Débit cardiaque:

monitorage non invasif

Benoît Tavernier
Pôle d'anesthésie réanimation
CHRU de Lille

CONFLITS D'INTERET

- Masimo, Cheetah med. : conférences (SFAR)

- Edwards : subvention projet recherche

Monitorage du débit cardiaque

Pourquoi ?

Hémodynamique - Oxygénation tissulaire

PRECHARGE CARDIAQUE

INOTROPISME

POSTCHARGE

↓

DEBIT CARDIAQUE
PA

↓

TRANSPORT O_2

DEMANDE O_2

Hémodynamique - Oxygénation tissulaire

PRECHARGE CARDIAQUE

INOTROPISME

POSTCHARGE

↓

DEBIT CARDIAQUE
PA

↓

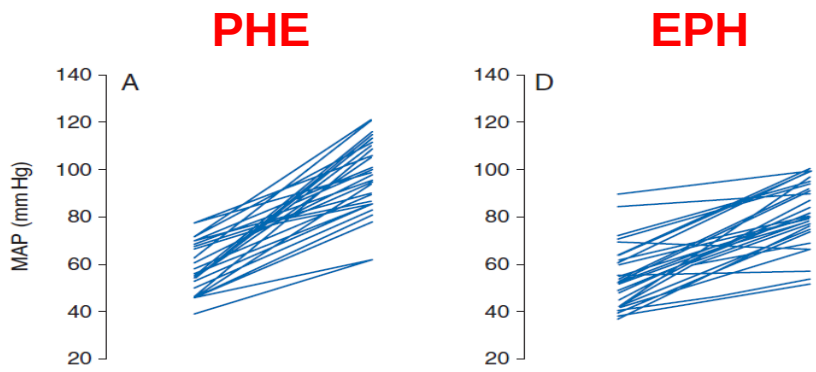
TRANSPORT O_2

DEMANDE O_2

Effect of phenylephrine and ephedrine bolus treatment on cerebral oxygenation in anaesthetized patients

L. Meng[1*], M. Cannesson[1], B. S. Alexander[1], Z. Yu[2], Z. N. Kain[1], A. E. Cerussi[3], B. J. Tromberg[3] and W. W. Mantulin[3]

PAM



British Journal of Anaesthesia **107** (2): 209–17 (2011)

RECOMMANDATIONS FORMALISÉES D'EXPERTS

SFAR
Société Française d'Anesthésie et de Réanimation

Stratégie du remplissage vasculaire périopératoire

Guidelines for perioperative haemodynamic optimization

Validation par le conseil d'administration de la Sfar du 19 octobre 2012.

En collaboration avec l'Adarpef

B. Vallet[a,*], Y. Blanloeil[b], B. Cholley[c], G. Orliaguet[d], S. Pierre[e], B. Tavernier[f]

Experts

Karim Asehnoune, Mathieu Biais, Olivier Collange, Souhayl Dahmani, Olivier Desebbe, Pascale Dewachter, Jacques Duranteau, Jean-Luc Fellahi, Emmanuel Futier, Thomas Geeraerts, Anne Godier, Olivier Joannes-Boyau, Gilles Lebuffe, Corinne Lejus, Dan Longrois, Frederic Mercier, Alexandre Mignon, Yves Ozier, Ivan Philip, Lionel Velly, Eric Wodey

Chargés de bibliographie

Adrien Bouglé, Grégory Dubar, Talna Kortchinsky

Patients à Haut Risque

- Chez les patients chirurgicaux considérés «à haut risque», il est **recommandé** de **titrer** le remplissage vasculaire peropératoire en se guidant sur une mesure de **volume d'éjection systolique** (VES) dans le but de réduire la morbidité postopératoire, la durée de séjour hospitalier, et le délai de reprise d'une alimentation orale des patients de chirurgie digestive (*Grade 1+*).

- Il est **recommandé** d'interrompre le remplissage en l'absence d'augmentation du VES (*Grade 1+*).

Hemodynamic monitoring and management in patients undergoing high risk surgery: a survey among north american and european anesthesiologists

Cannesson M. Crit Care 2011 ; 15 : R197

Table 1 Hemodynamic monitoring used for the management of high-risk surgery patients?.

	ASA respondents (n = 237)	ESA respondents (n = 195)
Answer options	**Response percent**	**Response percent**
Invasive arterial pressure	95.4%	89.7%
Central venous pressure	72.6%	83.6%
Non-invasive arterial pressure	51.9%	53.8%
Cardiac output	35.4%	34.9%
Pulmonary capillary wedge pressure	30.8%	14.4%
Transesophageal echocardiography	28.3%	19.0%
Systolic pressure variation	20.3%	23.6%
Plethysmographic waveform variation	17.3%	17.9%

RECOMMANDATIONS FORMALISÉES D'EXPERTS

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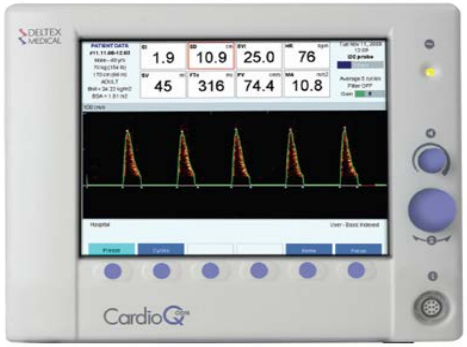
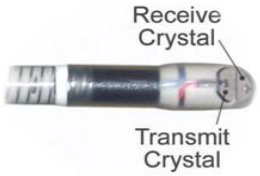
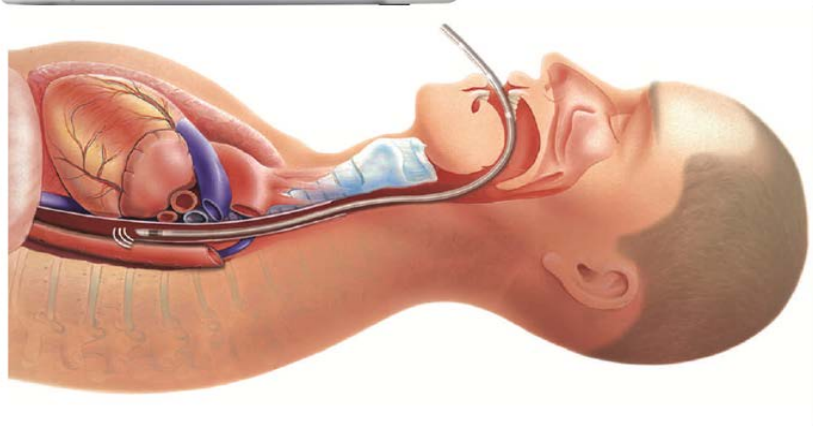






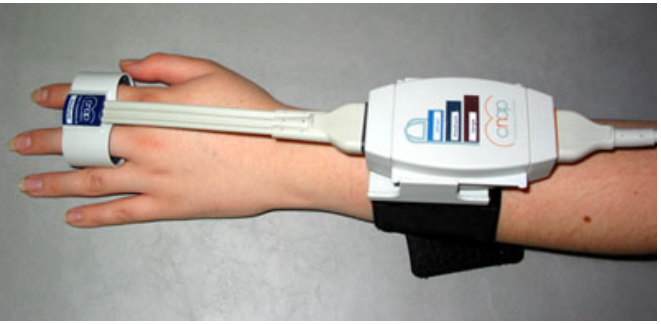
Monitorage du débit cardiaque

- mesure fiable (exact et précis)

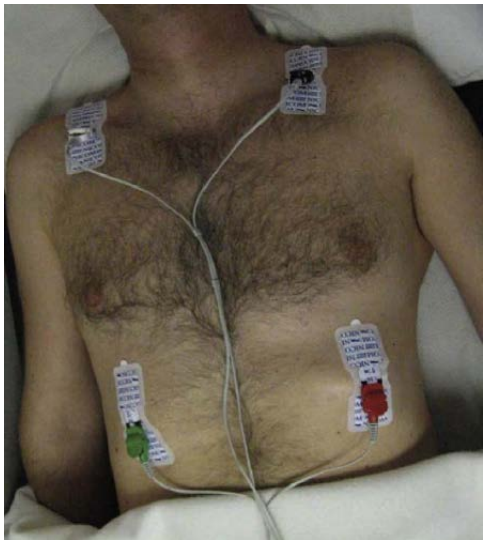
- opérateur-indépendant
- non invasif
- de mise en œuvre rapide

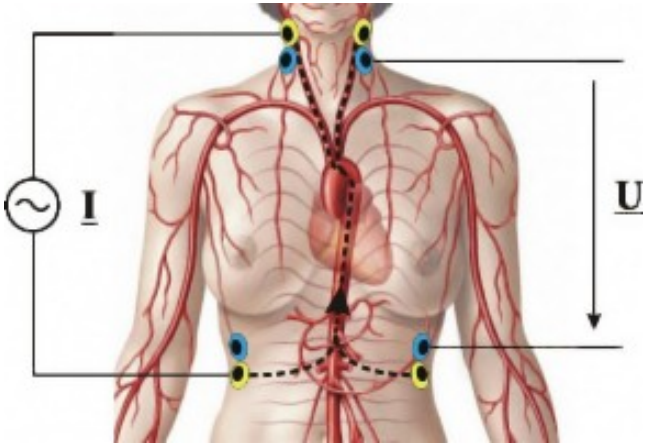
- consommable pas cher

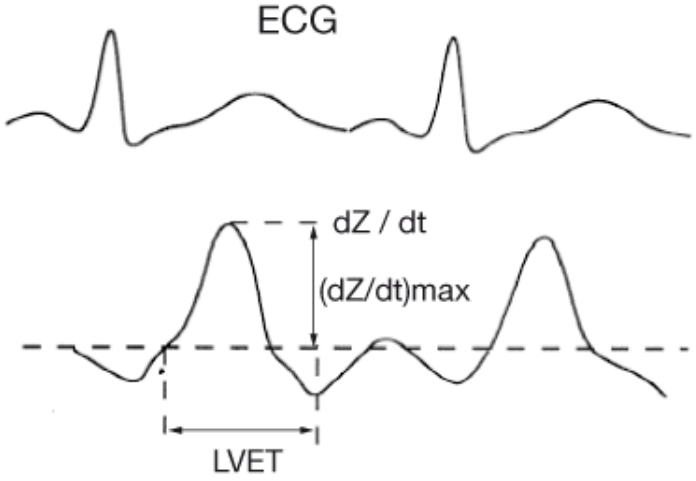
Non invasif : deux axes de développement …

