Journées Francophones de Réanimation

Thermodilution transpulmonaire

Mathieu Jozwiak, service MIR Nice

22 juin 2024

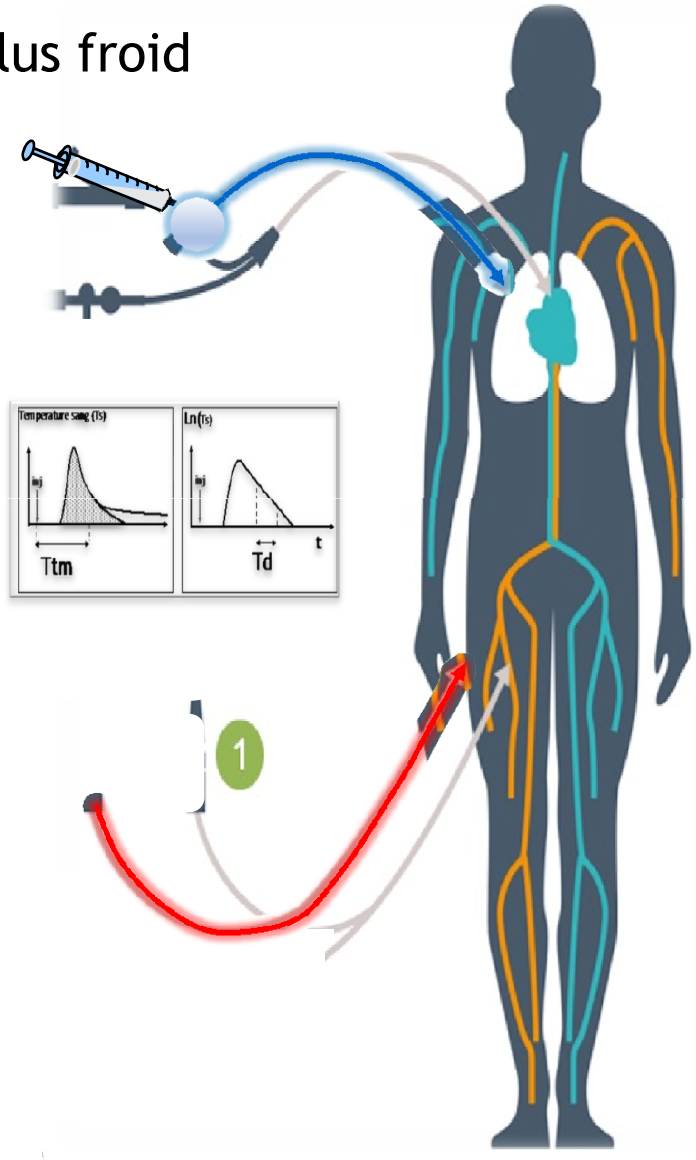
Liens d’intérêts

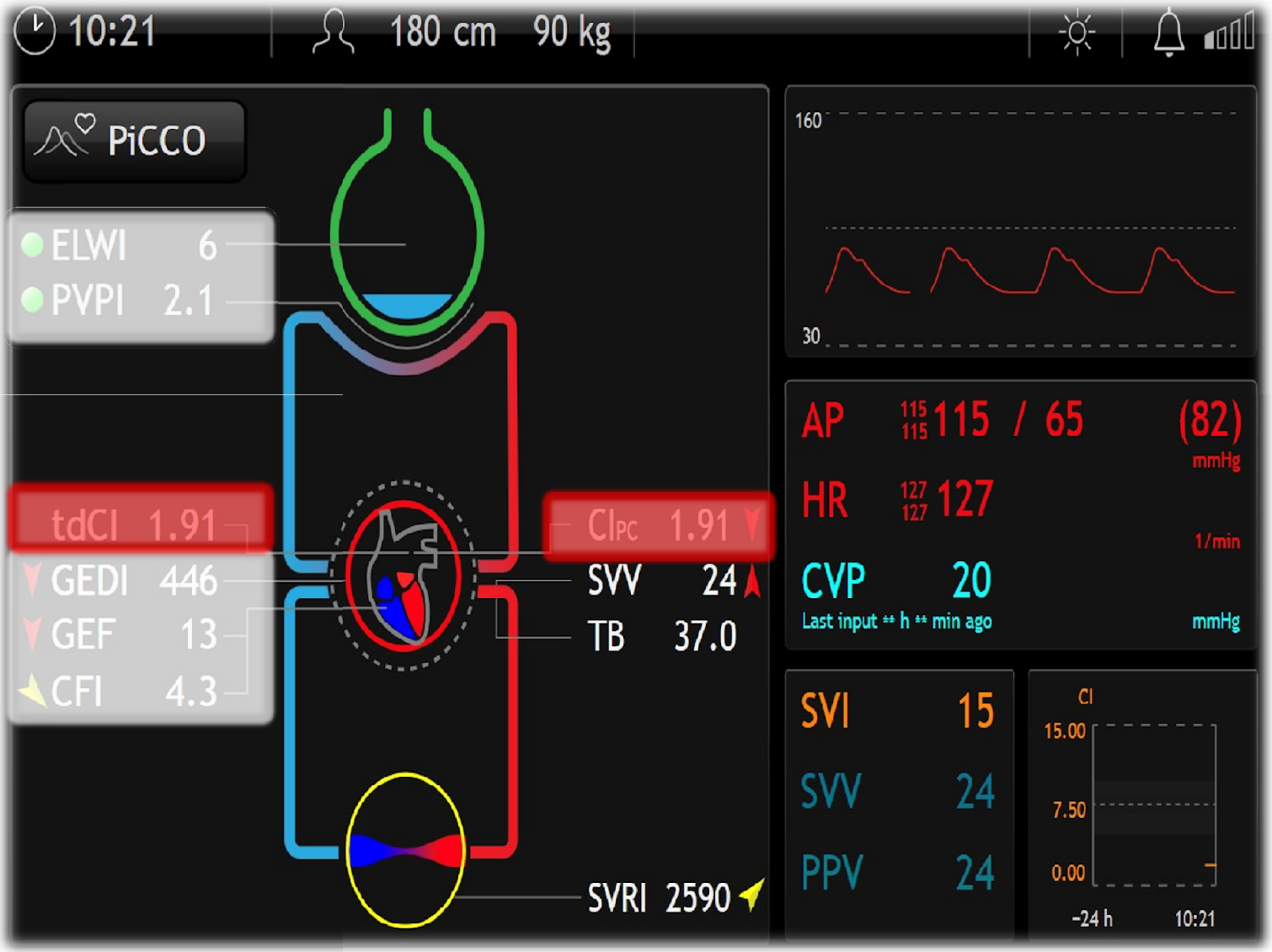
Lectures pour le laboratoire VIATRIS

PHRC-GIRCI 2022

Thermodilution transpulmonaire

lus froid





Thermodilution transpulmonaire

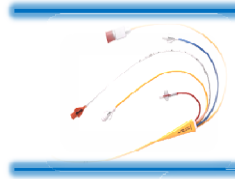
Hemosphere®
(Edwards)

PiCCO$_2$®
(Getinge)

- Utilisables avec un **CVC en fémoral**
- Utilisables chez les patients **en hypothermie thérapeutique**
- Utilisables chez les patients **sous EER**

- Non utilisables chez les patients **sous ECMO**
- Non utilisables chez les patients **avec un Piccline**

Thermodilution transpulmonaire

	Invasivité	Fiabilité	Facilité utilisation	Débit card. temps réel	Autre variab
	🔴	🟢	🔴	🔴	🟢
	🔴	🟢	🟡	🟢	🟢
	🟡	🟡	🟢	🟢	🟡
	🟢	🔴	🟢	🟢	🟡
	🟢	🔴	🟢	🟢	🔴
	🟢	🔴	🟢	🟢	🔴

