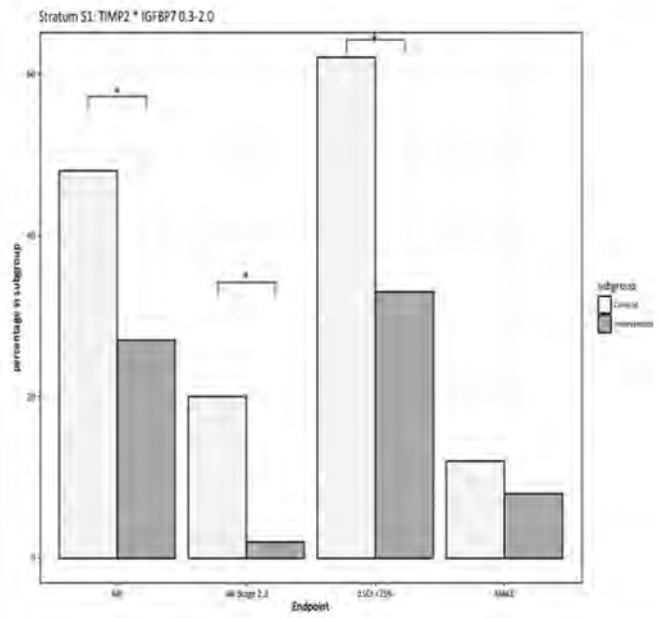


FIGURE 2. Incidence of primary and secondary study endpoints in biomarker stratum TIMP2 × IGFBP7 0.3–2.0 for control (light gray) and intervention (dark gray) group: AKI 24/50 versus 13/48, $P = 0.03$ (Chi-Quadrat test); AKI stage 2,3 10/50 versus 1/48, $P = 0.005$; ΔCr >25% 31/50 versus 16/48, $P = 0.005$; and MAKE 6/50 versus 4/48, P = n.s. Cr indicates creatinine; ΔCr, difference between peak Cr in the first 7 postoperative days and baseline Cr.

3-Conclusiones

- Es importante la detección del “shock compensado” para iniciar un proceso de Reanimación.
- La Fluidoterapia es un fármaco y como tal tiene indicaciones, dosis y efectos adversos
- Debemos de seguir midiendo la PVC, no para predecir la probable respuesta a fluido en caso de hipoperfusión, SI para valorar el acoplamiento retorno venoso-VD y limitar la reversión de la hipoperfusión con fluidos si está alta.

3-Conclusiones

- Presión y flujo no son equivalentes, no debemos de olvidarlo a la hora de monitorizar un paciente ni de reanimarlo.

- La Elastancia arterial dinámica puede constituir una herramienta de valoración de acoplamiento ventrículo-arterial

- Detectar y tratar una microcirculación alterada en el paciente quirúrgico puede evitar la aparición de alteraciones macrohemodinámicas, de momento solo pronóstico en el paciente séptico.

Bibliografía

- 1. Cecconi M, De Backer D, Antonelli M, Beale R, Bakker J, Hofer C, et al. Consensus on circulatory shock and hemodynamic monitoring Task force of the European Society of Intensive Care Medicine. Intensive Care Med. 2014;40:1795-815.
- 2. Cecconi M, Hofer C, Teboul JL, Pettila V, Wilkman E, Molnar Z, et al. Fluid challenges in intensive care: the FENICE study: a global inception cohort study. Intensive Care Med. 2015;41:1529-37.
- 3. Monge Garcia MI, Guijo Gonzalez P, Gracia Romero M, Gil Cano A, Oscier C, Rhodes A, et al. Effects of fluid administration on arterial load in septic shock patients. Intensive Care Med. 2015;41:1247-55.
- 4. Beck V, Chateau D, Bryson GL, Pisipati A, Zanotti S, Parrillo JE, et al. Timing of vasopressor initiation and mortality in septic shock: a cohort study. Crit Care. 2014;18:R97.
- 5. Monge Garcia MI, Saludes Orduna P, Cecconi M. Understanding arterial load. Intensive Care Med. 2016;42:1625-7.
- 6. Kato R, Pinsky MR. Personalizing blood pressure management in septic shock. Ann Intensive Care. 2015;5:41.
- 7. DellaVolpe JD, Moore JE, Pinsky MR. Arterial blood pressure and heart rate regulation in shock state. Curr Opin Crit Care. 2015;21:376-80.
- 8. Correa TD, Vuda M, Takala J, Djafarzadeh S, Silva E, Jakob SM. Increasing mean arterial blood pressure in sepsis: effects on fluid balance, vasopressor load and renal function. Crit Care. 2013;17:R21.
- 9. Jones AE, Trzeciak S, Dellinger RP. Arterial pressure optimiza- tion in the treatment of septic shock: a complex puzzle. Crit Care. 2010;14:102.
- 10. Marchick MR, Kline JA, Jones AE. The significance of non- sustained hypotension in emergency department patients with sepsis. Intensive Care Med. 2009;35:1261-4.
- 11. Dunser MW, Takala J, Ulmer H, Mayr VD, Luckner G, Jochberger S, et al. Arterial blood pressure during early sepsis and outcome. Intensive Care Med. 2009;35:1225-33.
- 12. Aya HD, Ster IC, Fletcher N, Grounds RM, Rhodes A, Cecconi M. Pharmacodynamic analysis of a fluid challenge. Crit Care Med. 2016;44:880-91.
- 13. Monge Garcia M, Gracia Romero M, Gil Cano A, Aya HD, Rhodes A, Grounds R, et al. Dynamic arterial elastance as a predictor of arterial pressure response to fluid administration: a validation study. Crit Care. 2014;18:626.