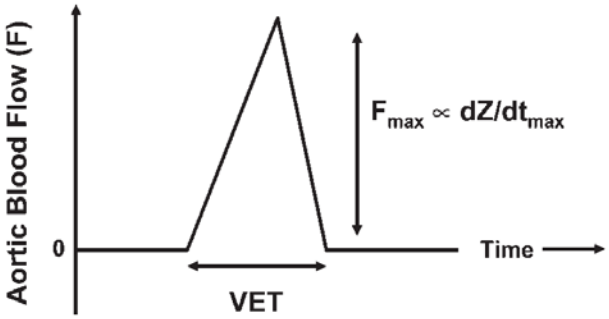


L’impédancemétrie transthoracique



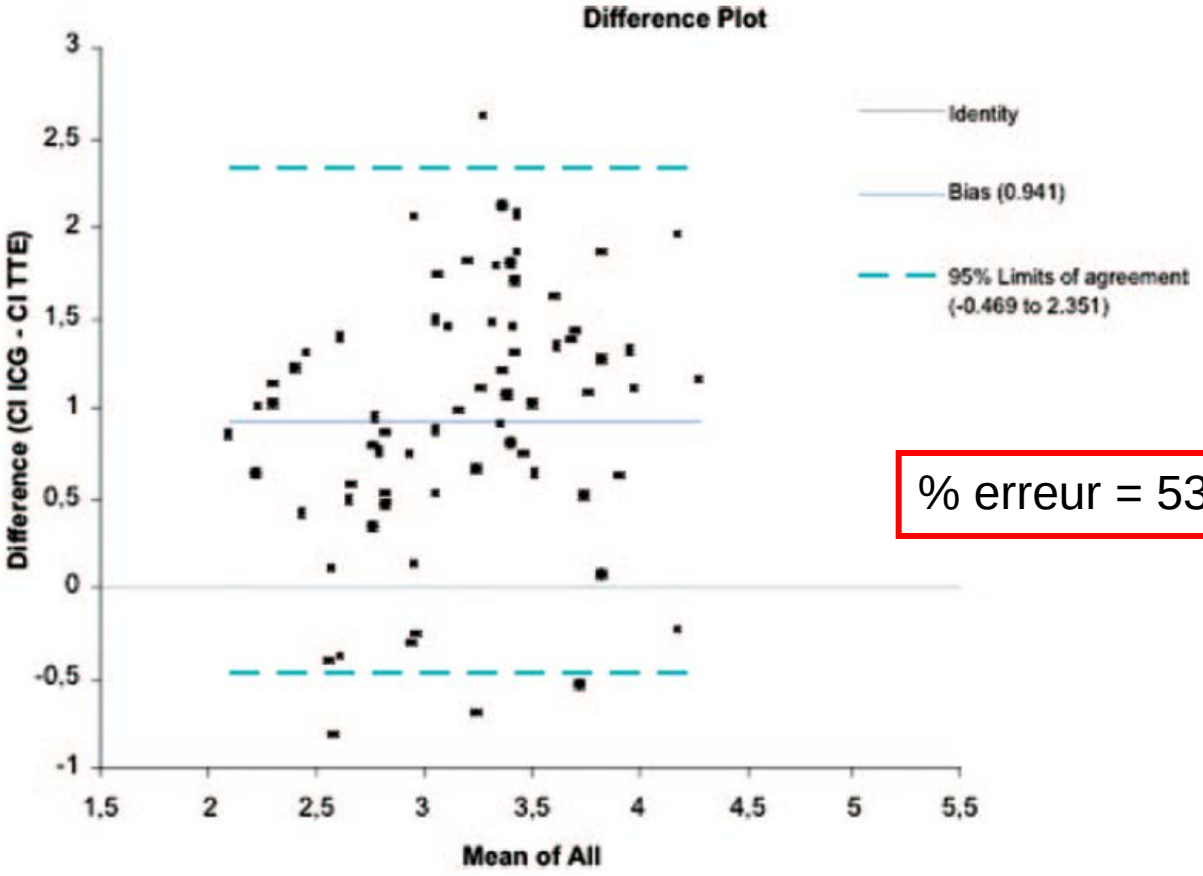






Noninvasive Assessment of Cardiac Index in Healthy Volunteers: A Comparison Between Thoracic Impedance Cardiography and Doppler Echocardiography

Jean-Luc Fellahi, MD, PhD* Vincent Caille, MD† Cyril Charron, MD†
Pierre-Hervé Deschamps-Berger MD‡ Antoine Vieillard-Baron, MD, PhD†



% erreur = 53 %

Anesth Analg 2009;108:1553–9

ELSEVIER MASSON

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

Annales Françaises d'Anesthésie et de Réanimation 28 (2009) 537–541

annales françaises DE ANESTHÉSIE ET DE RÉANIMATION

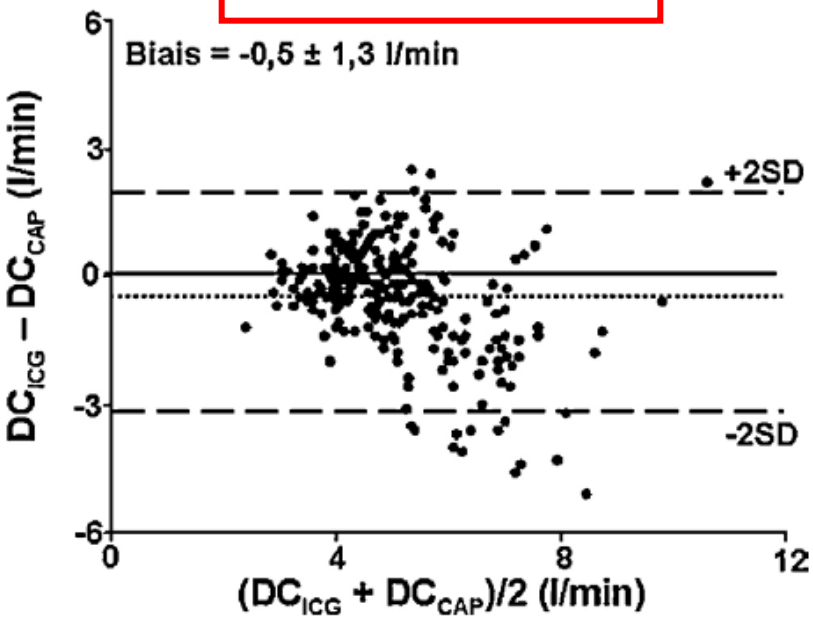
Article original

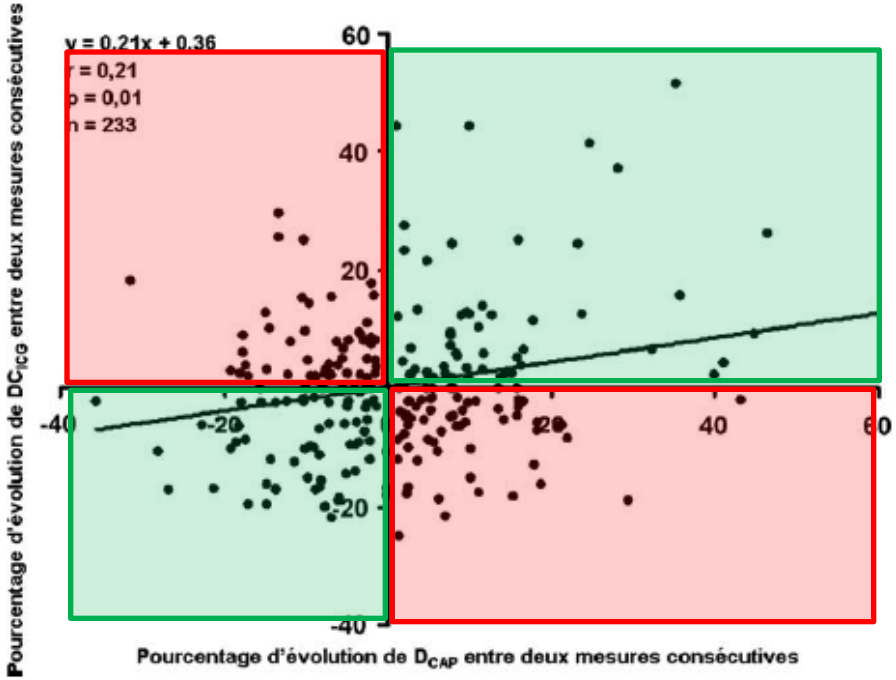
Comparaison des valeurs de débit cardiaque obtenues à l'aide d'un nouveau système d'impédancemétrie thoracique avec les données du cathéter artériel pulmonaire en postopératoire de chirurgie cardiaque☆

Comparison of ICG thoracic bioimpedance cardiac output monitoring system in patients undergoing cardiac surgery with pulmonary artery cardiac output measurements