Thermodilution transpulmonaire

e prospective, multicentrique
atients, en rythme sinusal
orage TDTP vs. Echo

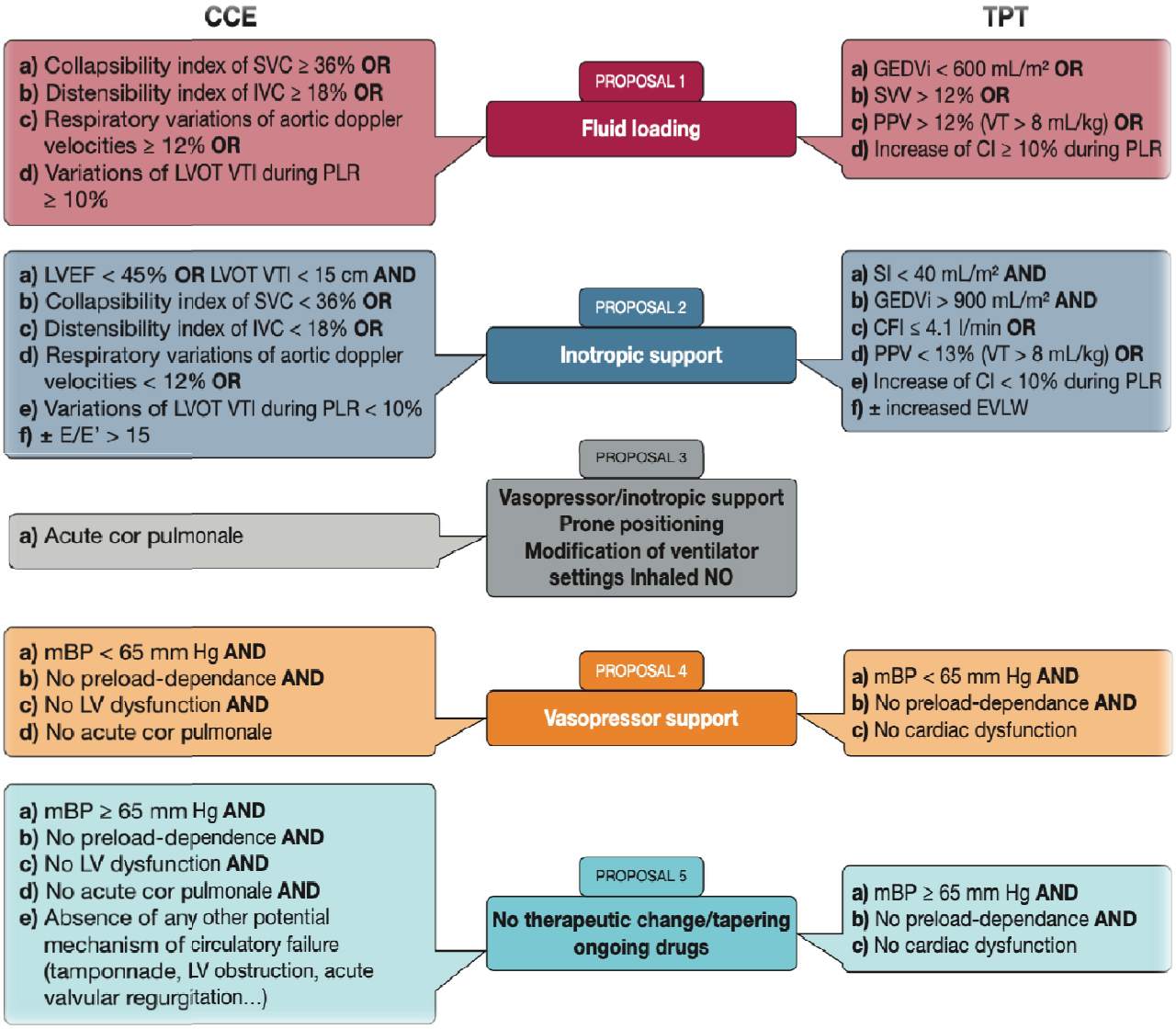
66% de concordance

ur pulmonaire aigu

vulopathie gauche sévère

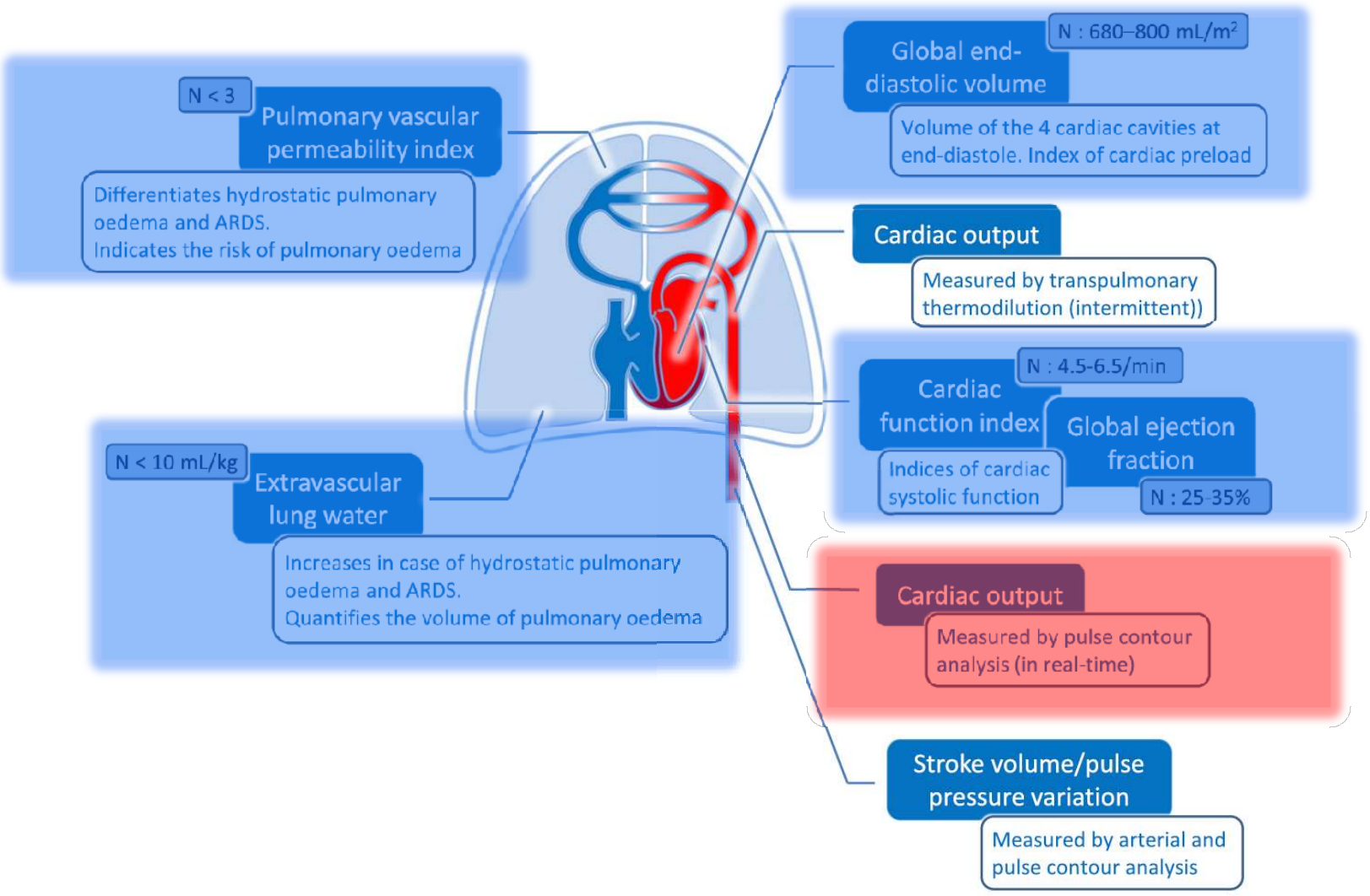
struction intra-VG

oit cardiaque très bas

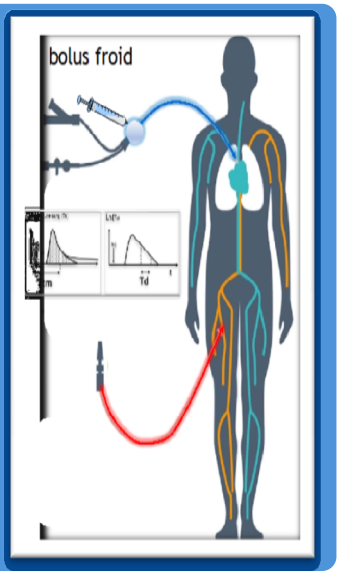


Vignon et al. *Chest* 2018; 153(1):5

Indices thermodilution transpulmonaire



Monnet et al. *Crit Care* 2017;21



Débit cardiaque

Précharge

10:21 180 cm 90 kg

PiCCO

ELWI 6

PVPI 2.1

tdCI 1.91

GEDI 446

GEF 13

CFI 4.3

CIPC 1.91

SVV 24

TB 37.0

SVRI 2590

160

30

AP 115 115 / 65 (82) mmHg

HR 127 127 1/min

CVP 20 mmHg

Last input ** h ** min ago

SVI 15

SVV 24

PPV 24

CI

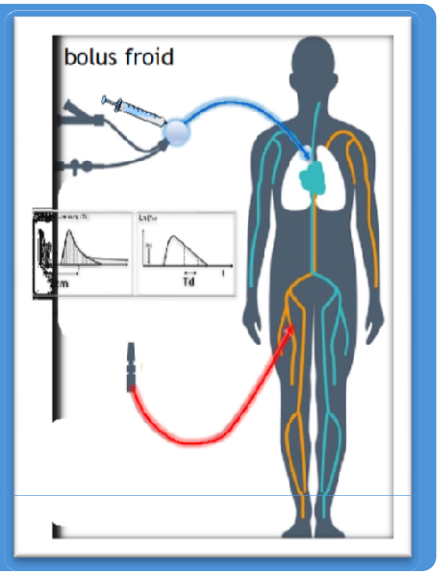
15.00

7.50

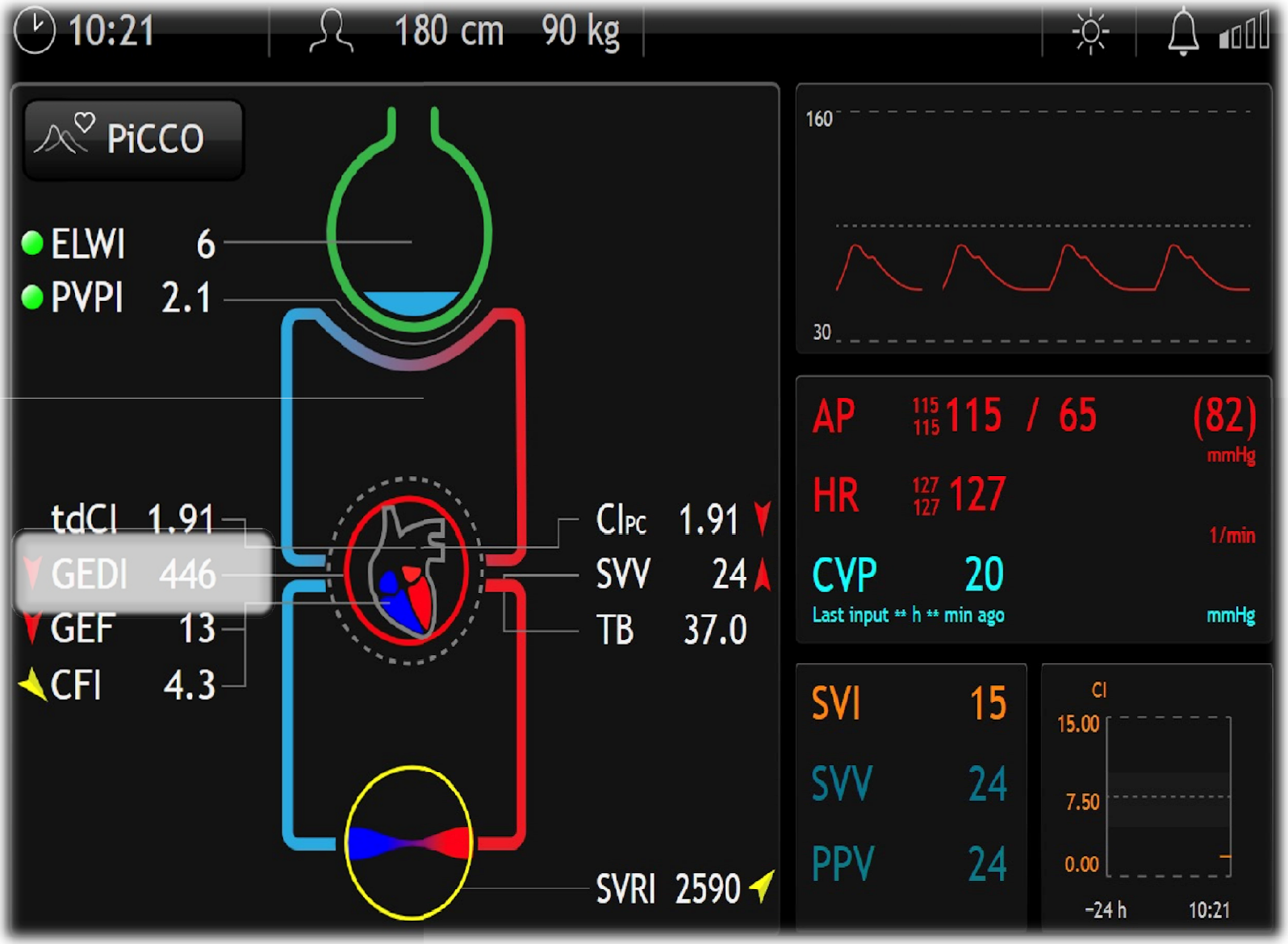
0.00

-24 h 10:21

VTDGI - *Mesure*

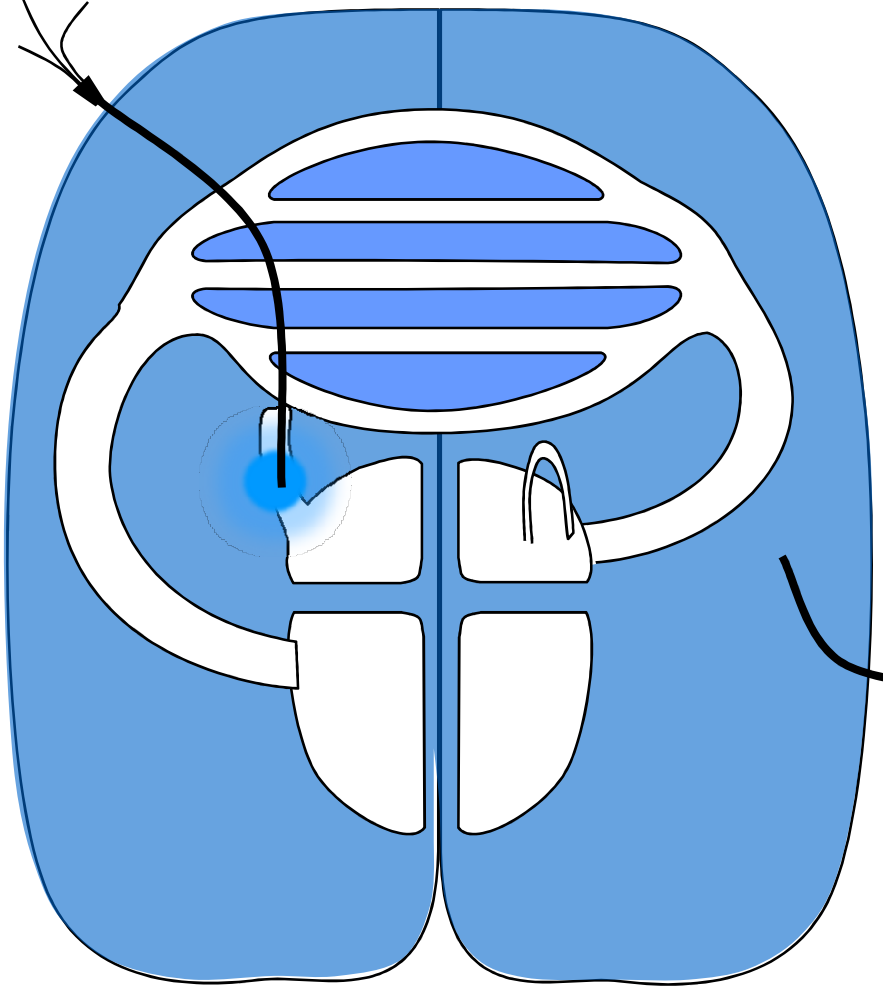


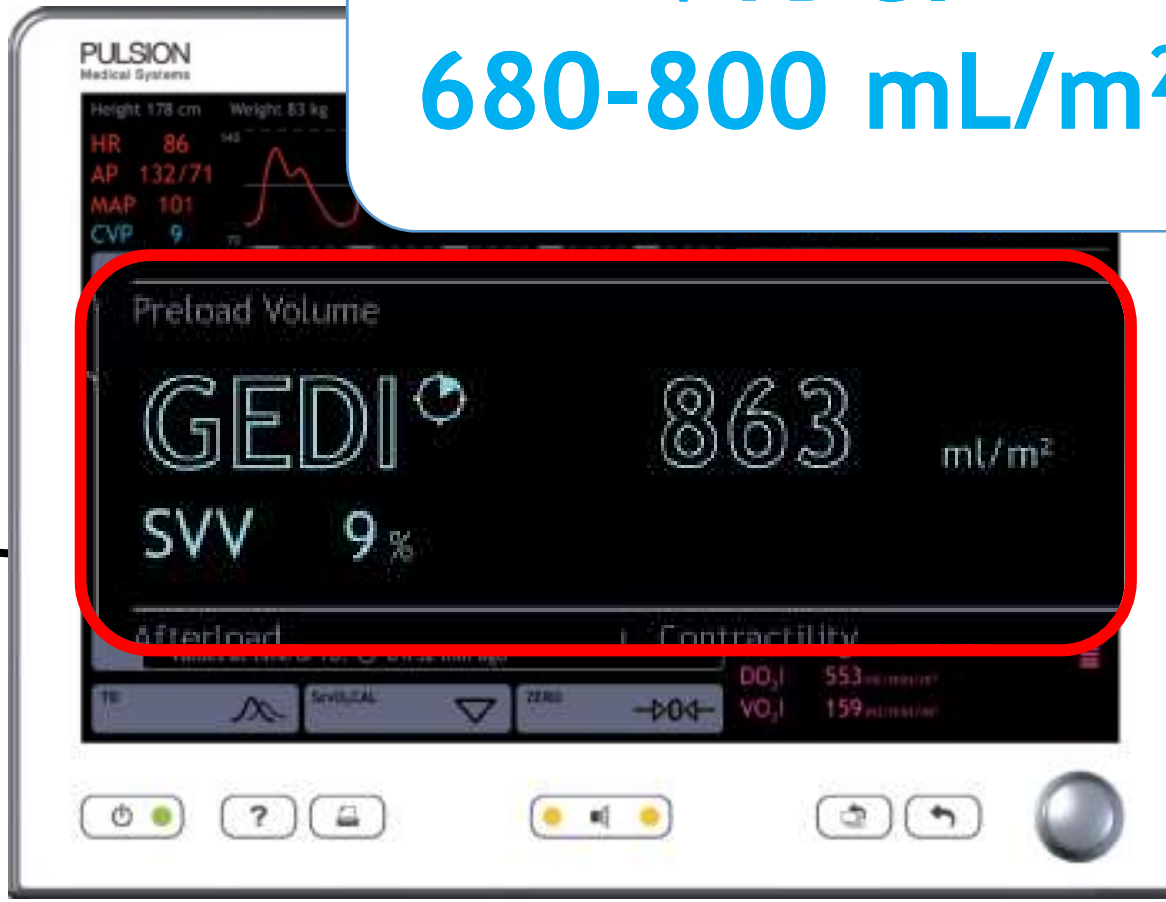
VTDGI
680-800 mL/m²



VTDGI - *Mesure*

bolus froid

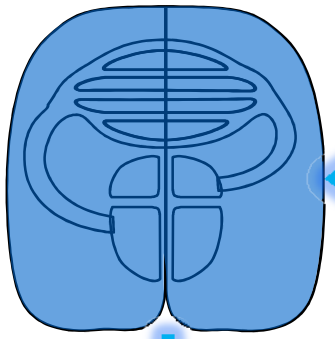




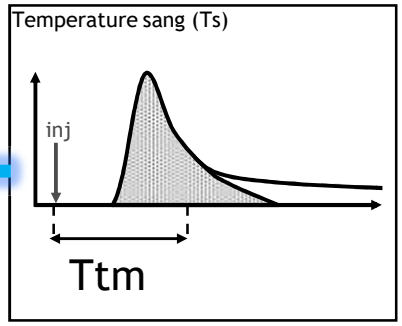
VTDGI
680-800 mL/m²

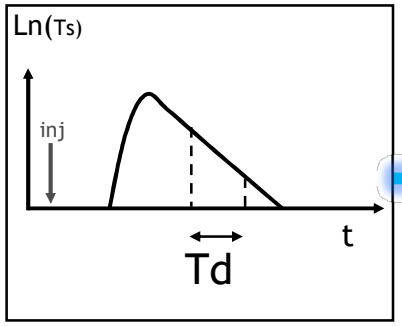
VTDGI - *Mesure*

bolus froid

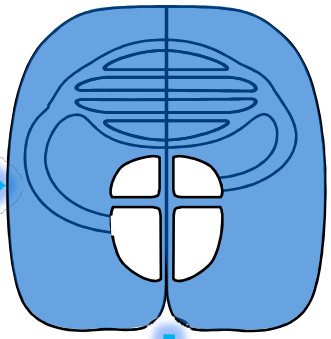


1





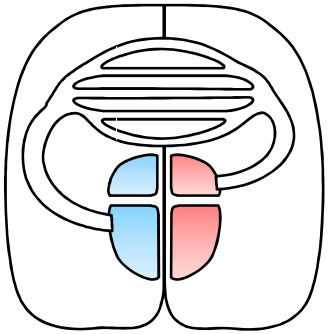
1



Principe de Stewart-Hamilton

Principe de Newman

Volume intrathoracique total



Volume pulmonaire total

2

Volume télédiastolique global (VTDGI)

2

VTDGI – *Avec un KTC en fémoral*

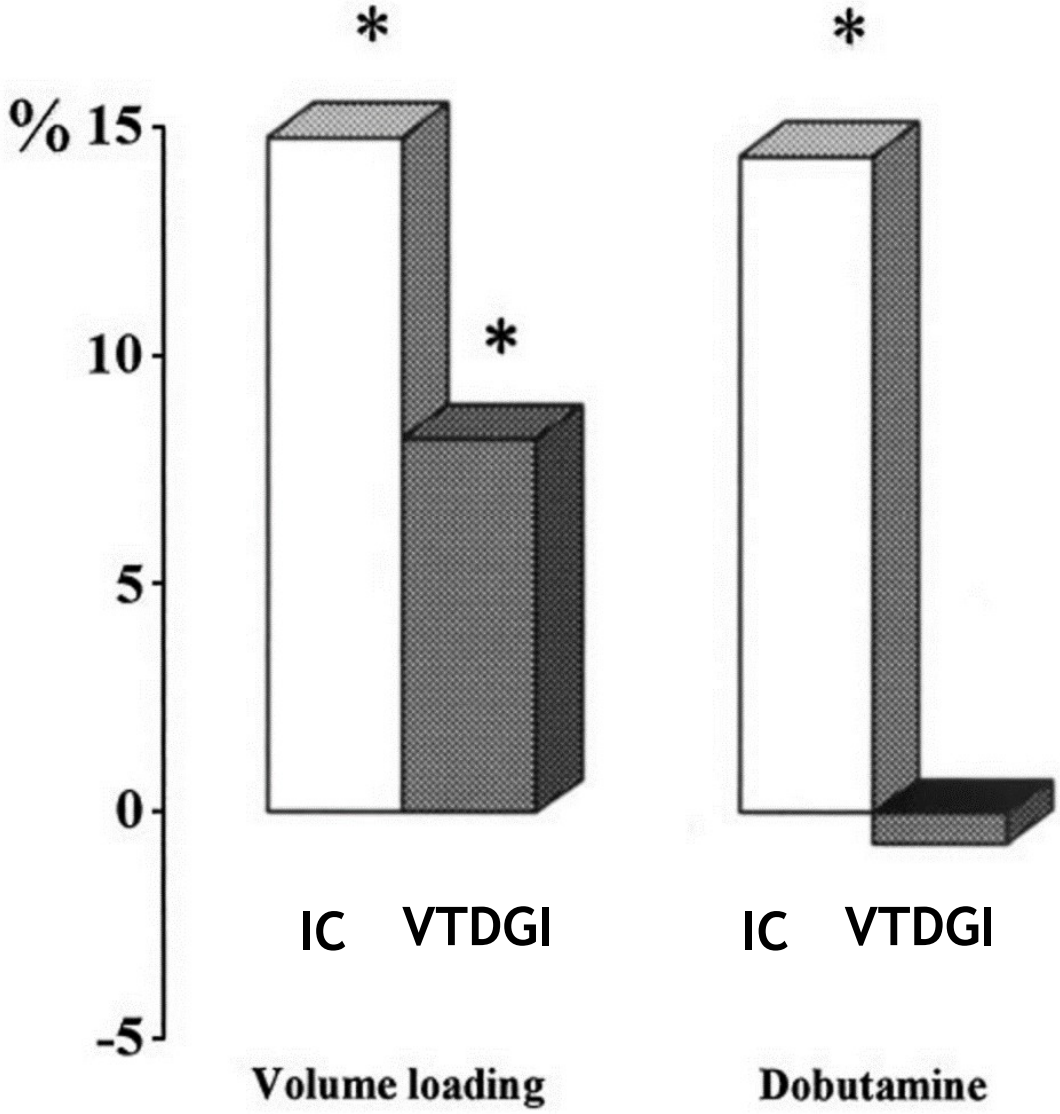
patients avec PiCCO
fémoral + jugulaire int

	Biais	LOA	% d'erreur
Index cardiaque (L/min/m²)	+ 0,29	-0,40 ; + 0,97	16%
VTDGI (mL/m²)	+ 241	-9 ; + 491	-

