MONITORAGE DE LA VOLÉMIE

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Réanimation respiratoire Ariana
Collège de réanimation – Juin 2013

INTRODUCTION

- Volémie = déterminent majeur du retour veineux Influençant

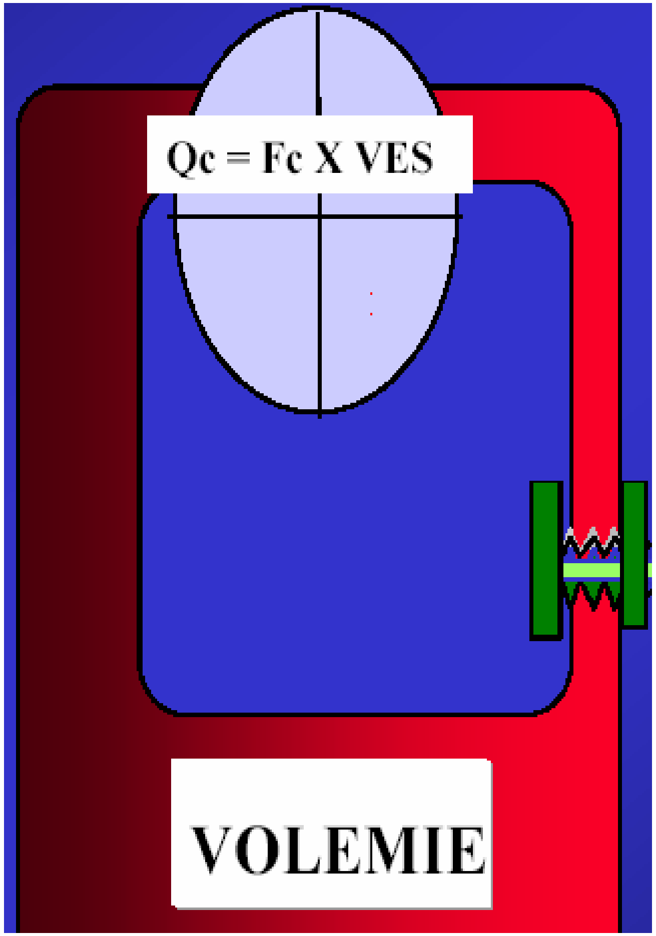
Précharge ventriculaire | **Débit cardiaque** | **Oxygénation tissulaire**

- Volémie= volume sanguin total de l'organisme

- La valeur normale de la volémie se situe ≈ 70 ml/kg soit 7% du poids du corps

INTRODUCTION

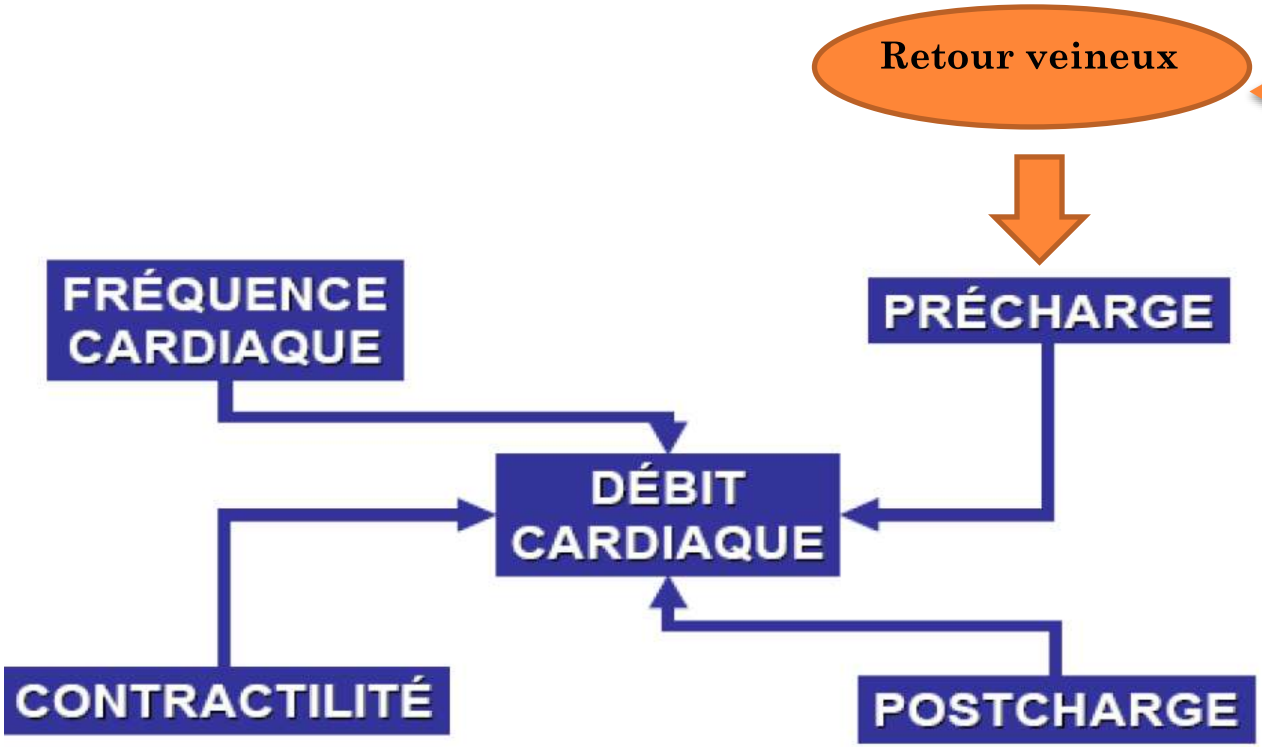
Le système veineux capacitif à basse pression 60 - 70 %