R. Simon [a], O. Desebbe [a], R. Hénaine [b], O. Bastien [a], J.-J. Lehot [a], M. Cannesson [a,*]

% erreur = 53 %

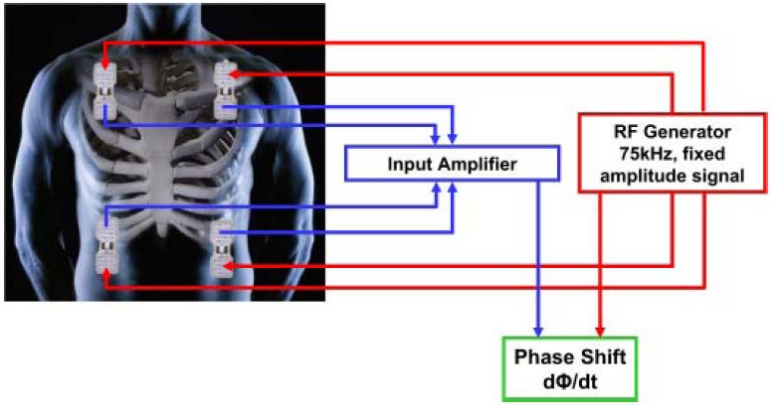


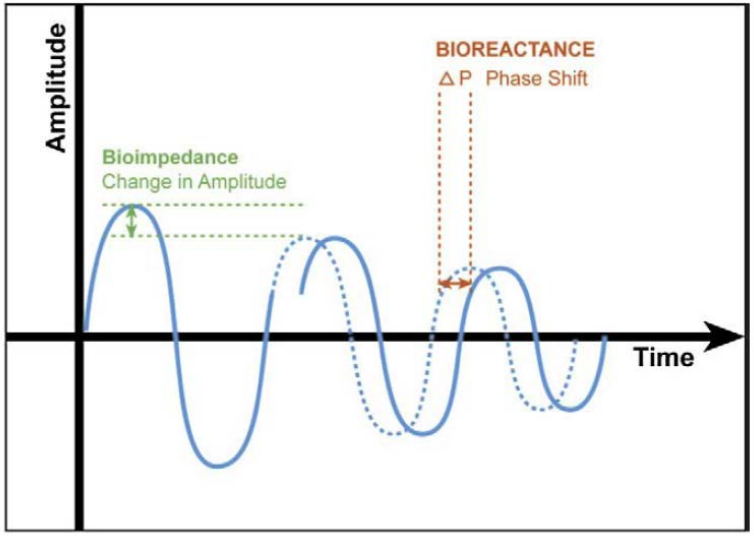


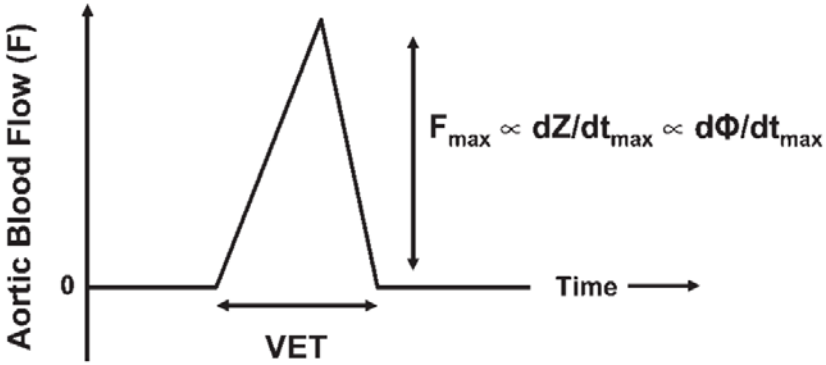
Am J Physiol Heart Circ Physiol 293: H583–H589, 2007.
First published March 23, 2007; doi:10.1152/ajpheart.00195.2007.

Evaluation of a noninvasive continuous cardiac output monitoring system based on thoracic bioreactance

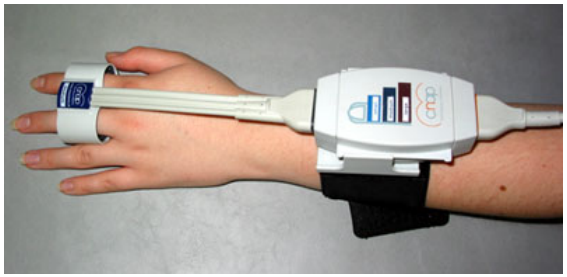
Hanan Keren,[1] Daniel Burkhoff,[2] and Pierre Squara[3]
[1]*Cheetah Medical Limited, Ra'anana, Israel;* [2]*Columbia University, New York, New York; and* [3]*Clinique Ambroise Pare, Neuilly, Paris, France*



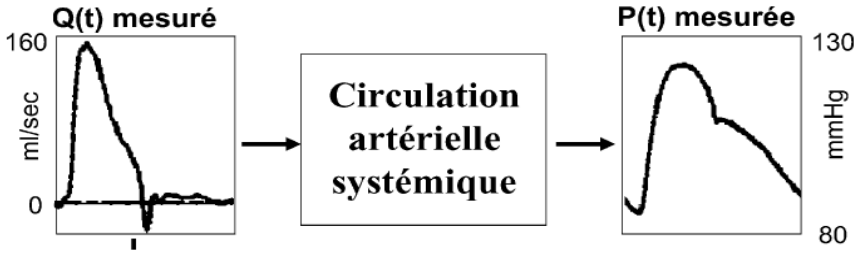




L’autre axe de développement …



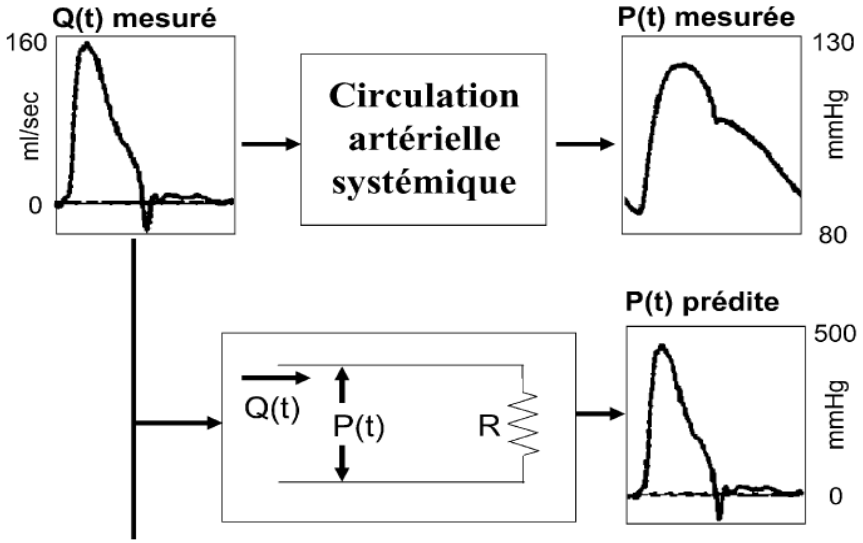
"Pulse contour" : comment ça marche?



Physio

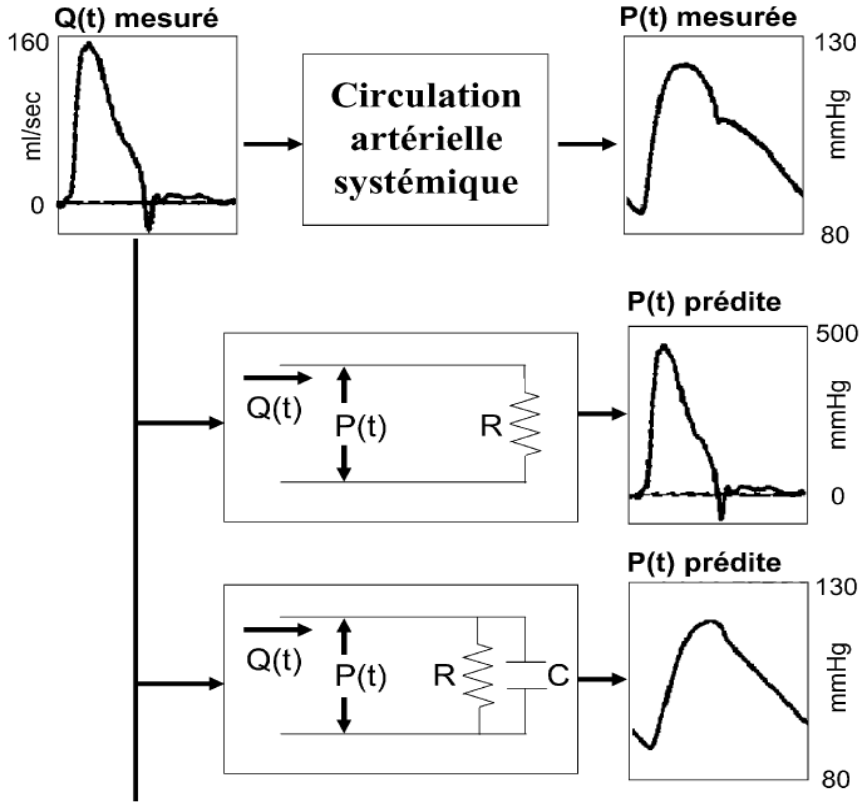
Moniteur

"Pulse contour" : comment ça marche?



résistance artérielle

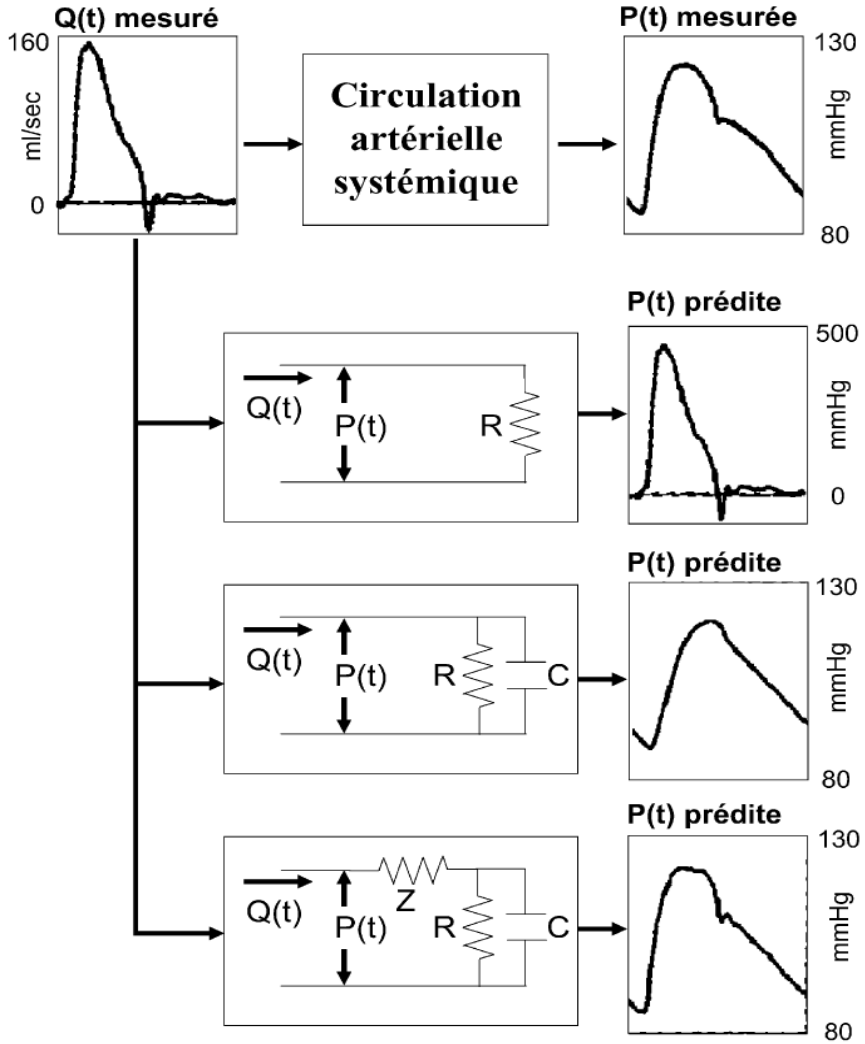
"Pulse contour" : comment ça marche?