Correction automatiquement appliquée par le PiCCO

Saugel et al. *Crit Care* 2010;14

VTDGI – *Indice de précharge statique*

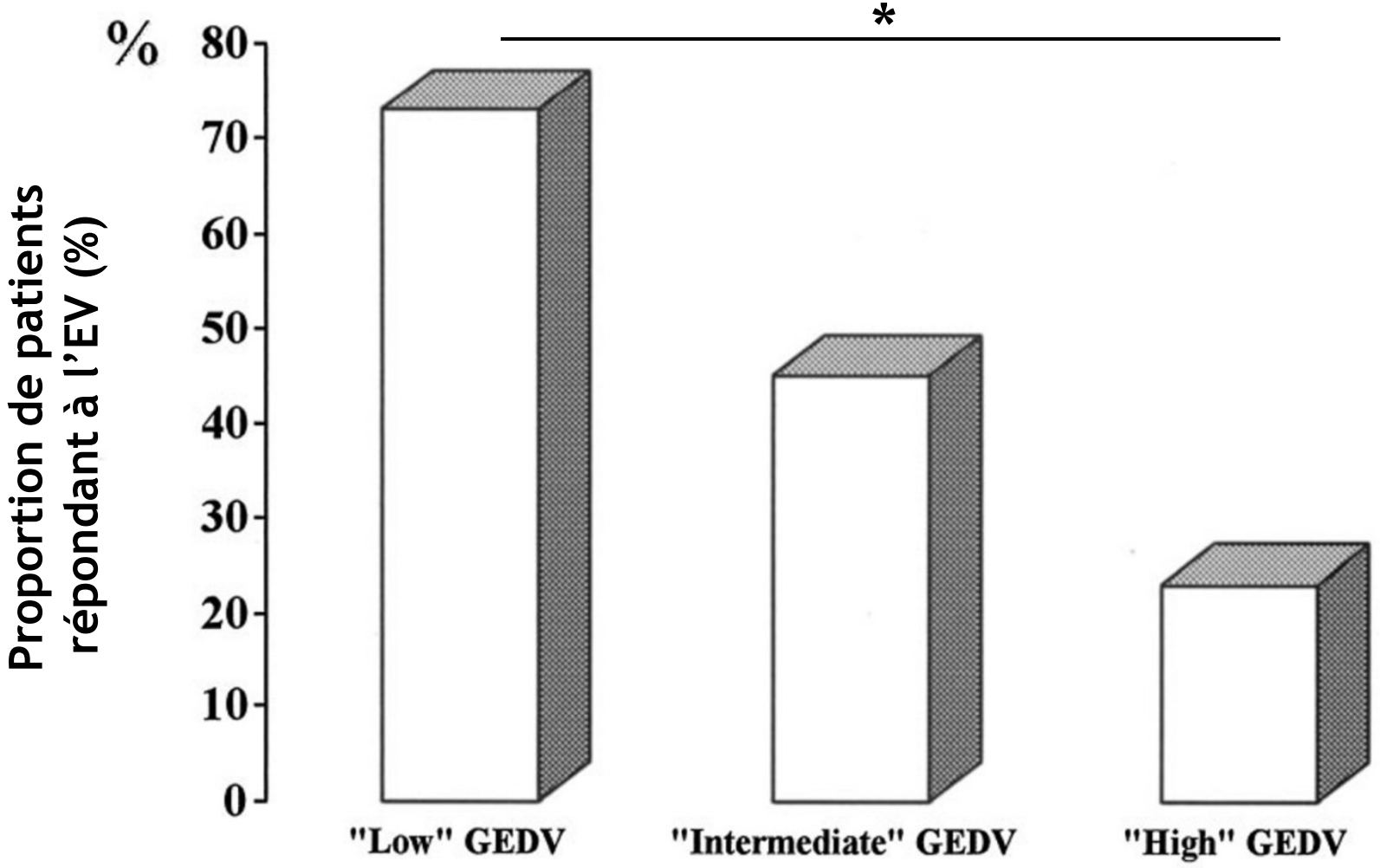


36 patients avec un Pi
EV ou Dobutamine

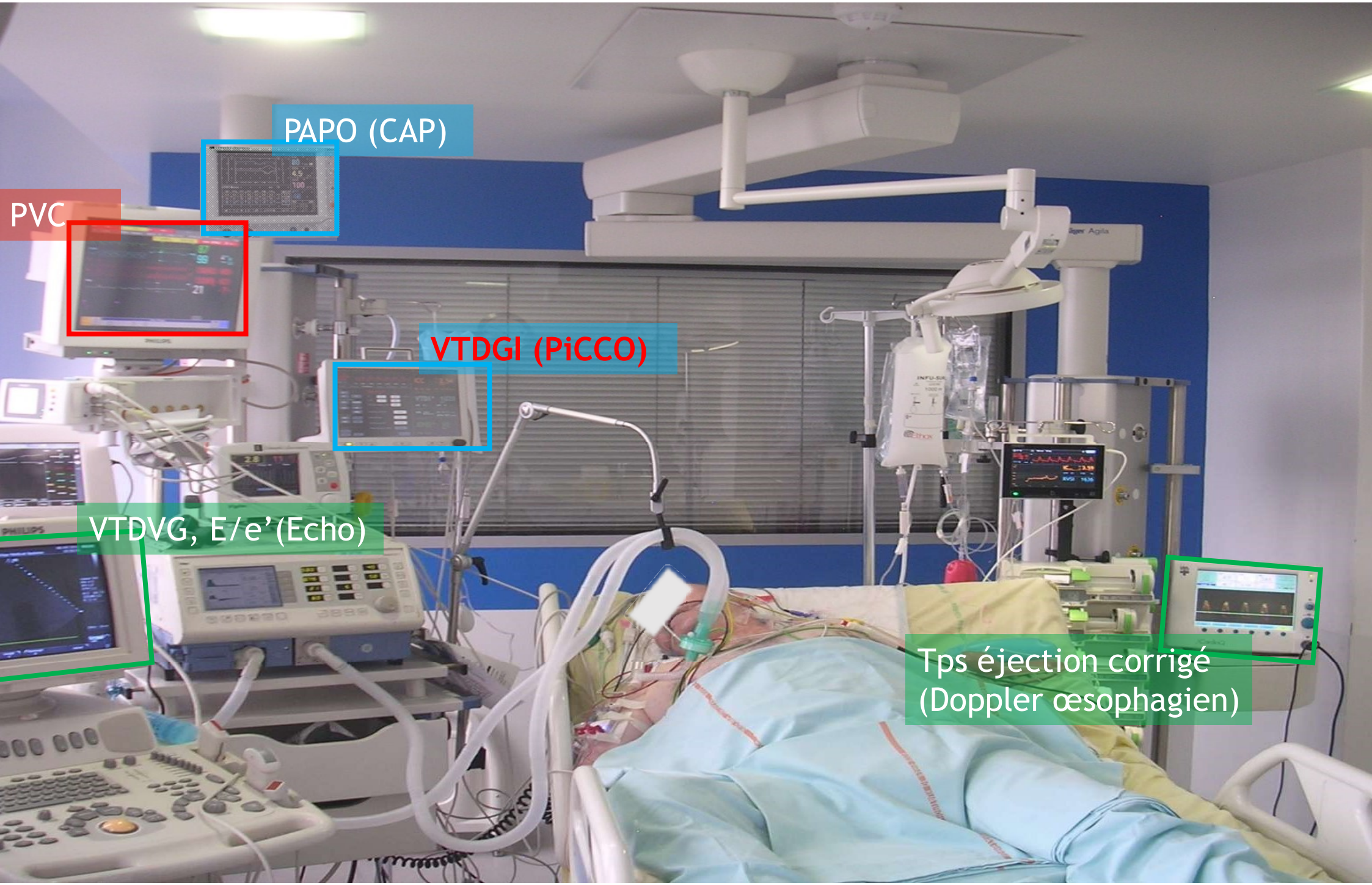
Michard et al. *Chest* 2003;124:1900-

VTDGI – *Indice de précharge statique*

36 patients avec un Pi
EV ou Dobutamine



Michard et al. *Chest* 2003;124:1900-


PAPO (CAP)
PVC
VTDGI (PiCCO)
VTDVG, E/e'(Echo)
Tps éjection corrigé
(Doppler œsophagien)

Les indices de précharge statiques

Méta-analyse
29 études, 685 patien

Les indices de précharge statiques ne sont pas de bons facteurs prédictifs de la réponse à l'expansion volémique

Method	Technology	AUC*
Pulse pressure variation (PPV)	Arterial waveform	0.94 (0.93-0.95)
Systolic pressure variation (SPV)	Arterial waveform	0.86 (0.82-0.90)
Stroke volume variation (SVV)	Pulse contour analysis	0.84 (0.78-0.88)
Left ventricular end-diastolic area (LVEDA)	Echocardiography	0.64 (0.53-0.74)
Global end-diastolic volume (GEDV)	Transpulmonary thermodilution	0.56 (0.37-0.67)
Central venous pressure (CVP)	Central venous catheter	0.55 (0.48-0.62)

Marik et al. *AIC* 2011

Les indices de précharge statiques

Méta-analyse
29 études, 685 patien

Les indices de précharge dynamiques sont de bons facteurs prédictifs de la réponse à l'expansion volémique

Method	Technology	AUC*
Pulse pressure variation (PPV)	Arterial waveform	0.94 (0.93-0.95)
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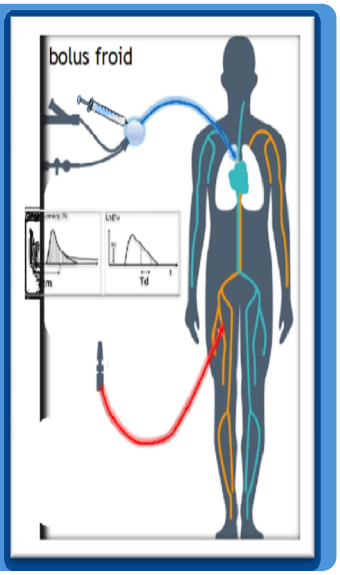
Marik et al. *AIC* 2011