Système artériel résistif à haute Pres° < 15 %

Les déterminants du débit cardiaque

- **La volémie**
- **Le tonus du secteur capacitif**
- La distribution du volume sanguin dans le système veineux
- La position du corps
- La pression intra-thoracique, de la pression intra-péricardique
- La contribution auriculaire



La précharge ventriculaire

- La précharge ventriculaire correspond à la tension pariétale en fin de diastole
- **« Loi de Franck Starling »** l'énergie de contraction du myocarde est fonction de la longueur de la fibre musculaire avant contraction

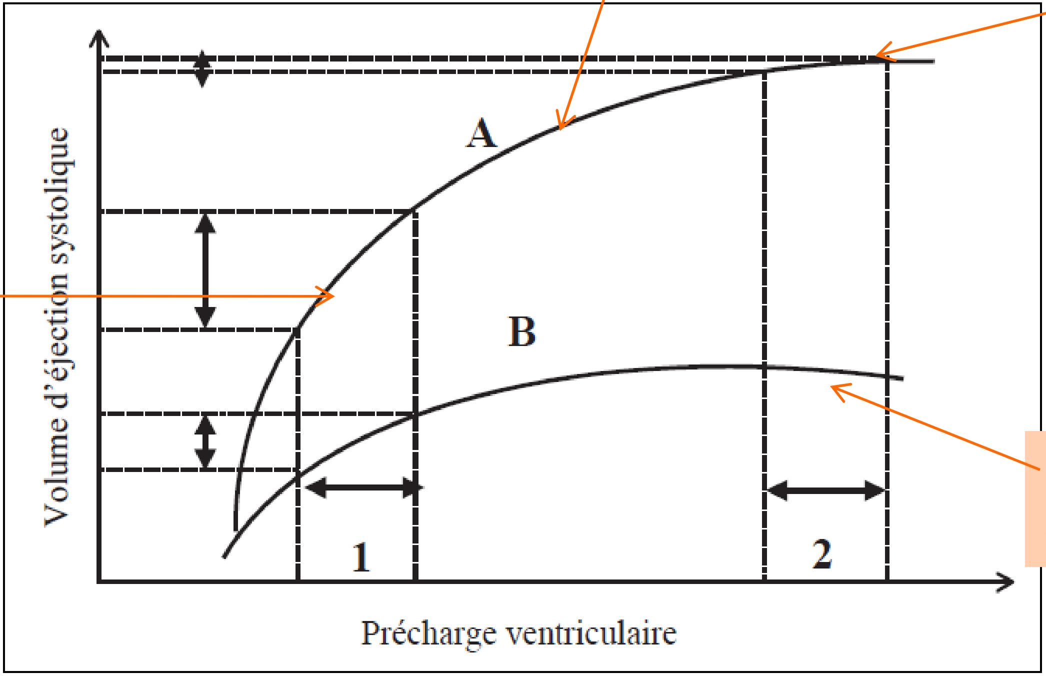
Capacité de distension de la fibre myocardique avant contraction

Courbe de précharge dépendance

Courbe A: VG de compliance nle

Zone de précharge indépendance

Zone de précharge dépendance



Courbe B: VG non compliant

En pratique clinique :

LE MONITORAGE DE LA VOLÉMIE

=

MONITORAGE DE LA PRECHARGE

OU

DE LA PRECHARGE DÉPENDANCE!!!

Pourquoi monitorer la volémie?