résistance artérielle

+ compliance art

"Pulse contour" : comment ça marche?



résistance artérielle

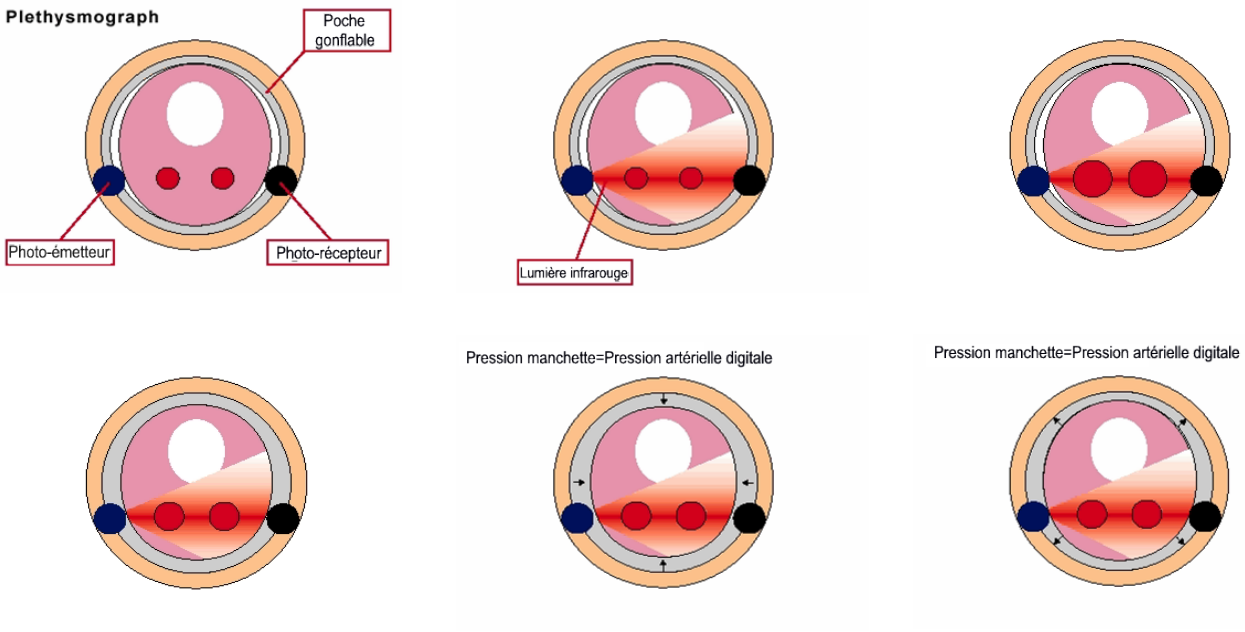
+ compliance art

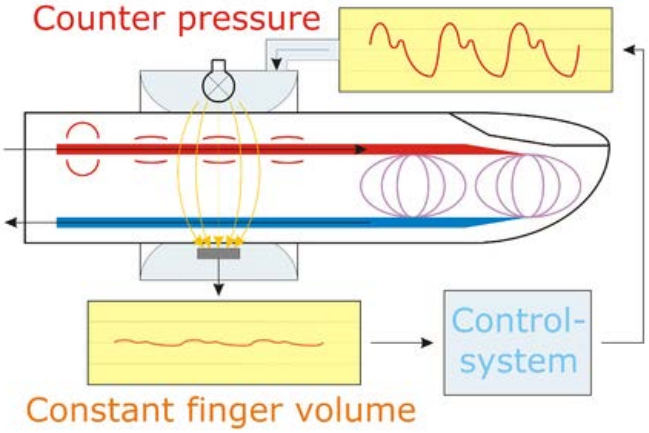
+ impédance caract

R. Chatti, B. Cholley*

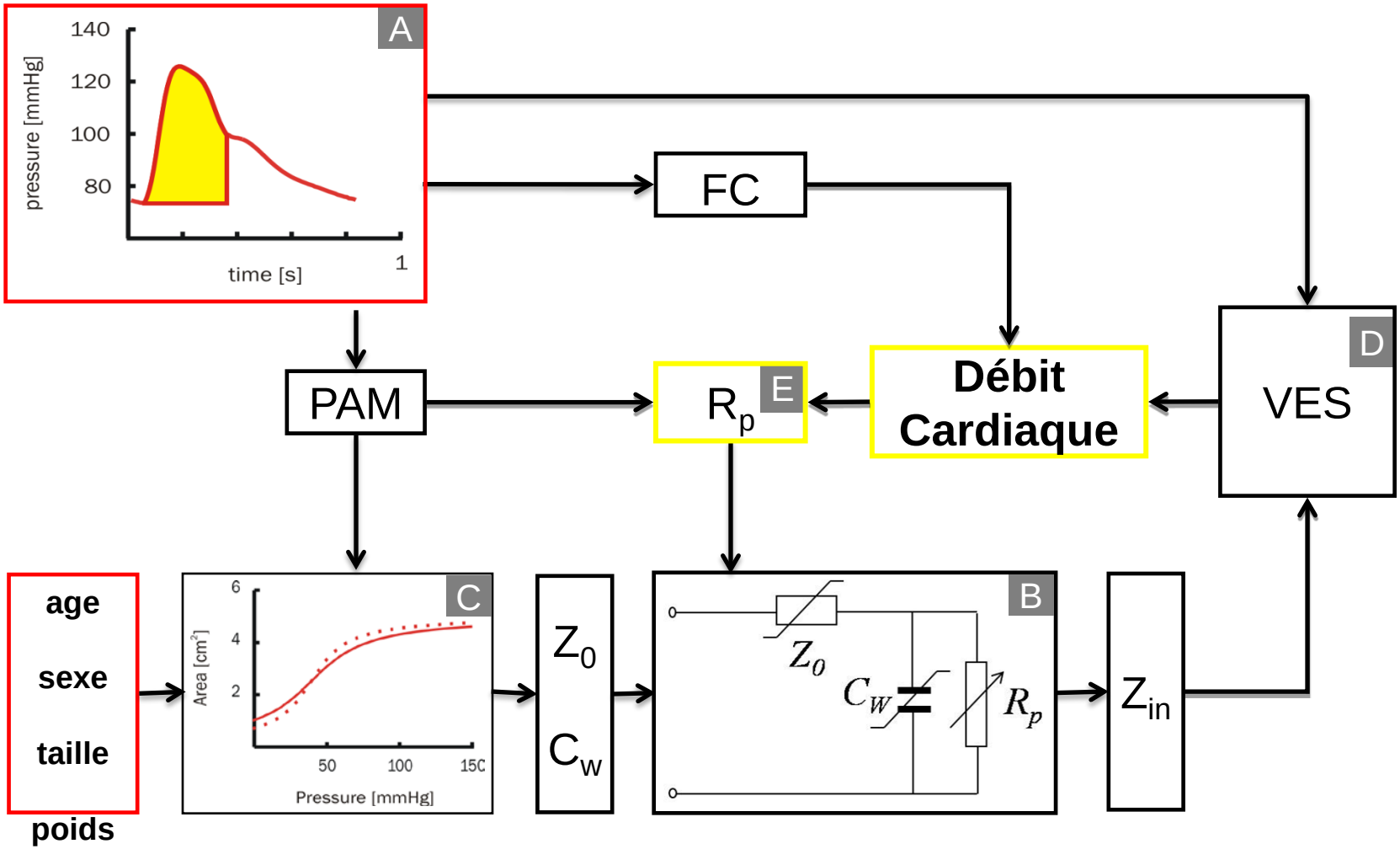
Réanimation 16 (2007) 156–162

Le Nexfin ®


Plethysmograph
Poche gonflable
Photo-émetteur
Photo-récepteur
Lumière infrarouge
Pression manchette=Pression artérielle digitale
Pression manchette=Pression artérielle digitale

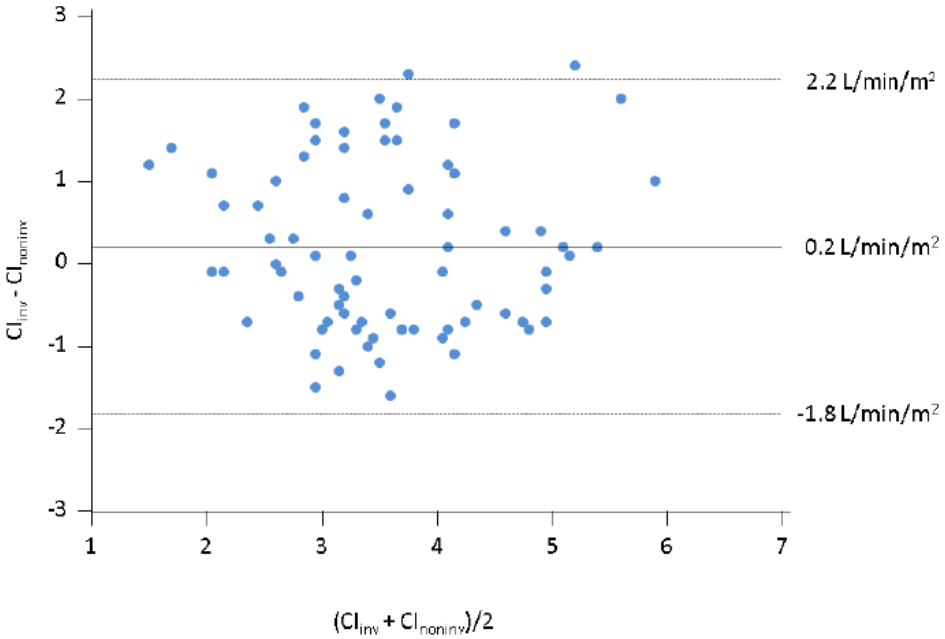

Counter pressure
Control-system
Constant finger volume

Le Nexfin ®


A
140
120
100
80
pressure [mmHg]
time [s]
1
FC
PAM
R_p
E
Débit Cardiaque
D
VES
age
sexe
taille
poids
C
6
4
2
Area [cm²]
50
100
150
Pressure [mmHg]
Z_0
C_w
B
Z_0
C_W
R_p
Z_{in}