Débit cardiaque

Précharge

Fonction systolique VG

10:21 180 cm 90 kg

PiCCO

ELWI 6

PVPI 2.1

tdCI 1.91

GEDI 446

GEF 13

CFI 4.3

CIPC 1.91

SVV 24

TB 37.0

SVRI 2590

160

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AP 115 115 / 65 (82) mmHg

HR 127 127 1/min

CVP 20 mmHg

Last input ** h ** min ago

SVI 15

SVV 24

PPV 24

CI

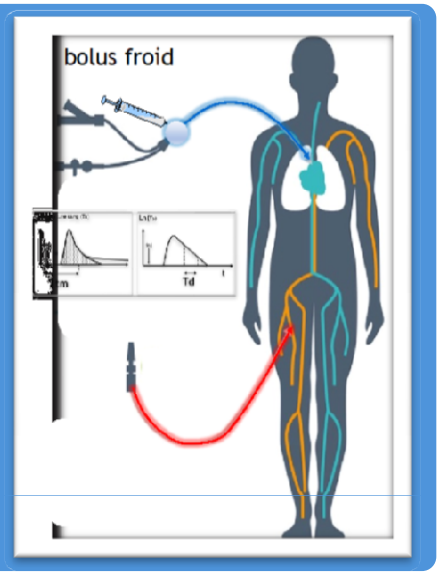
15.00

7.50

0.00

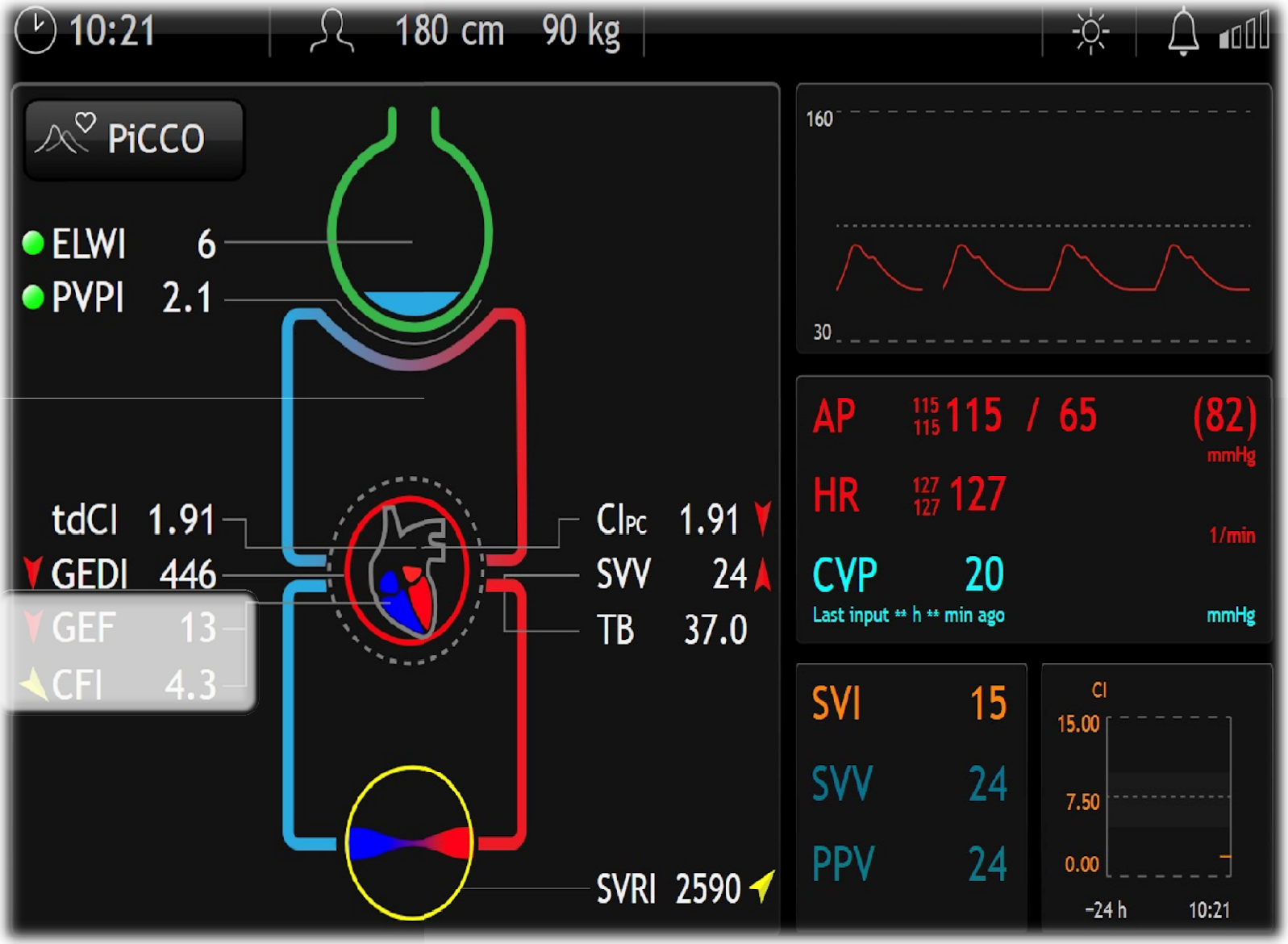
-24 h 10:21

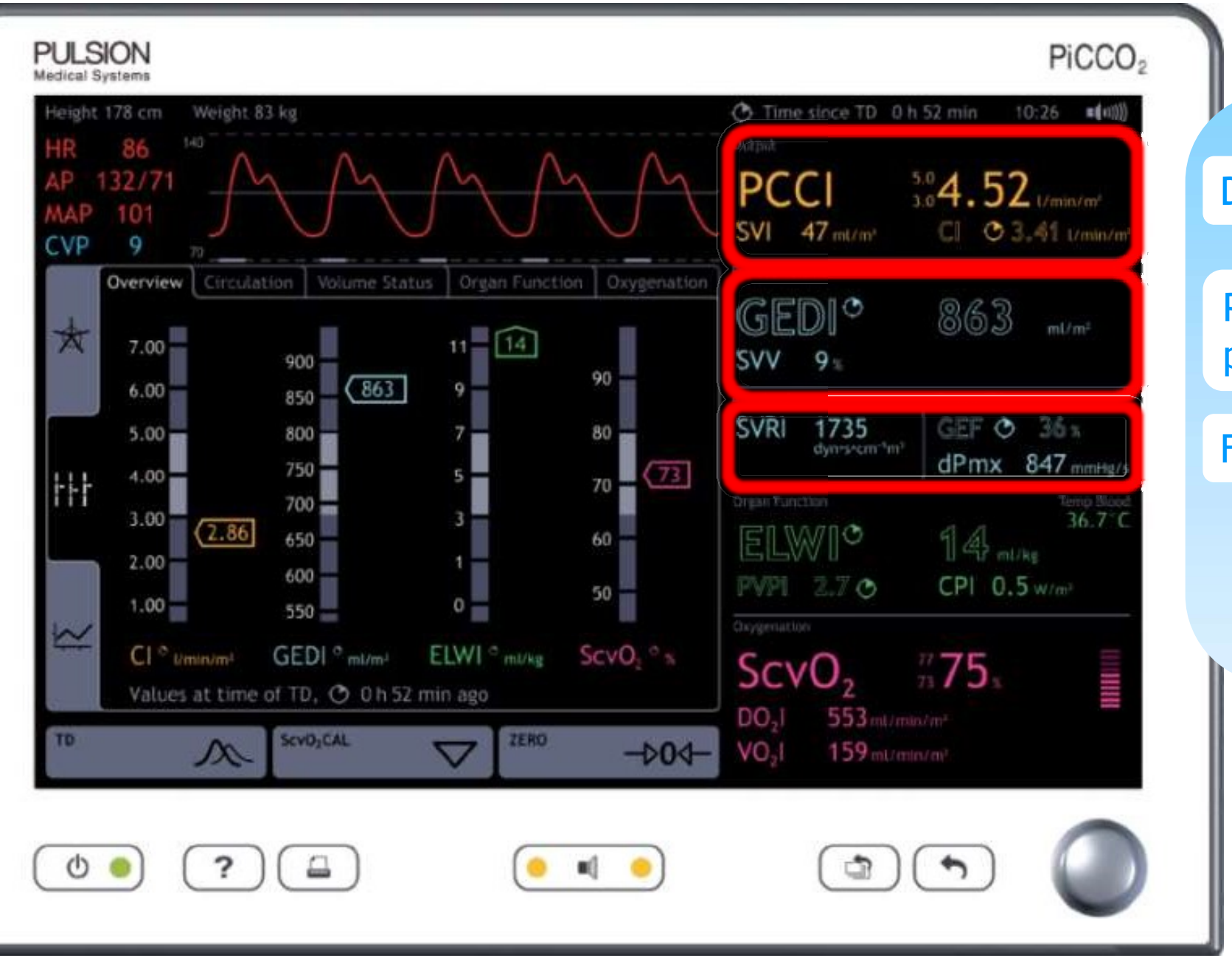
IFC - *Mesure*



IFC (> 4/min)
IC/VTDGI

FEG (25-35%)
IC/FC





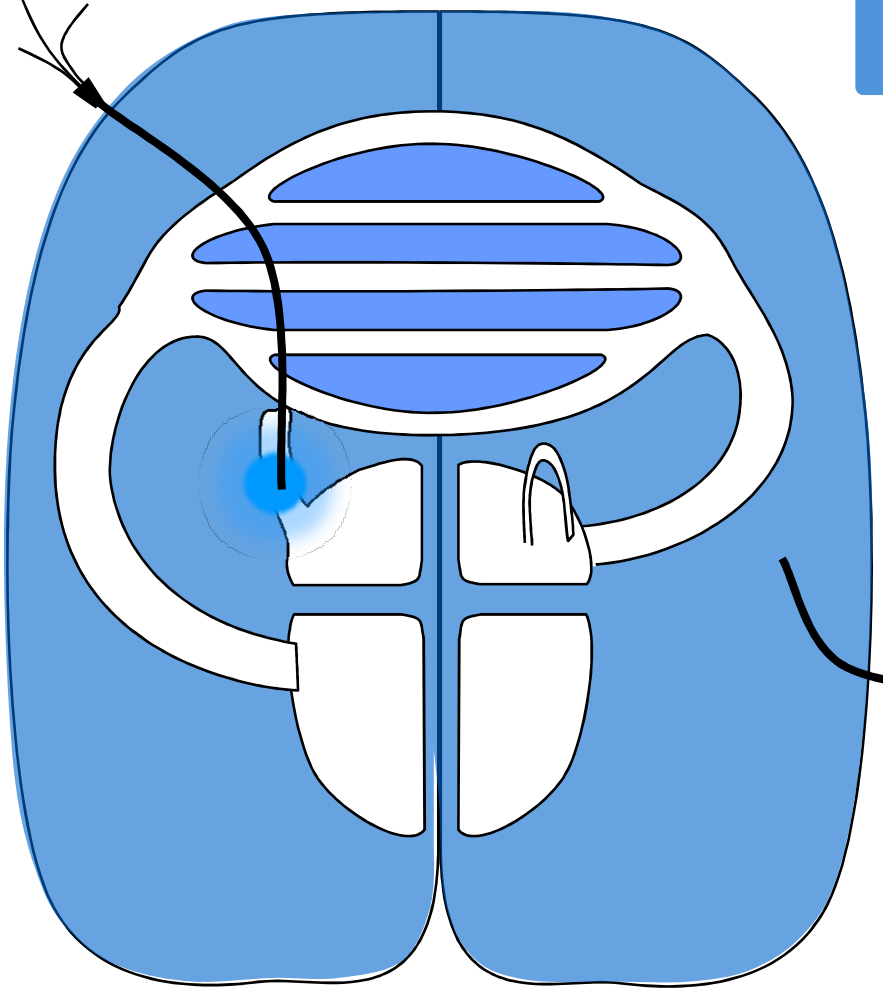
Débit cardiaque

Précharge et réserve de précharge

Fonction systolique VG

IFC - *Mesure*

bolus froid



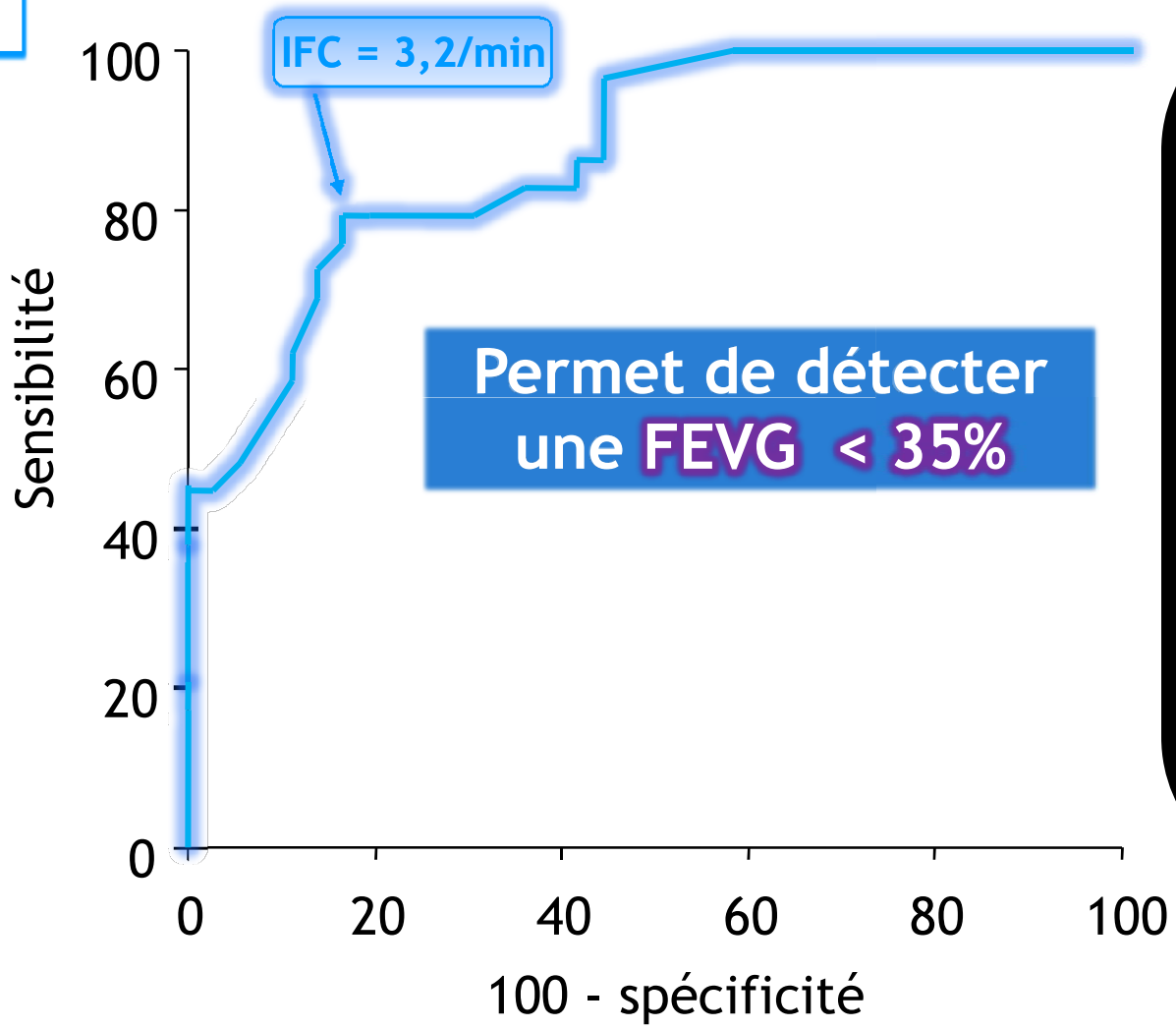
IFC = IC / VTDGI

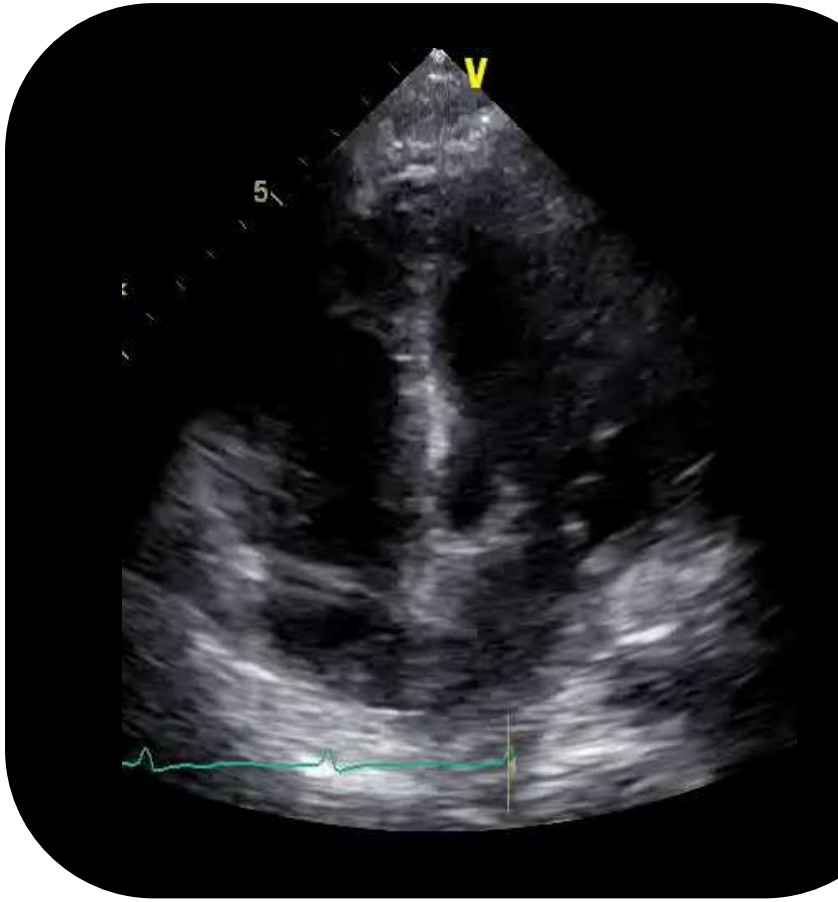
FEG = IFC /FC

FEG
25 à 35 %

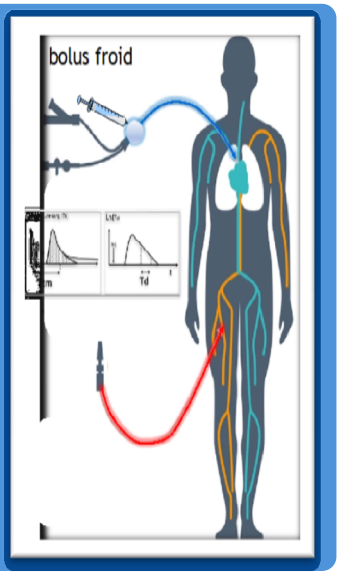
IFC – *Indice de contractilité*

atients
O et ETT





Jabot et al. *CCM* 2009;37(11):2913-



Débit cardiaque

Précharge

Fonction systolique VG

Eau pulmonaire extravasculaire

Perméabilité vasculaire pulmonaire

10:21 180 cm 90 kg

PiCCO

ELWI 6

PVPI 2.1

tdCI 1.91

GEDI 446

GEF 13

CFI 4.3

CIPC 1.91