The estimation of cardiac output by the Nexfin device is of poor reliability for tracking the effects of a fluid challenge

Xavier Monnet[1*], Fabien Picard[1], Elsa Lidzborski[1], Malcie Mesnil[2], Jacques Duranteau[2], Christian Richard[1] and Jean-Louis Teboul[1]



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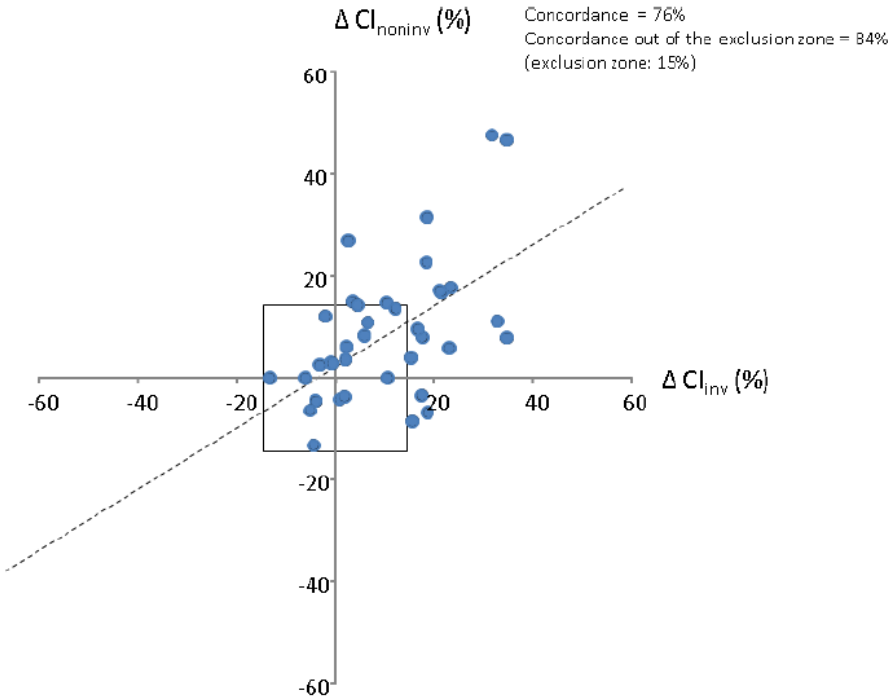


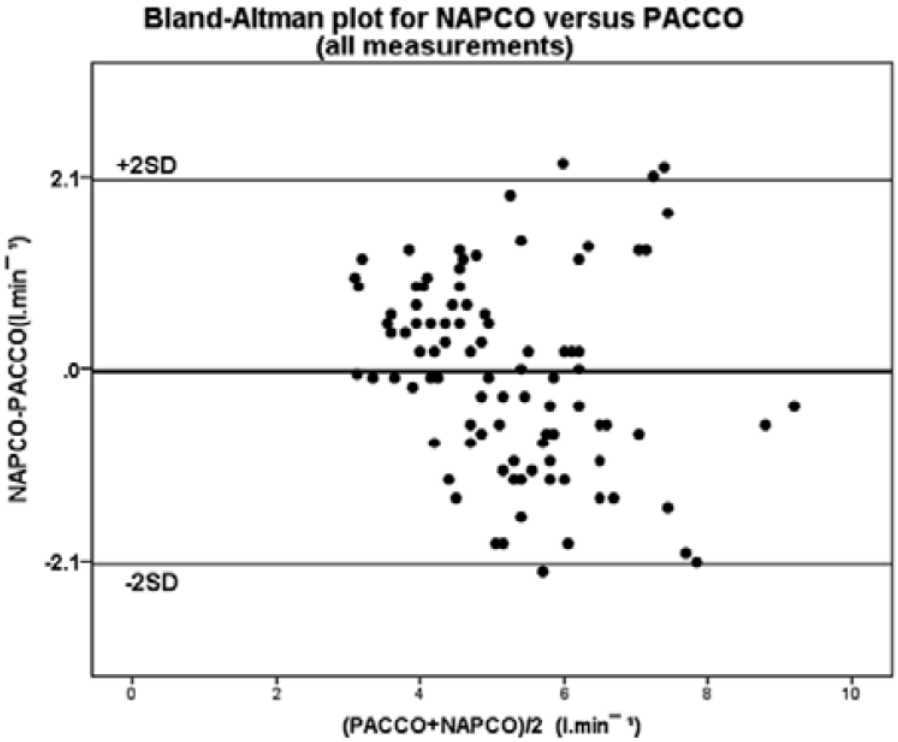
Remplissage vasculaire

Critical Care 2012, **16**:R212

Noninvasive Continuous Cardiac Output by the Nexfin Before and After Preload-Modifying Maneuvers: A Comparison with Intermittent Thermodilution Cardiac Output

Serban Ion Bubenek-Turconi, MD,*† Mihaela Craciun, PhD,† Ion Miclea, MD,† and Azriel Perel, MD‡

Chirurgie cardiaque
(VP ou ino+)



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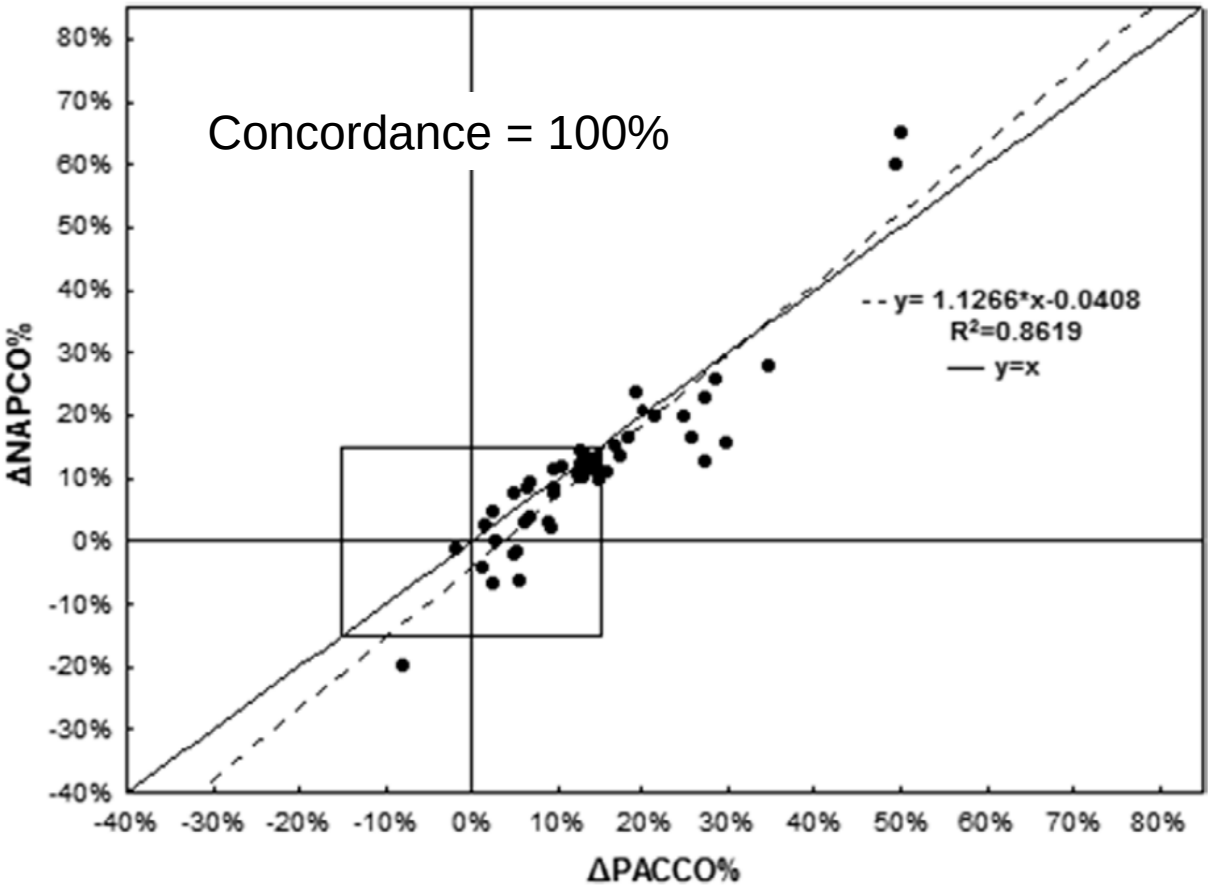
Anesth Analg 2013;117:366–72

Noninvasive Continuous Cardiac Output by the Nexfin Before and After Preload-Modifying Maneuvers: A Comparison with Intermittent Thermodilution Cardiac Output

Serban Ion Bubenek-Turconi, MD,*† Mihaela Craciun, PhD,† Ion Miclea, MD,† and Azriel Perel, MD‡

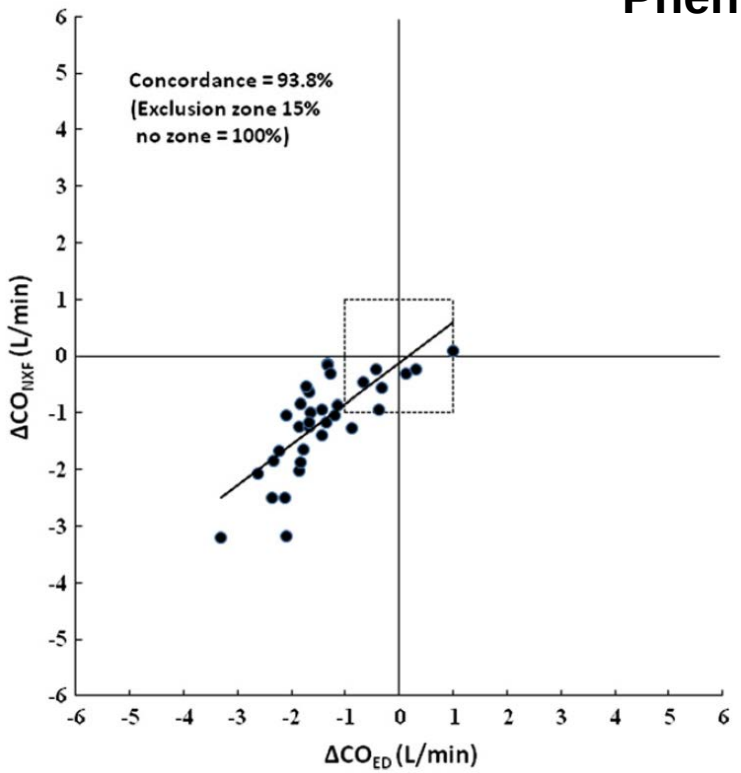


Anesth Analg 2013;117:366–72

Comparison of noninvasive cardiac output measurements using the Nexfin monitoring device and the esophageal Doppler☆

Guo Chen MD, PhD (Visiting Scholar, Attending)[a,b],
Lingzhong Meng MD (Assistant Clinical Professor)[a],
Brenton Alexander BS (Junior Specialist)[c], Nam Phuong Tran BS (Medical Student)
Zeev N. Kain MD, MBA (Professor and Chair)[a],
Maxime Cannesson MD, PhD (Associate Professor)[a,*]

Phenyléphrine



Journal of Clinical Anesthesia (2012) **24**, 275–283

« Pulse contour » non invasif

- dépendant d’assomptions encore prises en défaut
- mesure très « périphérique »
- valeur absolue (exactitude) : attention !
- variations au cours du temps et réponse au RV au bloc : plutôt oui

En pratique …

- capteur FLOTRAC : 180 €
- CardioQ-ODM, sonde UU : 150-200 €
- NICOM : électrodes : 70 €
- manchon digital Nexfin : 250 € (réutilisable 5 – 10 (30) pts)

Au total …

- Monitorage VES/DC utile : améliore le pronostic chez les patients à risque élevé
- La réponse au RV est l’élément le plus pertinent à évaluer en anesthésie
- Non invasif : des limites resteront (sans doute), mais les techniques progressent
- Connaître les principes et les limites des outils pour bien interpréter les données

Mortality after surgery in Europe: a 7 day cohort study

*Rupert M Pearse, Rui P Moreno, Peter Bauer, Paolo Pelosi, Philipp Metnitz, Claudia Spies, Benoit Vallet, Jean-Louis Vincent, Andreas Hoeft, Andrew Rhodes, for the European Surgical Outcomes Study (EuSOS) group for the Trials groups of the European Society of Intensive Care Medicine and the European Society of Anaesthesiology**

	All patients (n=46 539)	Died in hospital (n=1864)	Survived to hospital discharge (n=44 657)	Odds ratio (95% CI)	p value
ASA score					
1	11 642	362	11 280	Reference	..
2	21 582	633	20 944	0·94 (0·83–1·07)	0·36
3	11 574	539	11 025	1·51 (1·32–1·73)	<0·0001
4	1559	279	1277	6·75 (5·71–7·97)	<0·0001
5	90	49	41	35·61 (23·23–54·59)	<0·0001

Lancet 2012; 380: 1059–65

Mortality after surgery in Europe: a 7 day cohort study

*Rupert M Pearse, Rui P Moreno, Peter Bauer, Paolo Pelosi, Philipp Metnitz, Claudia Spies, Benoit Vallet, Jean-Louis Vincent, Andreas Hoeft, Andrew Rhodes, for the European Surgical Outcomes Study (EuSOS) group for the Trials groups of the European Society of Intensive Care Medicine and the European Society of Anaesthesiology**

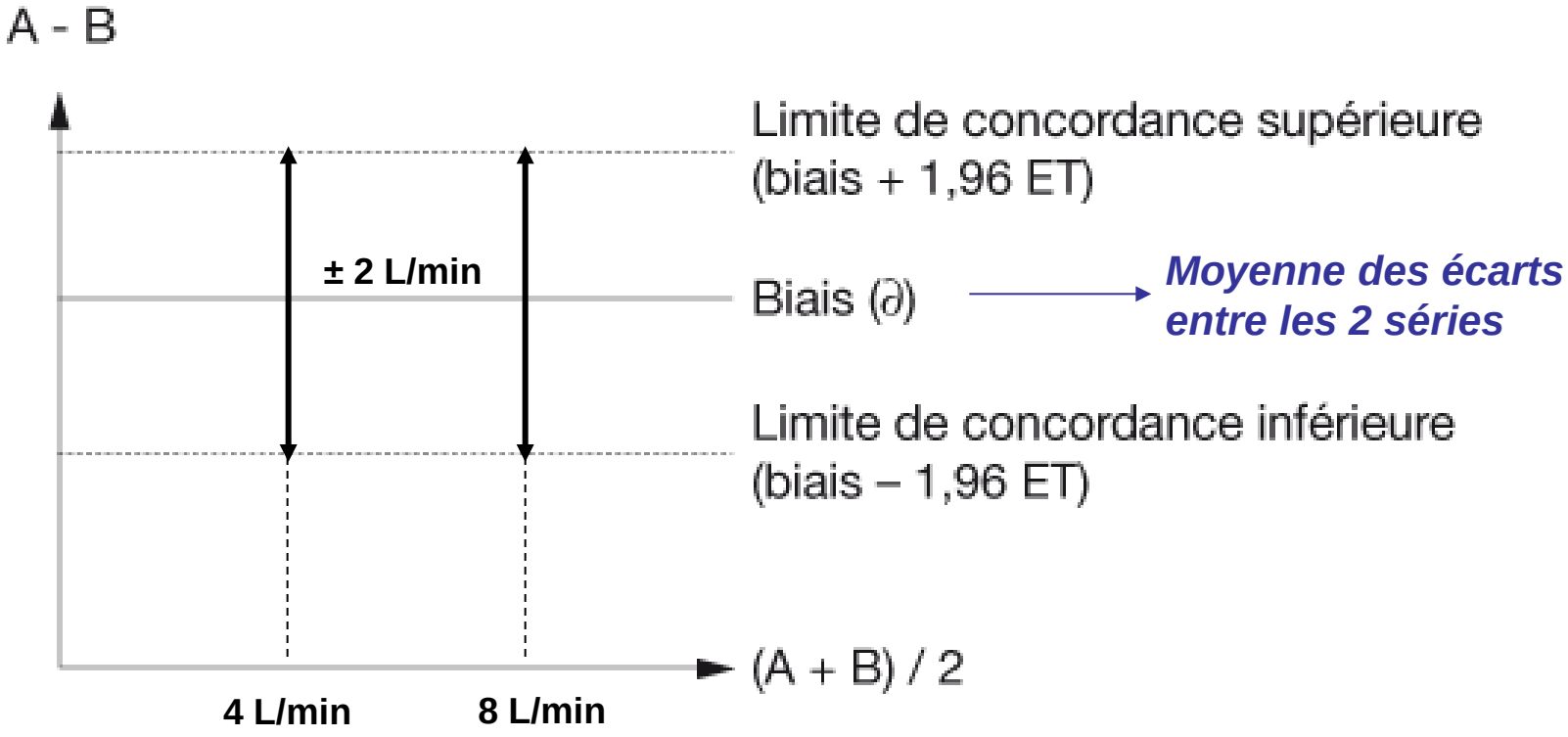
	All patients (n=46 539)	Died in hospital (n=1864)	Survived to hospital discharge (n=44 657)	Odds ratio (95% CI)	p value
Urgency of surgery					
Elective	35 049	1129	33 908	Reference	..
Urgent	8923	483	8436	1·71 (1·52–1·91)	<0·0001
Emergency	2557	249	2303	3·20 (2·77–3·70)	<0·0001

Lancet 2012; 380: 1059–65

	All patients (n=46 539)	Died in hospital (n=1864)	Survived to hospital discharge (n=44 657)	Odds ratio (95% CI)	p value
Orthopaedics	12 214	468	11 744	1·02 (0·84–1·24)	0·85
Breast	1500	43	1456	0·76 (0·53–1·07)	0·12
Gynaecology	3972	115	3857	0·76 (0·59–0·99)	0·04
Vascular	2376	140	2233	1·61 (1·26–2·05)	0·0001
Upper gastrointestinal	2228	155	2071	1·88 (1·48–2·39)	0·0001
Lower gastrointestinal	4972	284	4683	1·54 (1·25–1·91)	0·0001
Hepato-biliary	2247	113	2134	1·35 (1·04–1·74)	0·025
Plastic or cutaneous	2432	73	2356	0·79 (0·59–1·06)	0·12
Urology	4881	144	4737	0·78 (0·61–0·99)	0·042
Kidney	463	9	454	0·51 (0·26–1·01)	0·05
Head and neck	5640	174	5466	0·82 (0·65–1·03)	0·09
Other	3463	132	3329	Reference	
Laparoscopic surgery	5510	160	5350	0·69 (0·59–0·82)	<0·0001

Evaluation d'un moniteur de débit cardiaque

Méthode de concordance : Bland & Altman



A META-ANALYSIS OF STUDIES USING BIAS AND PRECISION STATISTICS TO COMPARE CARDIAC OUTPUT MEASUREMENT TECHNIQUES

Lester A. H. Critchley, MD, FFARCSI, FHKAM,[1] and Julian A. J. H. Critchley, MBChB, PhD, FRCP, FHKAM,[2]

J Clin Monit 1999; 15: 85–91

$$\% \text{ erreur} = \frac{\text{Limites d'agréments du biais}}{\text{Moyenne des mesures (de la méthode de référence)}}$$

Interchangeabilité si < 30%

A META-ANALYSIS OF STUDIES USING BIAS AND PRECISION STATISTICS TO COMPARE CARDIAC OUTPUT MEASUREMENT TECHNIQUES

Lester A. H. Critchley, MD, FFARCSI, FHKAM,[1] *and Julian A. J. H. Critchley, MBChB, PhD, FRCP, FHKAM,*[2]