SVV 24

TB 37.0

SVRI 2590

160

AP 115 115 / 65 (82) mmHg

HR 127 127 1/min

CVP 20 mmHg

Last input ** h ** min ago

SVI 15

SVV 24

PPV 24

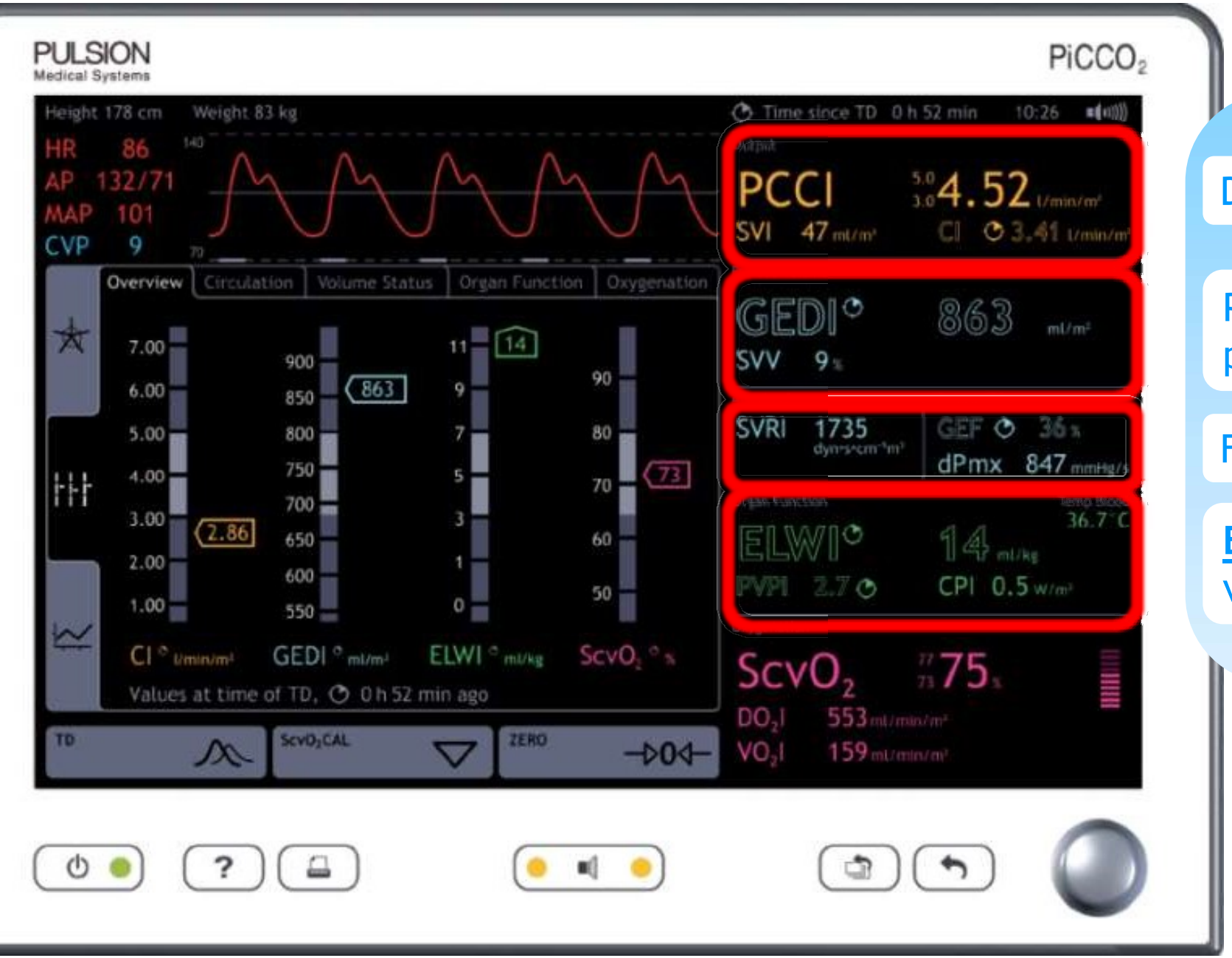
CI

15.00

7.50

0.00

-24 h 10:21



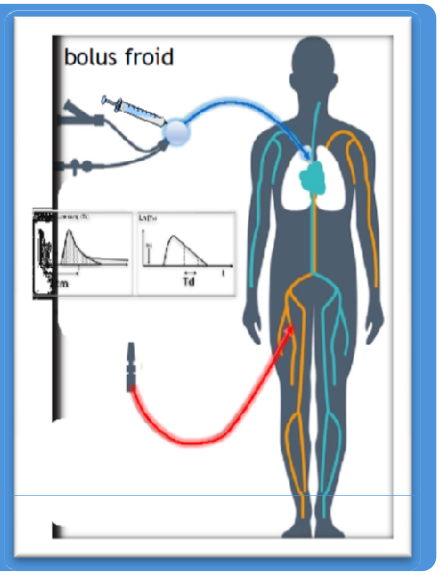
Débit cardiaque

Précharge et réserve de précharge

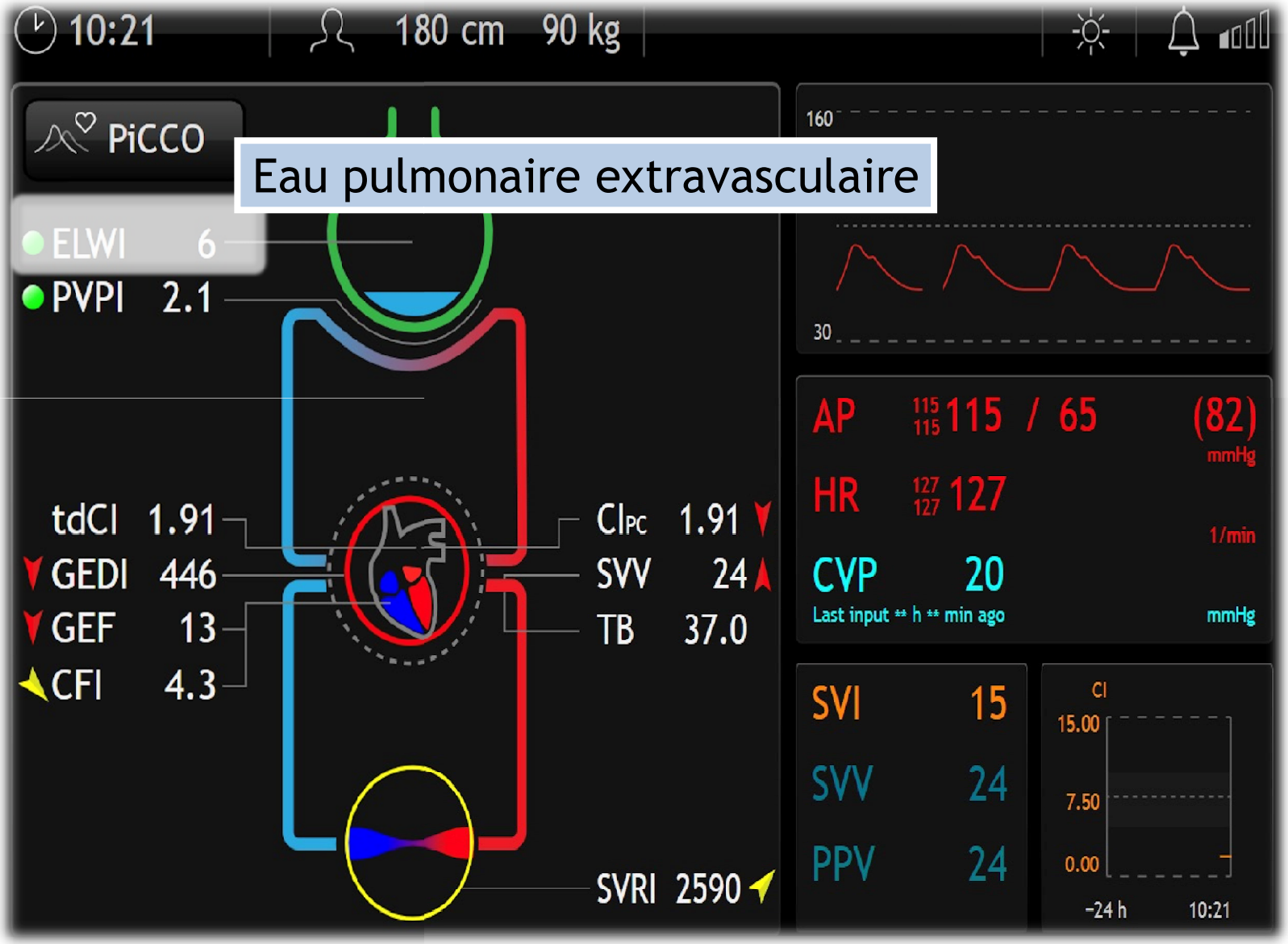
Fonction systolique VG

Eau et perméabilité vasculaire pulmonaires

EPEV - *Mesure*

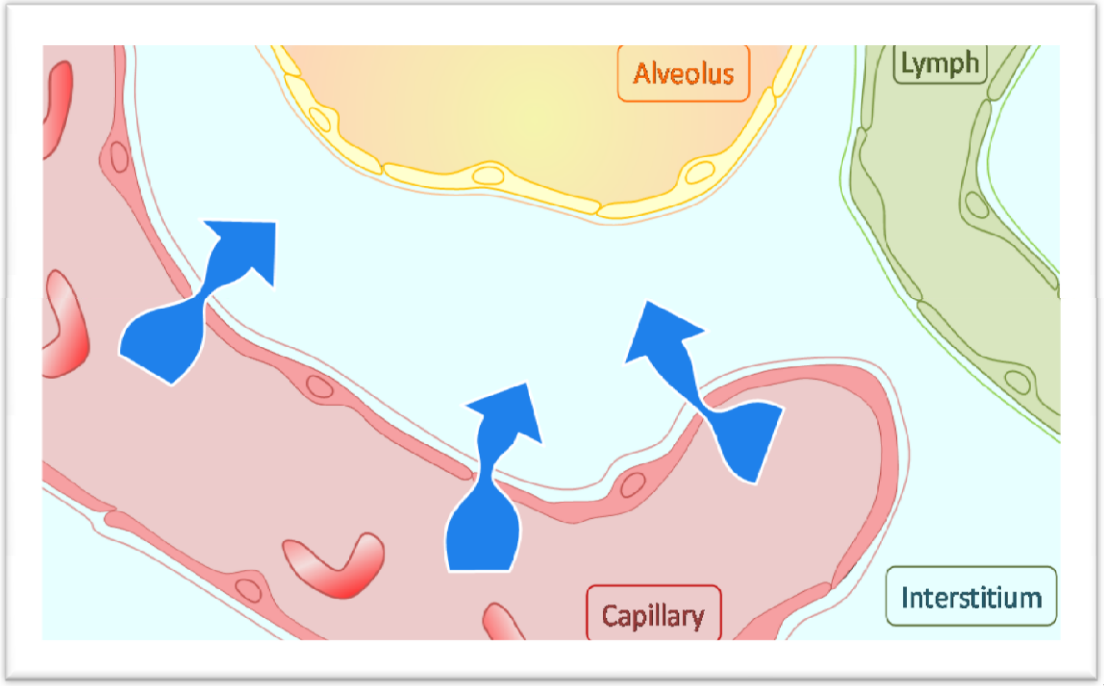


EPEV
< 10 mL/kg

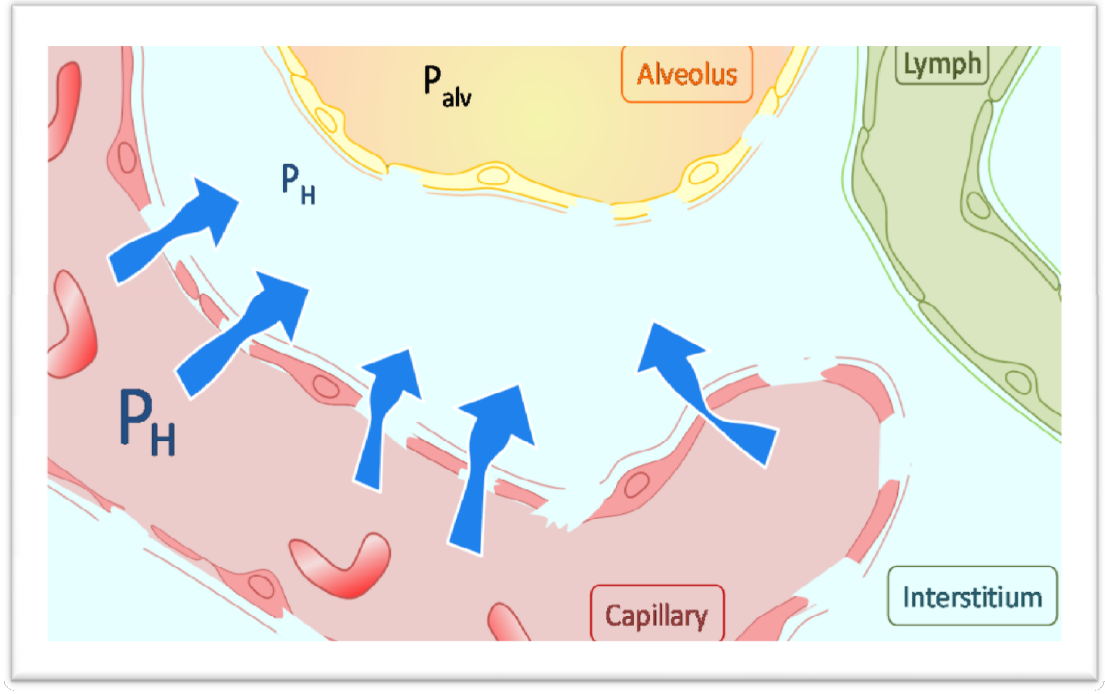


Eau pulmonaire extravasculaire (EPEV)

EPEV = volume de l'œdème pulmonaire



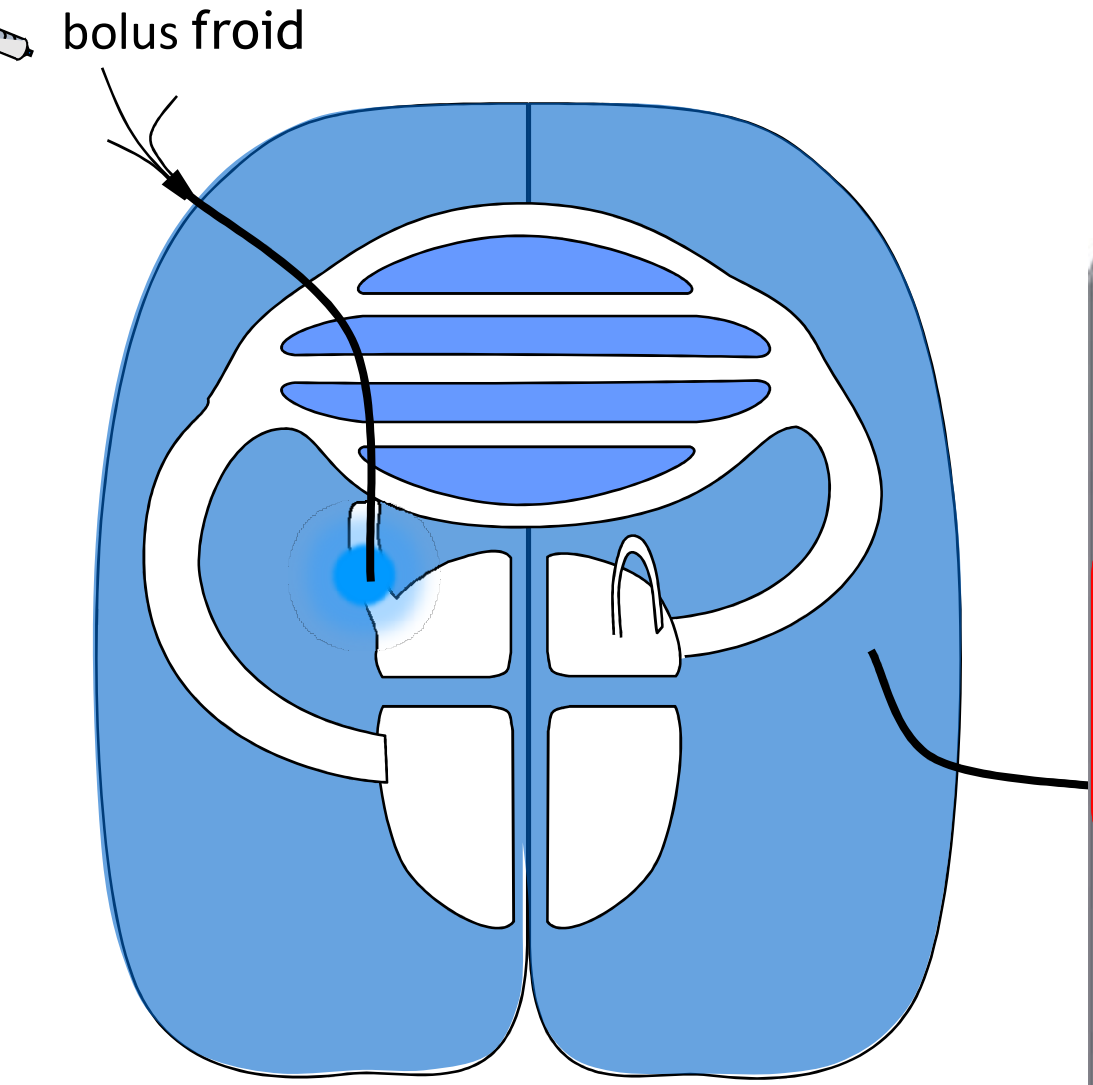
œdème pulmonaire hydrostatique

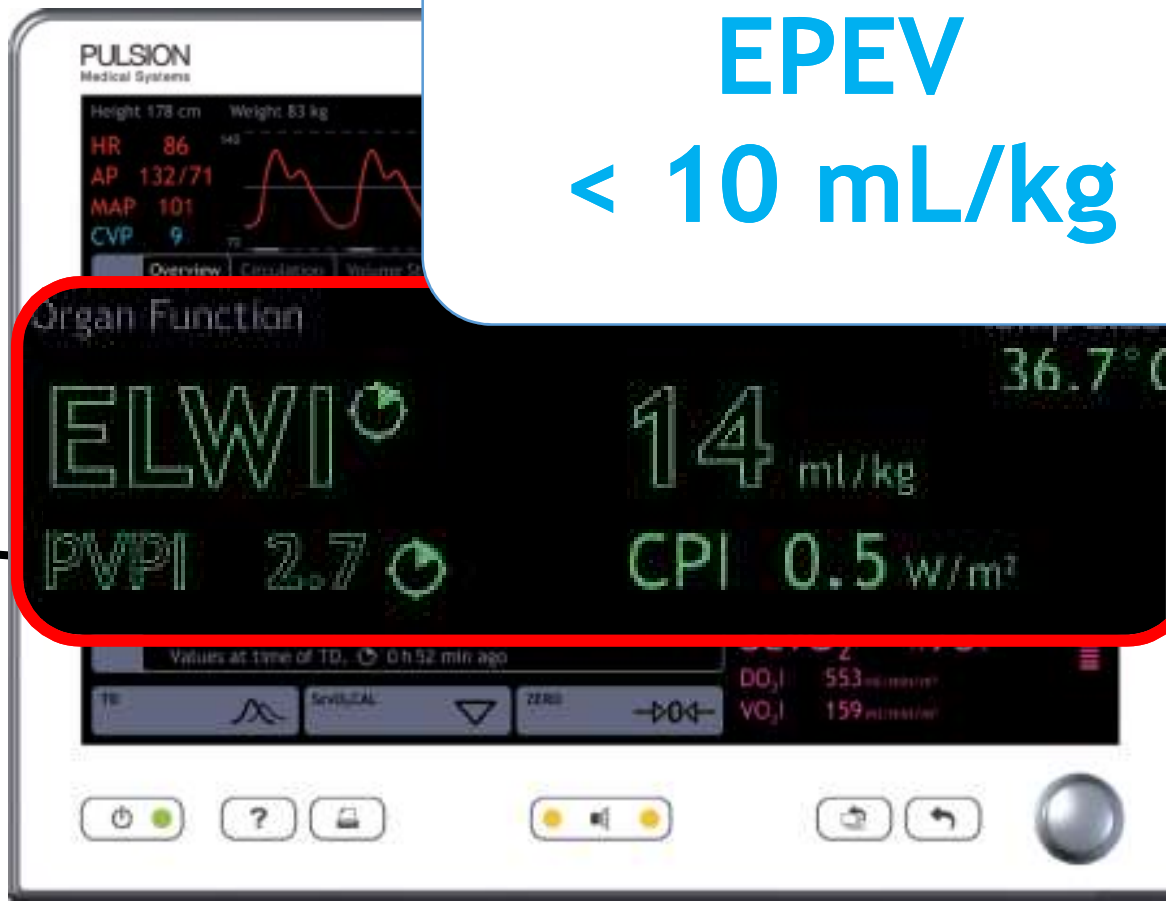


œdème pulmonaire lésionnel

Jozwiak et al. *AIC* 2015;

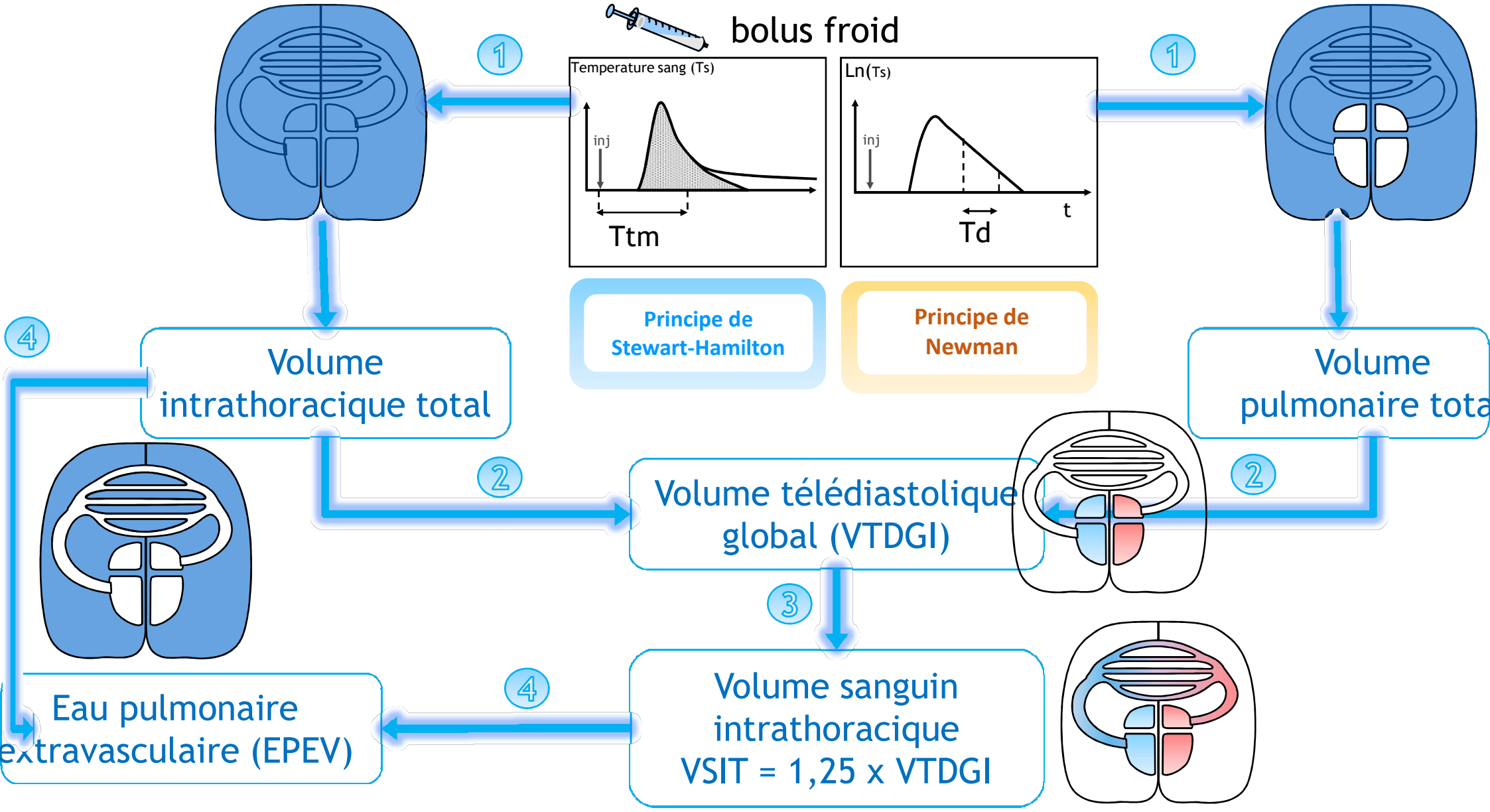
EPEV - *Mesure*





EPEV
< 10 mL/kg

EPEV - *Mesure*


bolus froid
1
Temperature sang (Ts)
inj
Ttm
Ln(Ts)
inj
t
Td
1
Principe de Stewart-Hamilton
Principe de Newman
4
Volume intrathoracique total
Volume pulmonaire tota
2
2
Volume télédiastolique global (VTDGI)
3
4
Eau pulmonaire extravasculaire (EPEV)
Volume sanguin intrathoracique VSIT = 1,25 x VTDGI

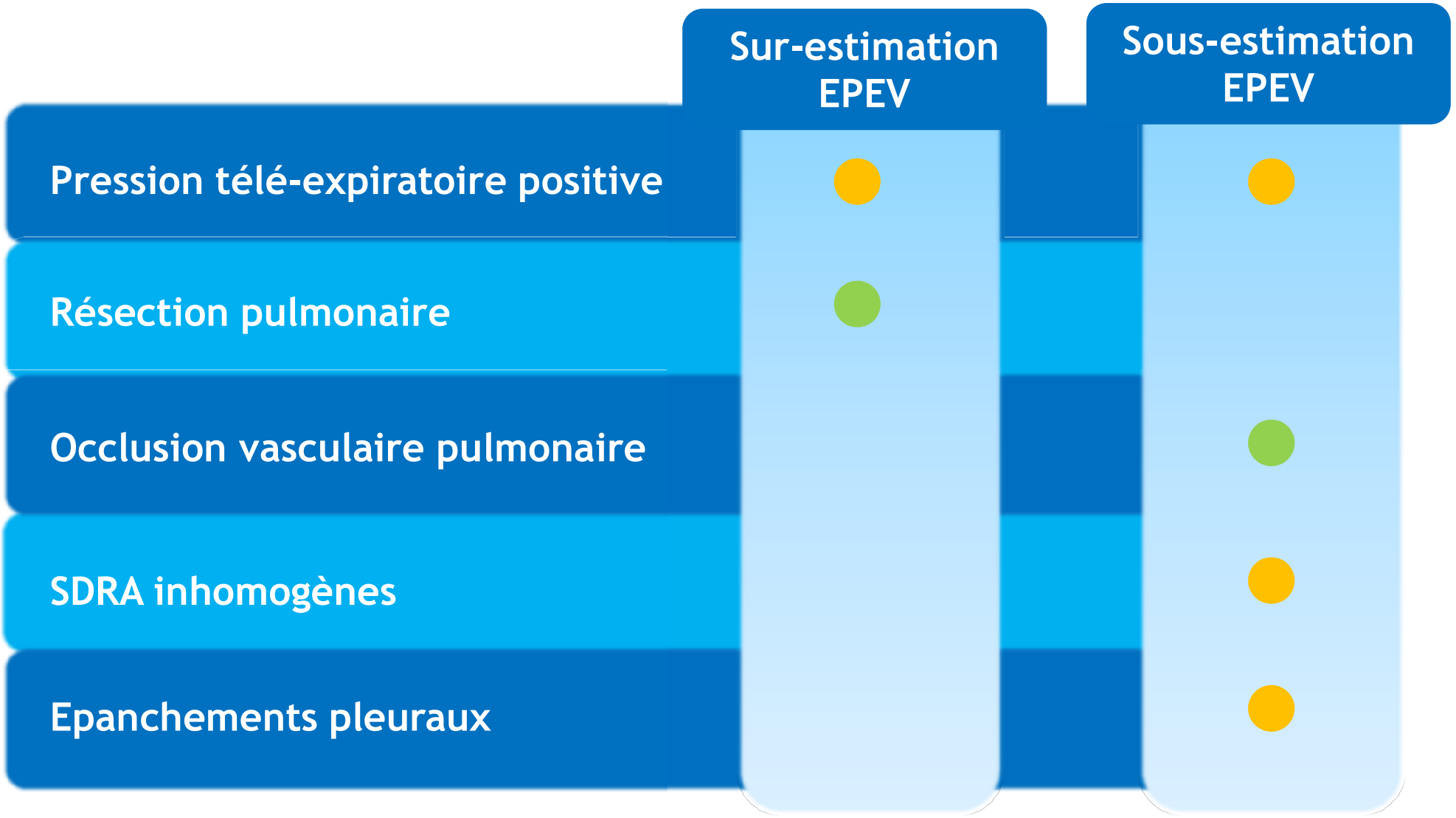
EPEV – *Avec un KTC en fémoral*

atients avec PiCCO
fémoral + jugulaire int

	Biais	LOA	% d'erreur
	Mesure EPEV valable en fémoral		
Index cardiaque (L/min/m²)	+ 0,29	-0,40 ; + 0,97	16%
VTDGI (mL/m²)	+ 241	-9 ; + 491	-
EPEV (mL/kg)	+ 0,83	- 2,61 ; + 4,28	-

Saugel et al. *Crit Care* 2010;14

EPEV – *Pièges de mesure*

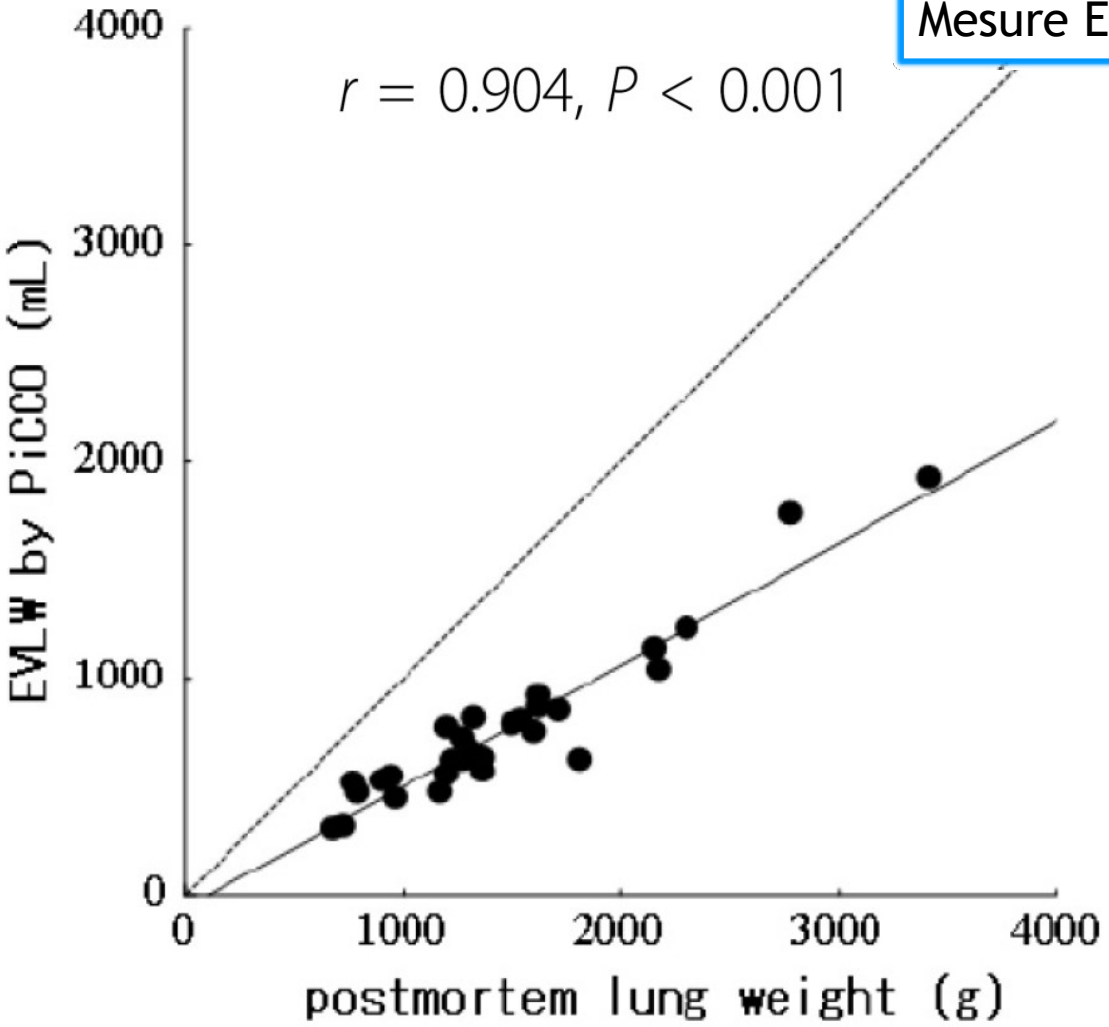


Jozwiak et al. *AIC* 2015;

EPEV - *Validation*

30 patients

Mesure EPEV par TDTP et gravimétrie (post-morten

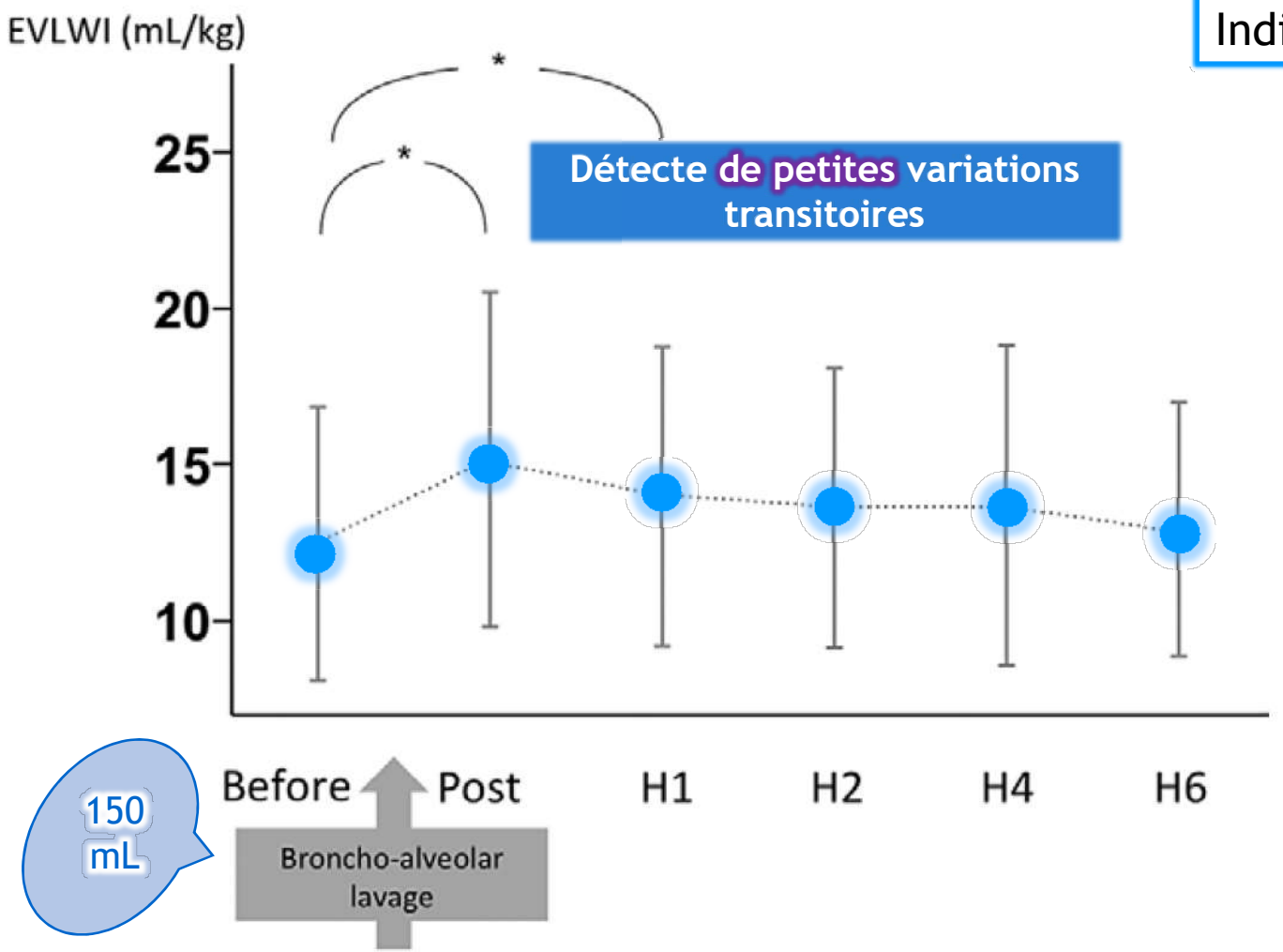


Mesure validée chez l'homme

Tagami et al. *Crit Care* 2010;14:

EPEV - *Indice sensible*

25 patients avec PiCCO
Indication LBA



Dres et al. *CCM* 2014;42:1869-

EPEV - *Intérêt pronostic*

arch

Open Access

ıvascular lung water in patients with severe sepsis: a pective cohort study

Martin[1], Stephanie Eaton[2], Meredith Mealer[3] and Marc Moss[4]

Critical Care 2005, 9:R74-R82

eptique

Extravascular lung water in sepsis-associated acute respi distress syndrome: Indexing with predicted body weight correlation with severity of illness and survival*

Charles R. Phillips, MD; Mark S. Chesnutt, MD; Stephen M. Smith, PhD, FJFICM

Crit Care M

SDRA

Prognostic Value of Extravascular Lung Water in Critically Ill Patients*

Samir G. Sakka, MD; DEAA; Magdalena Klein; Konrad Reinhart, MD; and Andreas Meier-Hellmann, MD

Réanimation

Brown *et al. Annals of Intensive Care* 2013, **3**:25
http://www.annalsofintensivecare.com/content/3/1/25

Annals of Intensiv
a SpringerOpen Journal

RESEARCH Open

Comparison of thermodilution measured extravascular lung water with chest radiograph assessment of pulmonary oedema in patients with acute lung injury

Lisa M Brown[1,2], Carolyn S Calfee[3,4], James P Howard[2,5], Thelma R Craig[6,7], Michael A Matthay[2,3,8*] and Daniel F McAuley[6,7]

xtravascular Lung Water is an Independent rognostic Factor in Patients with Acute espiratory Distress Syndrome

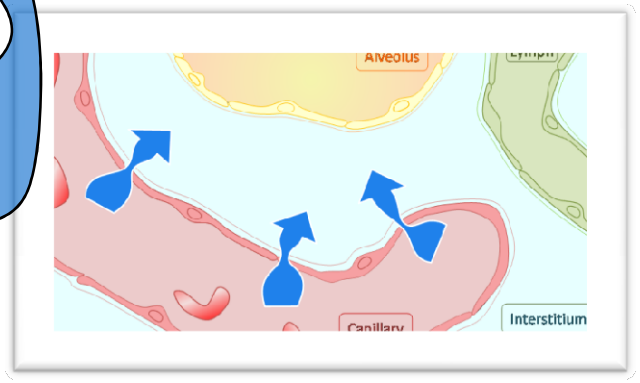
Crit Care Med 2013

Mathieu Jozwiak, MD; Serena Silva, MD; Romain Persichini, MD; Nadia Anguel, MD; David Osman, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD; Xavier Monnet, MD, PhD

SDRA

Facteur pronostic indépendant de mortalité chez l'homme

EPEV – *Intérêt pronostique*

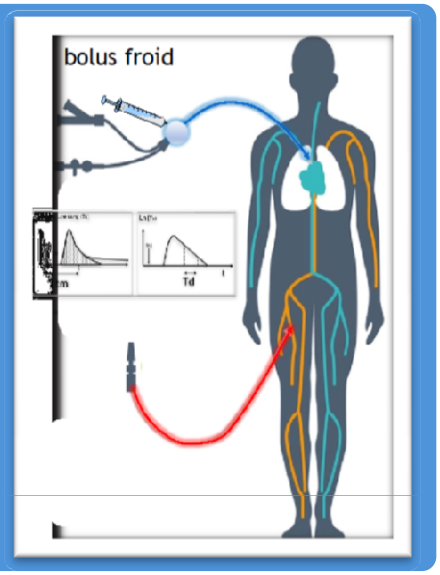


Etude rétrospective
200 patients avec un SD
NAD : 0,3 à 1,3 µg/kg/r
Mortalité de 54% à J28

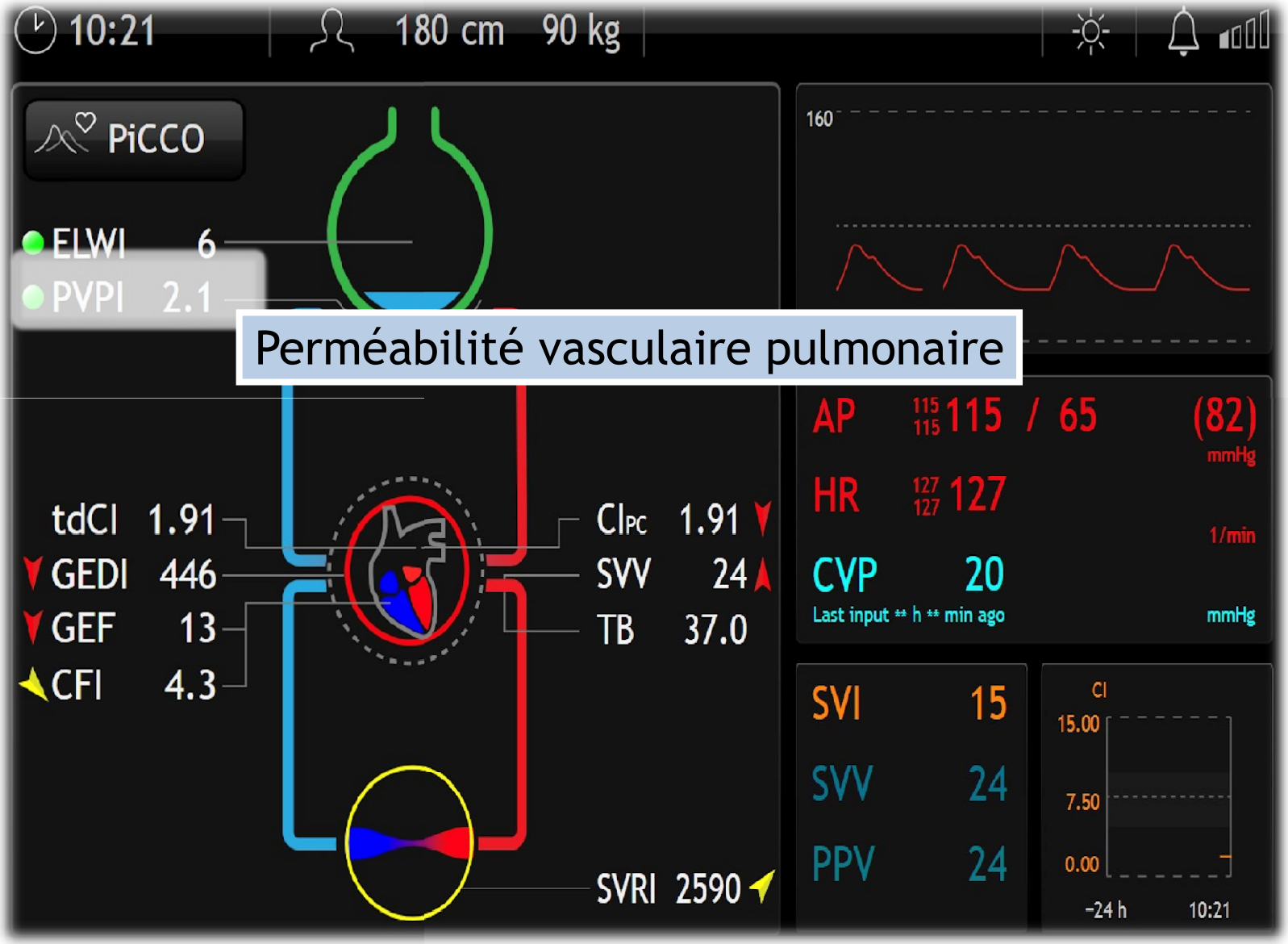
Maximum value of extravascular lung water indexed to predicted body weight recorded during the acute respiratory distress syndrome episode (1 unit = 1 mL/kg)	1.07 (1.02–1.12)	0.007
Maximum blood lactate (1 unit = 1 mmol/L)	1.29 (1.14–1.46)	0.0001
Minimum Pao_2/Fio_2 (1 unit = 1 mm Hg)	0.98 (0.97–0.99)	0.006
Mean positive end-expiratory pressure (1 unit = 1 cm H_2O)	0.78 (0.67–0.91)	0.002
Simplified Acute Physiologic Score II (1 unit = 1 point)	1.03 (1.01–1.05)	0.02
Mean cumulative fluid balance (1 unit = 1 mL)	1.0004 (1.0001–1.0008)	0.02