J Clin Monit 1999; 15: 85–91

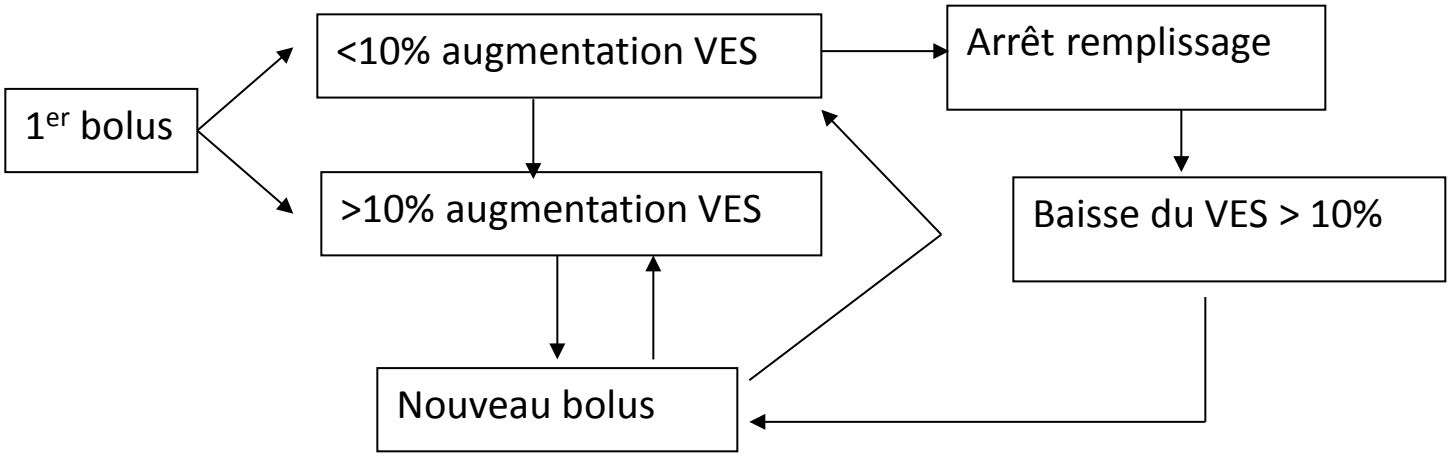
- The acceptance of a new method for the measurement of cardiac output should be judged against the ±10-20% accuracy of the current reference method (e.g. thermodilution).

- $\%\ \text{erreur}_{(a\text{-}b)} = \sqrt{[(precision_a)^2 + (precision_b)^2]}$.

- Consequently, we recommend that limits of agreement between the new and the reference technique of up to 30% be accepted.

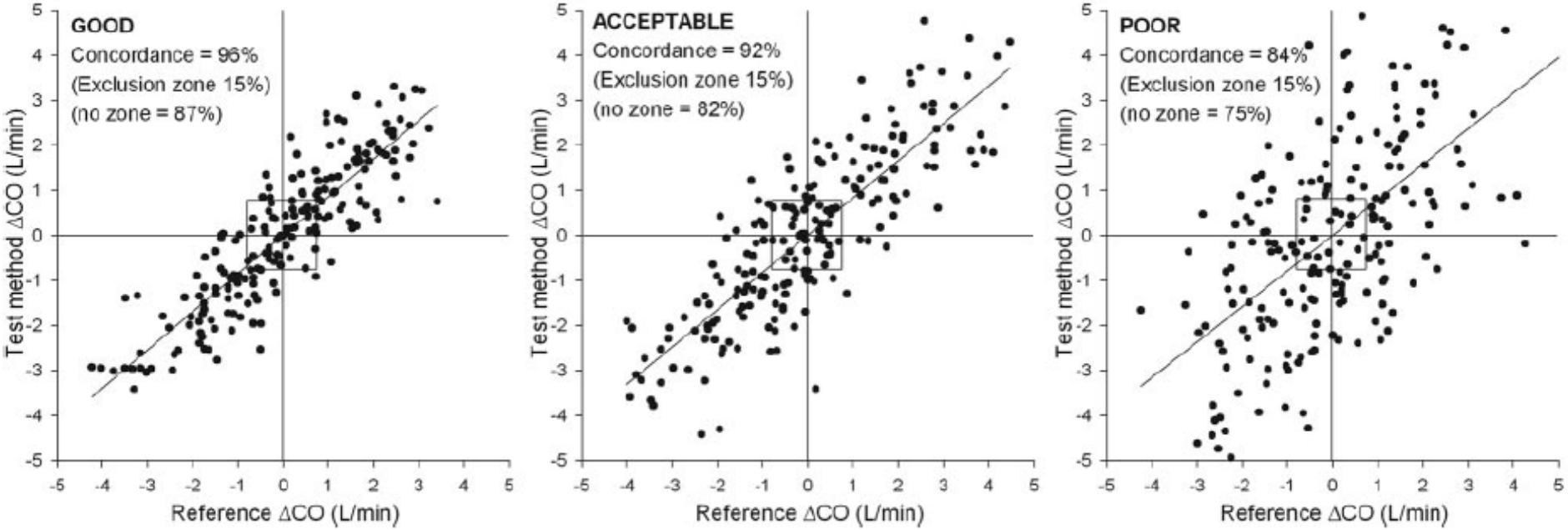
Patients à Haut Risque

- Il est **recommandé** de réévaluer régulièrement le VES et son augmentation (ou non) en réponse à une épreuve de remplissage vasculaire, en particulier lors des séquences d'instabilité hémodynamique afin de s'assurer de la pertinence de cette thérapeutique *(GRADE 1+).*



A Critical Review of the Ability of Continuous Cardiac Output Monitors to Measure Trends in Cardiac Output

Lester A. Critchley, MD, FFARCSI, FHKAM, Anna Lee, PhD, MPH, and Anthony M.-H. Ho, MD, FCCP, FHKAM