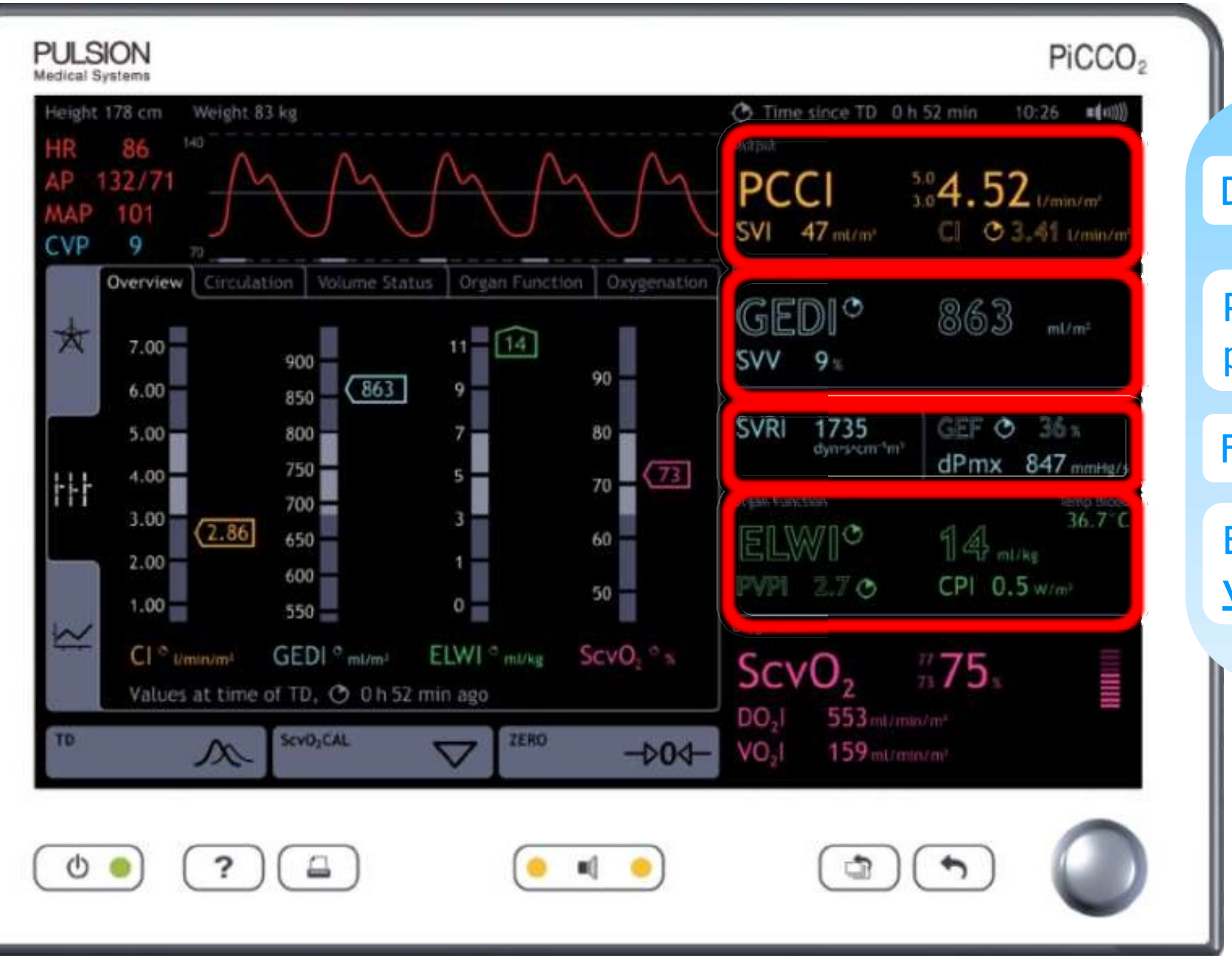
Jozwiak et al. *CCM* 2013;41:472

IPVP - *Mesure*



IPVP < 3





Débit cardiaque

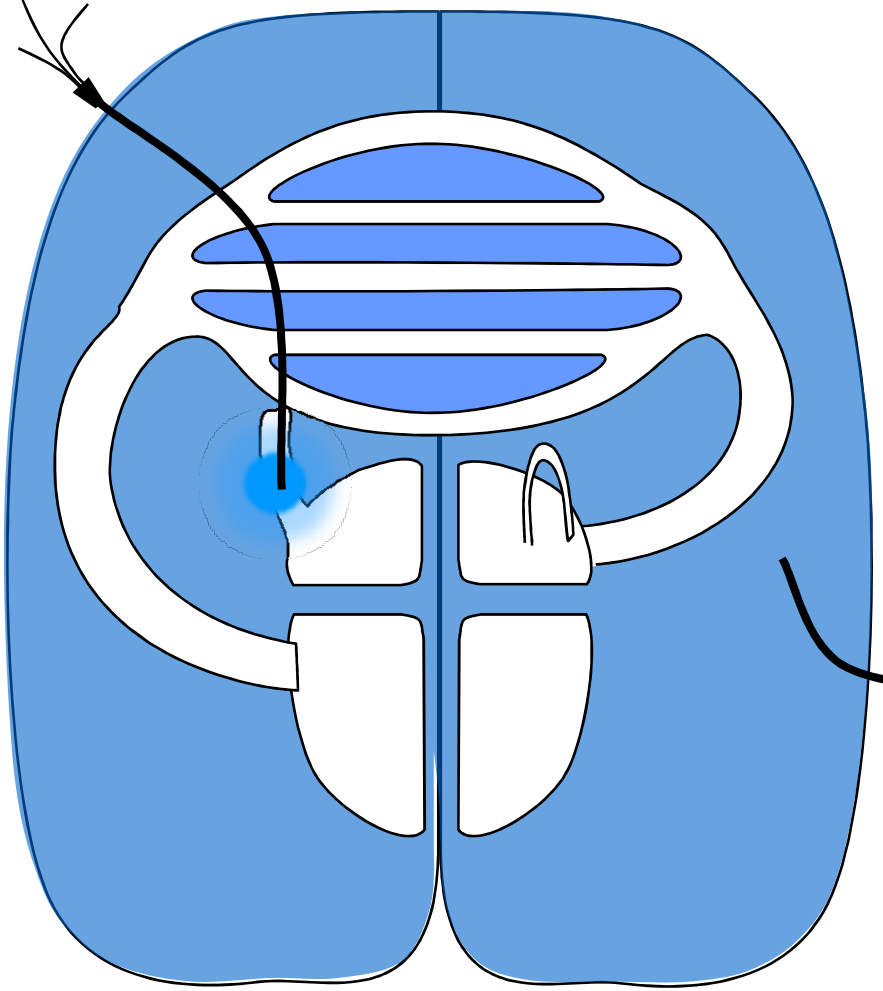
Précharge et réserve de précharge

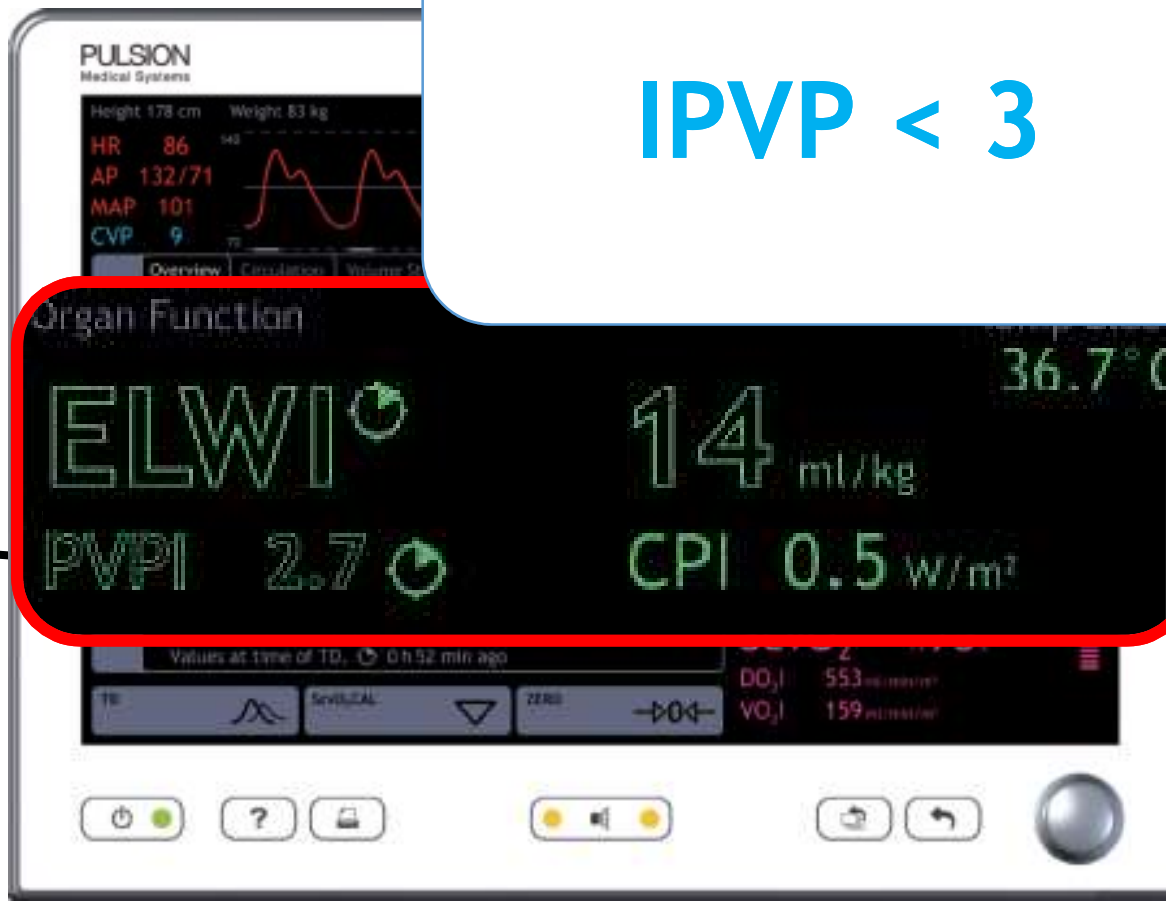
Fonction systolique VG

Eau et **perméabilité vasculaire** pulmonaires

IPVP - *Mesure*

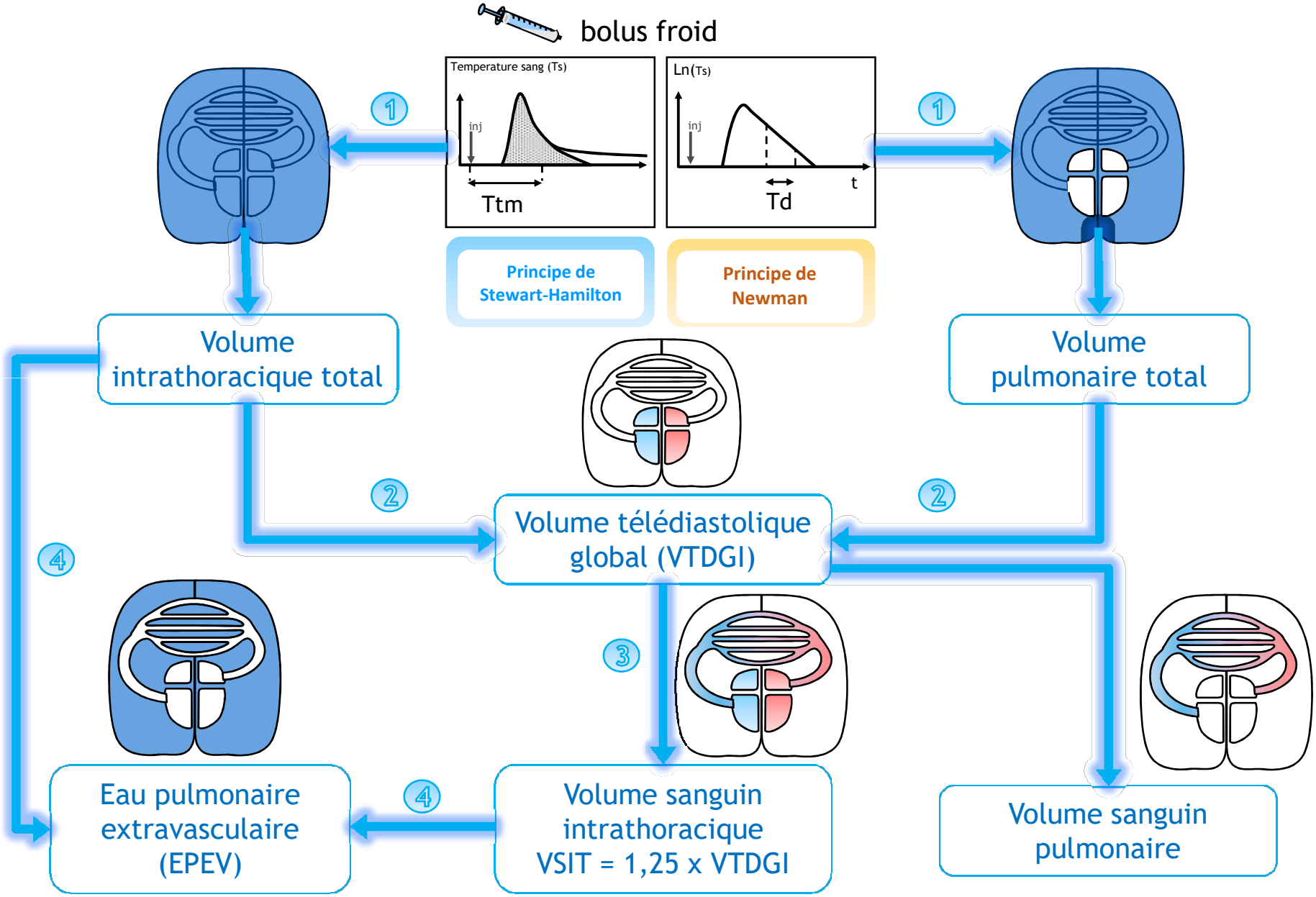
bolus froid





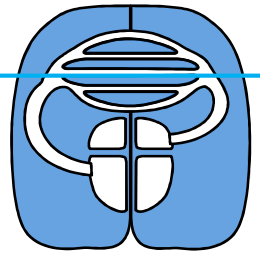
IPVP < 3

IPVP - *Mesure*

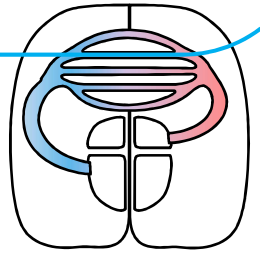

bolus froid
Temperature sang (Ts)
inj
Ttm
Ln(Ts)
inj
Td
t
1
1
Principe de Stewart-Hamilton
Principe de Newman
Volume intrathoracique total
Volume pulmonaire total
2
2
Volume télédiastolique global (VTDGI)
4
3
4
Eau pulmonaire extravasculaire (EPEV)
Volume sanguin intrathoracique VSIT = 1,25 x VTDGI
Volume sanguin pulmonaire

IPVP - *Mesure*

IPVP = Volume extravasculaire / Volume intravasculaire

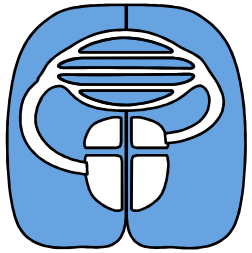


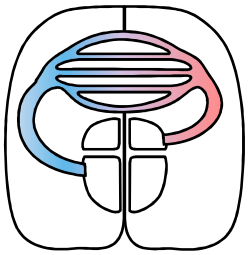
Eau pulmonaire extravasculaire (EPEV)