Anesth Analg 2010;111:1180–92

BJA

''I would have everie man write what he knowes and no more.''—Montaigne

BRITISH JOURNAL OF ANAESTHESIA

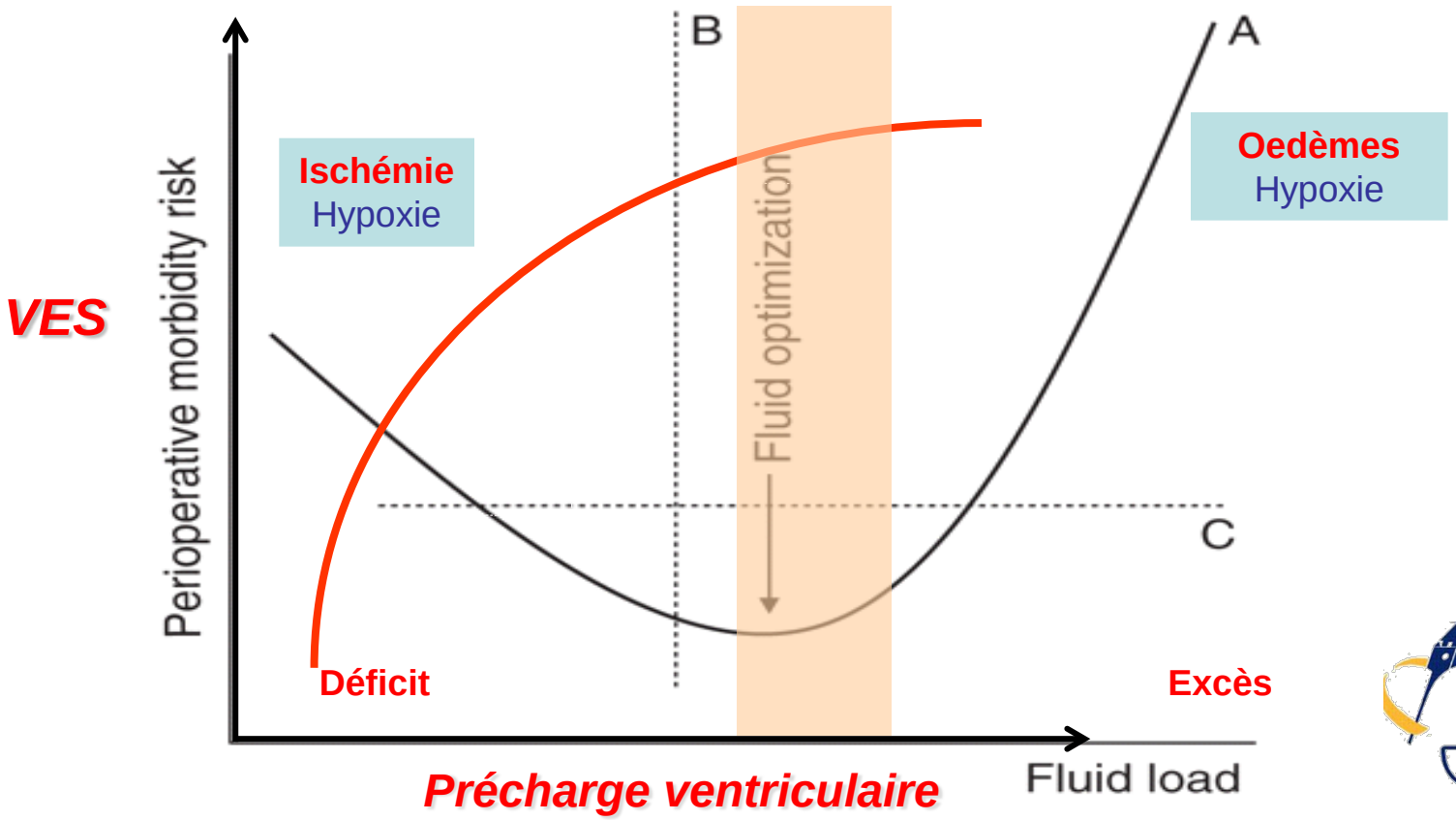
Volume 97, Number 6, December 2006

British Journal of Anaesthesia 97 (6): 755–7 (2006)
doi:10.1093/bja/ael290

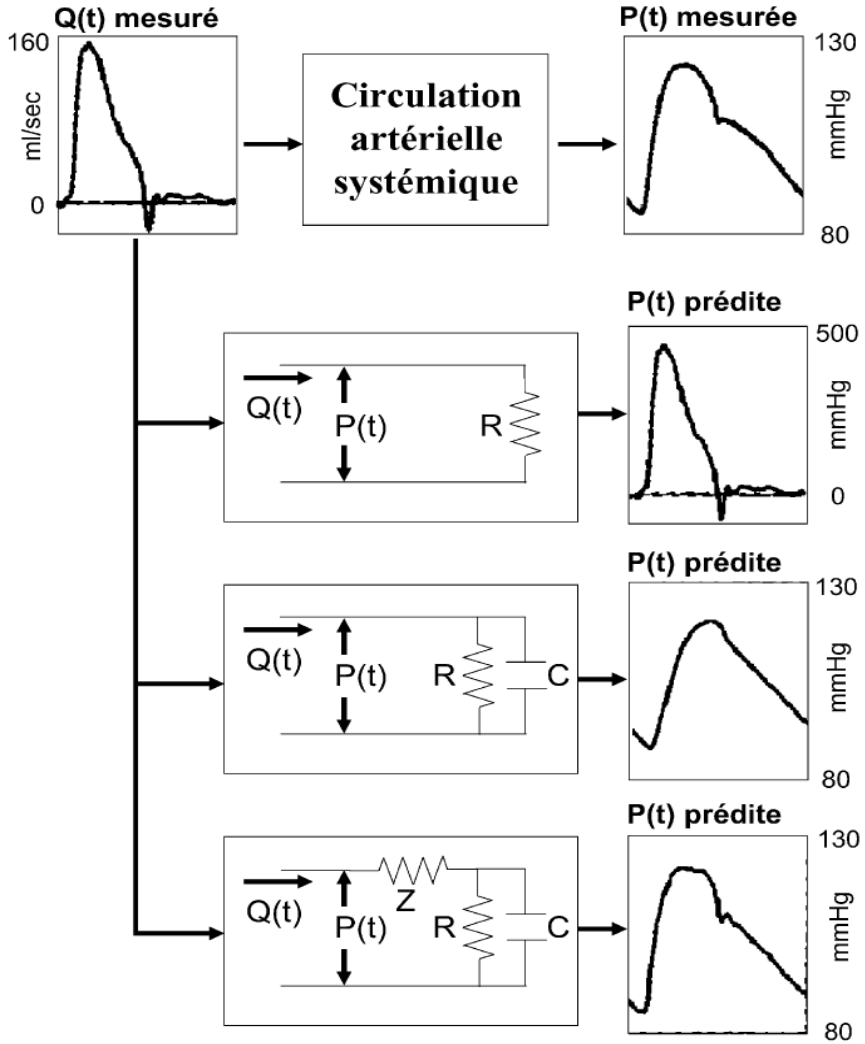
Editorial

Wet, dry or something else?

Bellamy MC



Principes du « pulse contour »



résistance artérielle

+ compliance art

+ impédance caract

R. Chatti, B. Cholley*

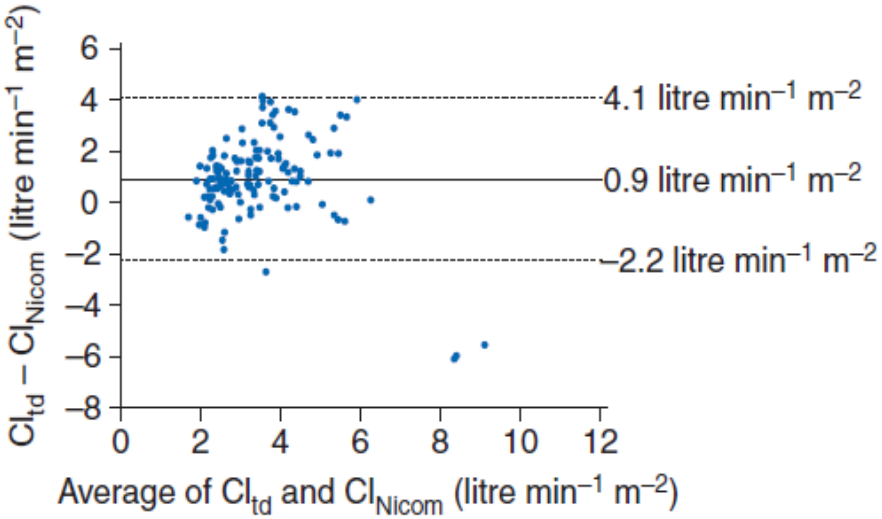
Réanimation 16 (2007) 156-162

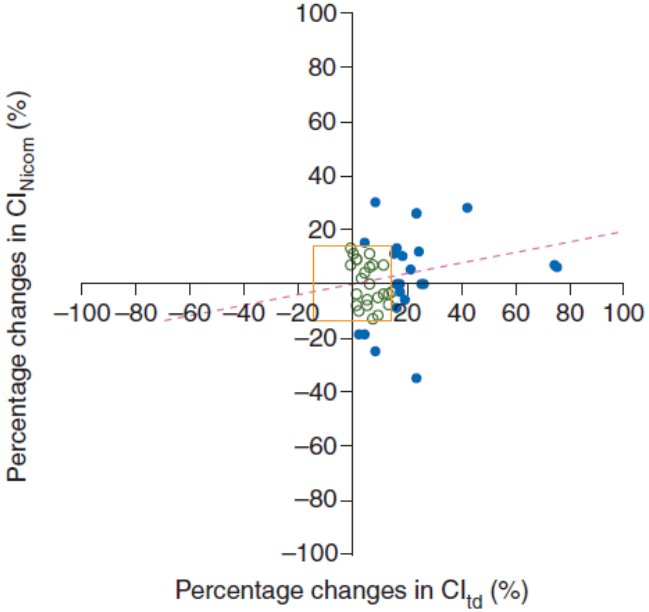
British Journal of Anaesthesia **111** (6): 961–6 (2013)
Advance Access publication 28 August 2013 · doi:10.1093/bja/aet282

BJA

Bioreactance is not reliable for estimating cardiac output and the effects of passive leg raising in critically ill patients

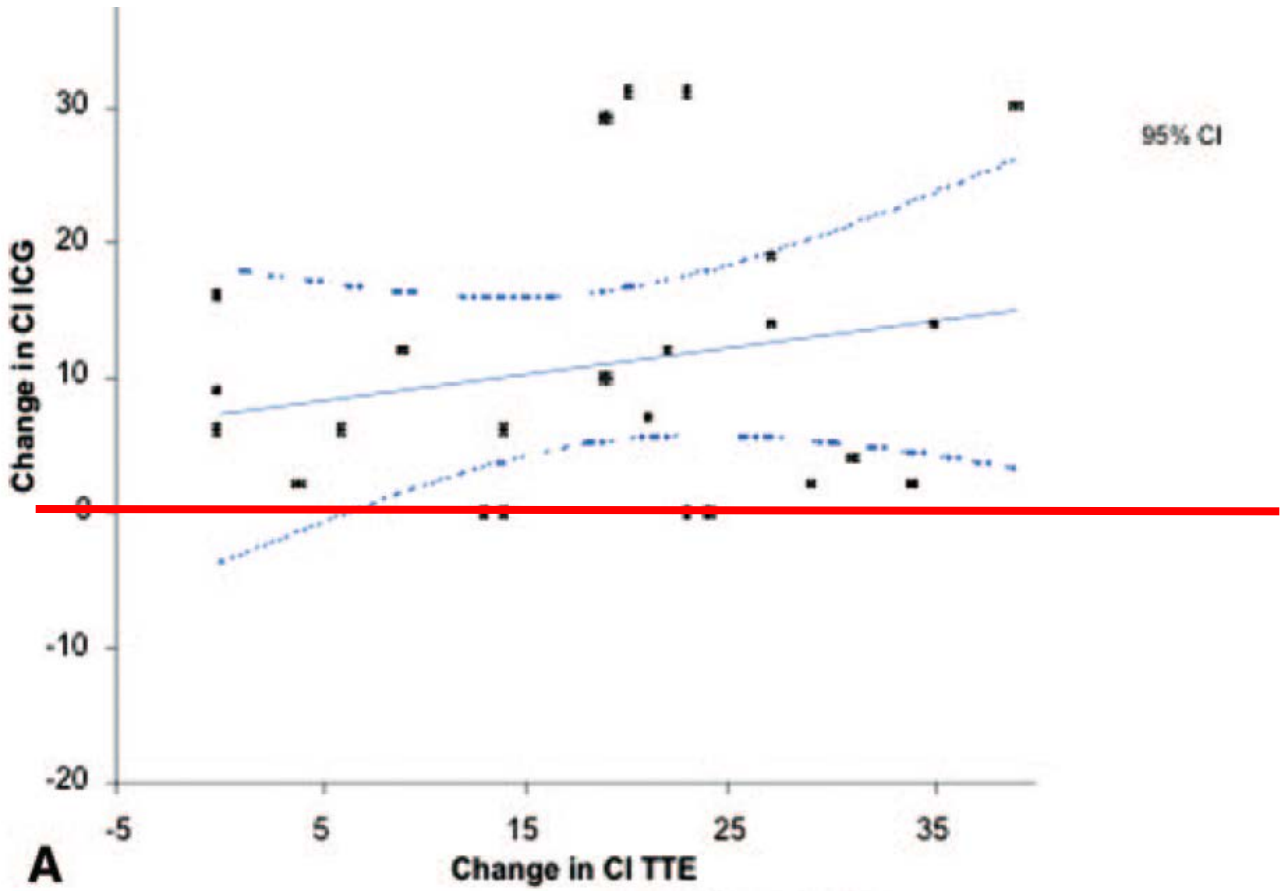
E. Kupersztych-Hagege[1,2], J.-L. Teboul[1,2], A. Artigas[3], A. Talbot[1,2], C. Sabatier[3], C. Richard[1,2] and X. Monnet[1,2*]





Noninvasive Assessment of Cardiac Index in Healthy Volunteers: A Comparison Between Thoracic Impedance Cardiography and Doppler Echocardiography

Jean-Luc Fellahi, MD, PhD* Vincent Caille, MD† Cyril Charron, MD†
Pierre-Hervé Deschamps-Berger MD‡ Antoine Vieillard-Baron, MD, PhD†



Anesth Analg 2009;108:1553–9

Impédancemétrie : limites

- Problème de l’impédance de base
- Mouvements du patient
- Bistouri électrique
- VC vs VS
- Très peu d’études récentes dans un contexte pertinent
- Exactitude n’est pas au RdV