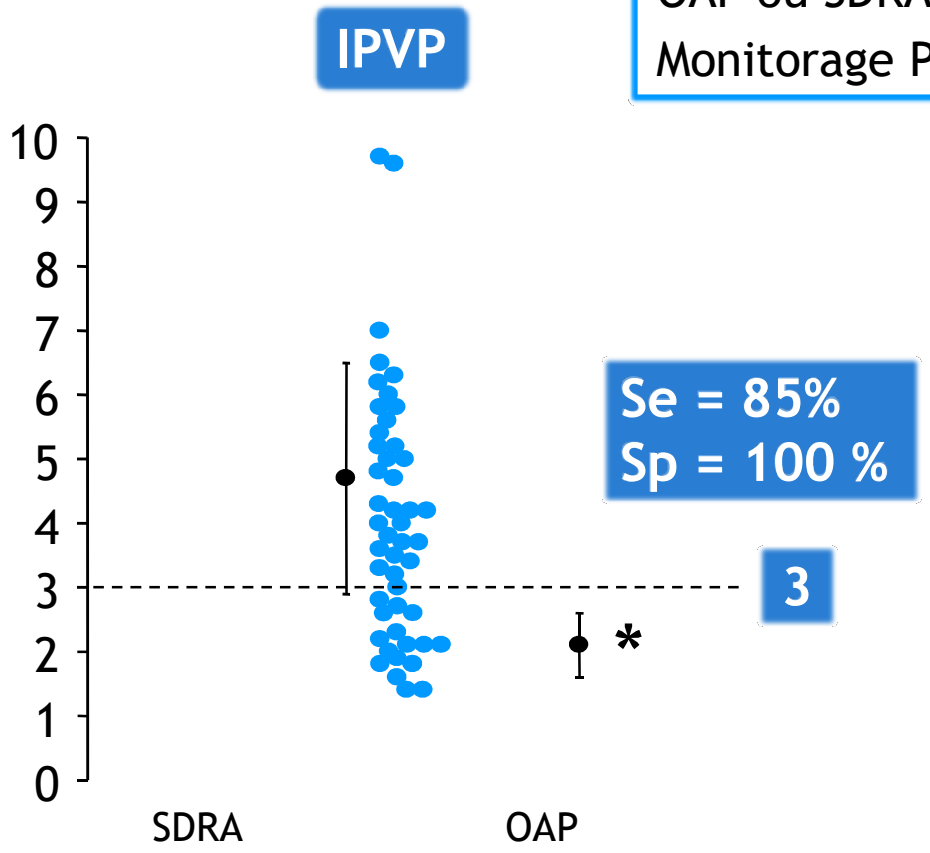
Volume sanguin pulmonaire

IPVP – *Validation*



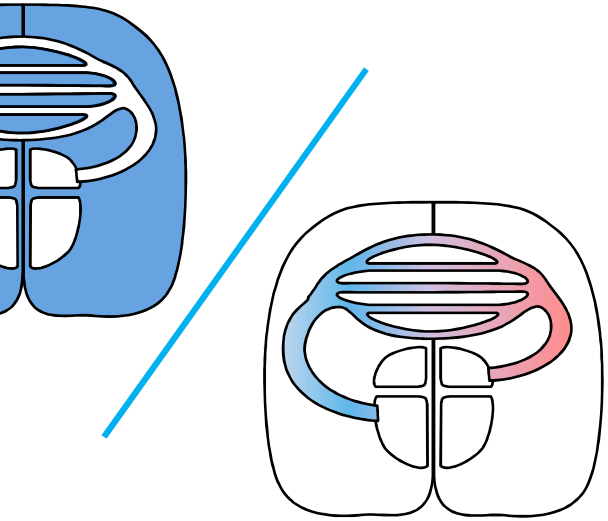


48 patients
OAP ou SDRA (avis d'expert
Monitorage PiCCO



Monnet et al. *ICM* 2007;33:448

IPVP – *Intérêt pronostic*

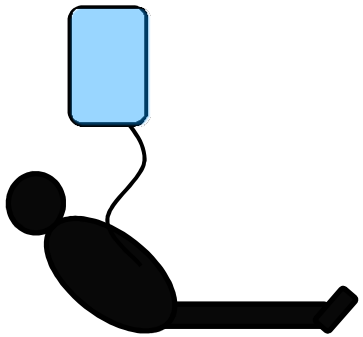


Etude rétrospective
200 patients avec un SD
NAD : 0,3 à 1,3 µg/kg/r
Mortalité de 54% à J28

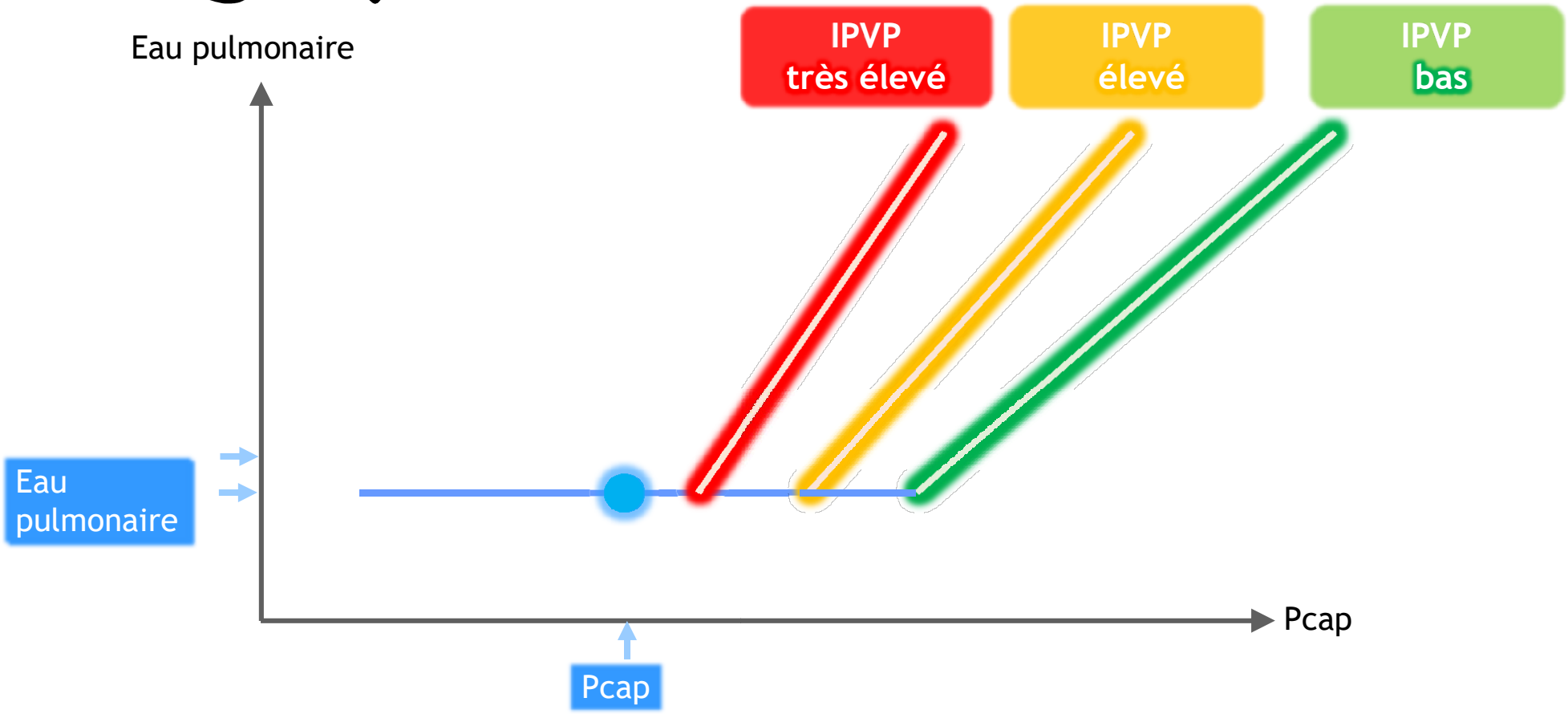
Maximum value of pulmonary vascular permeability index recorded during the acute respiratory distress syndrome episode (1 unit = 1 point)	1.27 (1.03–1.57)	0.03
imum blood lactate (1 unit = 1 mmol/L)	1.27 (1.12–1.45)	0.0
mum Pao_2/Fio_2 (1 unit = 1 mm Hg)	0.98 (0.97–0.99)	0.0
n positive end-expiratory pressure (1 unit = 1 cm H_2O)	0.78 (0.67–0.91)	0.0
plified Acute Physiologic Score II (1 unit = 1 point)	1.03 (1.01–1.05)	0.0
n cumulative fluid balance (1 unit = 1 mL)	1.0004 (1.0000–1.0007)	0.0

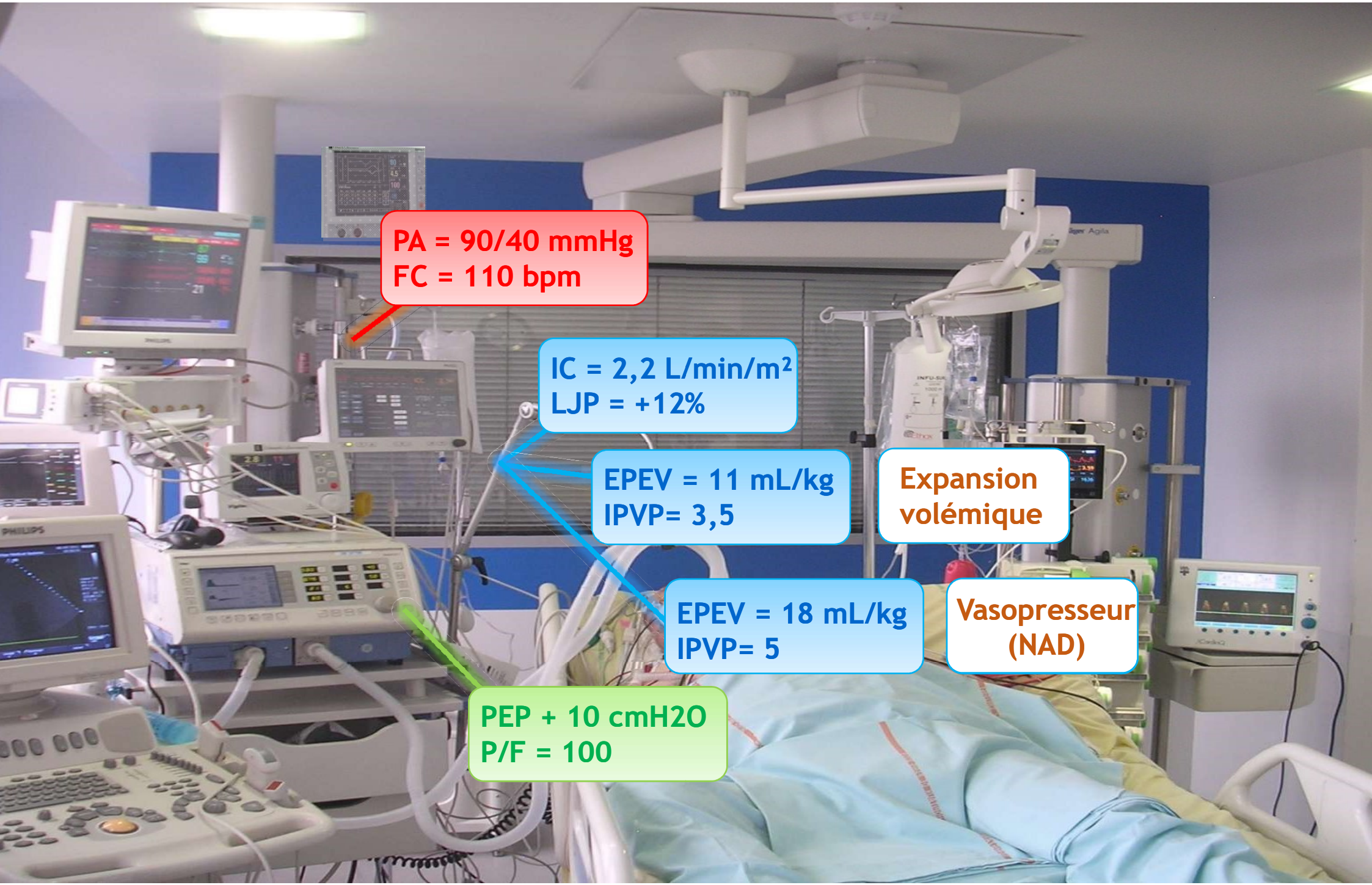
Jozwiak et al. *CCM* 2013;41:472

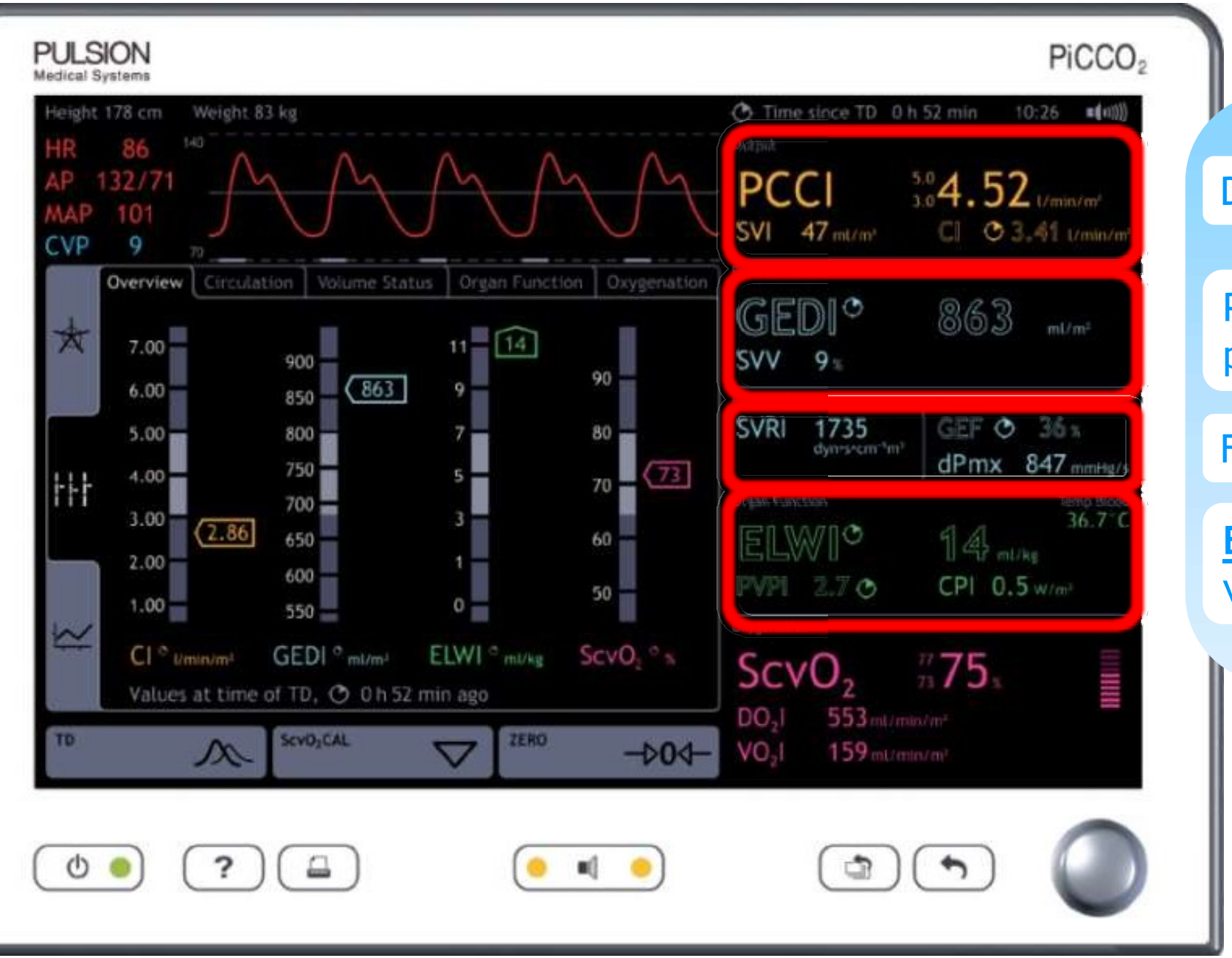
IPVP - *Intérêt thérapeutique*



Eau pulmonaire




PA = 90/40 mmHg
FC = 110 bpm
IC = 2,2 L/min/m²
LJP = +12%
EPEV = 11 mL/kg
IPVP= 3,5
Expansion volémique
EPEV = 18 mL/kg
IPVP= 5
Vasopresseur (NAD)
PEP + 10 cmH2O
P/F = 100

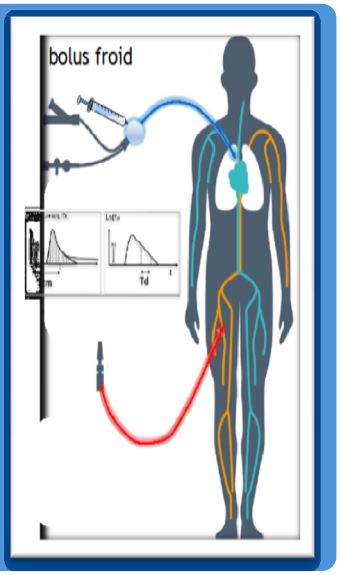


Débit cardiaque

Précharge et réserve de précharge

Fonction systolique VG

Eau et perméabilité vasculaire pulmonaires



Débit cardiaque

Précharge

Fonction systolique VG

Eau pulmonaire extravasculaire

Perméabilité vasculaire pulmonaire

10:21 180 cm 90 kg

PiCCO

ELWI 6

PVPI 2.1

tdCI 1.91

GEDI 446

GEF 13

CFI 4.3

CIPC 1.91

SVV 24

TB 37.0

SVRI 2590

160

AP 115 115 / 65 (82) mmHg

HR 127 127 1/min

CVP 20 mmHg

Last input ** h ** min ago

SVI 15

SVV 24

PPV 24

CI

15.00

7.50

0.00

-24 h 10:21

Journées Francophones de Réanimation

Thermodilution transpulmonaire

Mathieu Jozwiak, service MIR Nice

22 juin 2024