- le remplissage vasculaire est le traitement de première ligne de l'insuffisance circulatoire aigue dans le but d' augmenter le débit cardiaque
- Toutefois,

  - les patients ont souvent déjà reçus du remplissage depuis des heures ou jours ➡ **Précharge dépendance ?**

  - risque de surcharge pulmonaire chez certains

  - une balance hydrique cumulée positive : facteur indépendant de mortalité au cours du choc septique, de prolongation de la durée d'hospitalisation et de VM au cours du SDRA

Sepsis in European intensive care units: Results of the SOAP study*

Jean-Louis Vincent, MD, PhD, FCCM; Yasser Sakr, MB, BCh, MSc; Charles L. Sprung, MD; V. Marco Ranieri, MD; Konrad Reinhart, MD, PhD; Herwig Gerlach, MD, PhD; Rui Moreno, MD, PhD; Jean Carlet, MD, PhD; Jean-Roger Le Gall, MD; Didier Payen, MD; on behalf of the Sepsis Occurrence in Acutely Ill Patients Investigators

Crit Care Med 2006; 34:344–353

Table 7. Multivariate, forward stepwise logistic regression analysis in sepsis patients (n = 1177), with intensive care unit mortality as the dependent factor

	OR (95% CI)	*p* Value
SAPS II score[a] (per point increase)	1.0 (1.0–1.1)	<.001
Cumulative fluid balance[b] (per liter increase)	1.1 (1.0–1.1)	.001
Age (per year increase)	1.0 (1.0–1.0)	.001
Initial SOFA score (per point increase)	1.1 (1.0–1.1)	.002
Blood stream infection	1.7 (1.2–2.4)	.004
Cirrhosis	2.4 (1.3–4.5)	.008
Pseudomonas infection	1.6 (1.1–2.4)	.017
Medical admission	1.4 (1.0–1.8)	.049
Female gender	1.4 (1.0–1.8)	.044

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Comparison of Two Fluid-Management Strategies in Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*

N Engl J Med 2006;354:2564-75.

Table 3. Main Outcome Variables.*

Outcome	Conservative Strategy	Liberal Strategy	P Value
Death at 60 days (%)	25.5	28.4	0.30
Ventilator-free days from day 1 to day 28†	14.6±0.5	12.1±0.5	<0.001
ICU-free days†			
Days 1 to 7	0.9±0.1	0.6±0.1	<0.001
Days 1 to 28	13.4±0.4	11.2±0.4	<0.001
Organ-failure–free days†‡			
Days 1 to 7			
Cardiovascular failure	3.9±0.1	4.2±0.1	0.04
CNS failure	3.4±0.2	2.9±0.2	0.02
Renal failure	5.5±0.1	5.6±0.1	0.45
Hepatic failure	5.7±0.1	5.5±0.1	0.12
Coagulation abnormalities	5.6±0.1	5.4±0.1	0.23
Days 1 to 28			
Cardiovascular failure	19.0±0.5	19.1±0.4	0.85
CNS failure	18.8±0.5	17.2±0.5	0.03
Renal failure	21.5±0.5	21.2±0.5	0.59
Hepatic failure	22.0±0.4	21.2±0.5	0.18
Coagulation abnormalities	22.0±0.4	21.5±0.4	0.37
Dialysis to day 60			
Patients (%)	10	14	0.06
Days	11.0±1.7	10.9±1.4	0.96

COMMENT MONITORER LA VOLÉMIE?

- Moyens direct: dilution d'un indicateur qui reste dans le secteur vasculaire et suivre la courbe de décroissance de la concentration sanguine

- Mais: éliminations lentes, prélèvements sanguins répétés

Moyens indirectes statiques et dynamiques pour évaluer la précharge dépendance

Définition de le précharge dépendance

Annales Françaises d'Anesthésie et de Réanimation 24 (2005) 568–576

RECOMMANDATIONS

Recommandations d'experts de la SRLF
« Indicateurs du remplissage vasculaire au cours de l'insuffisance circulatoire »

J.-L. Teboul, et le groupe d'experts de la SRLF
Service de réanimation médicale, CHU Bicêtre, 78, rue du Général-Leclerc, 94275 Le Kremlin-Bicêtre cedex, France

Augmentation du volume d'éjection systolique

et/ou du débit cardiaque *> 10 - 15 %*

Comment estimer la précharge dépendance?

- Par les pressions de remplissage : PVC, PAPO?
- Par les dimensions : VTDVDi; VTDVGi; STDVGi,VCI
- Par les volumes: VTDVG
- Par les biomarqueurs : BNP

Recommandations d'experts de la SRLF

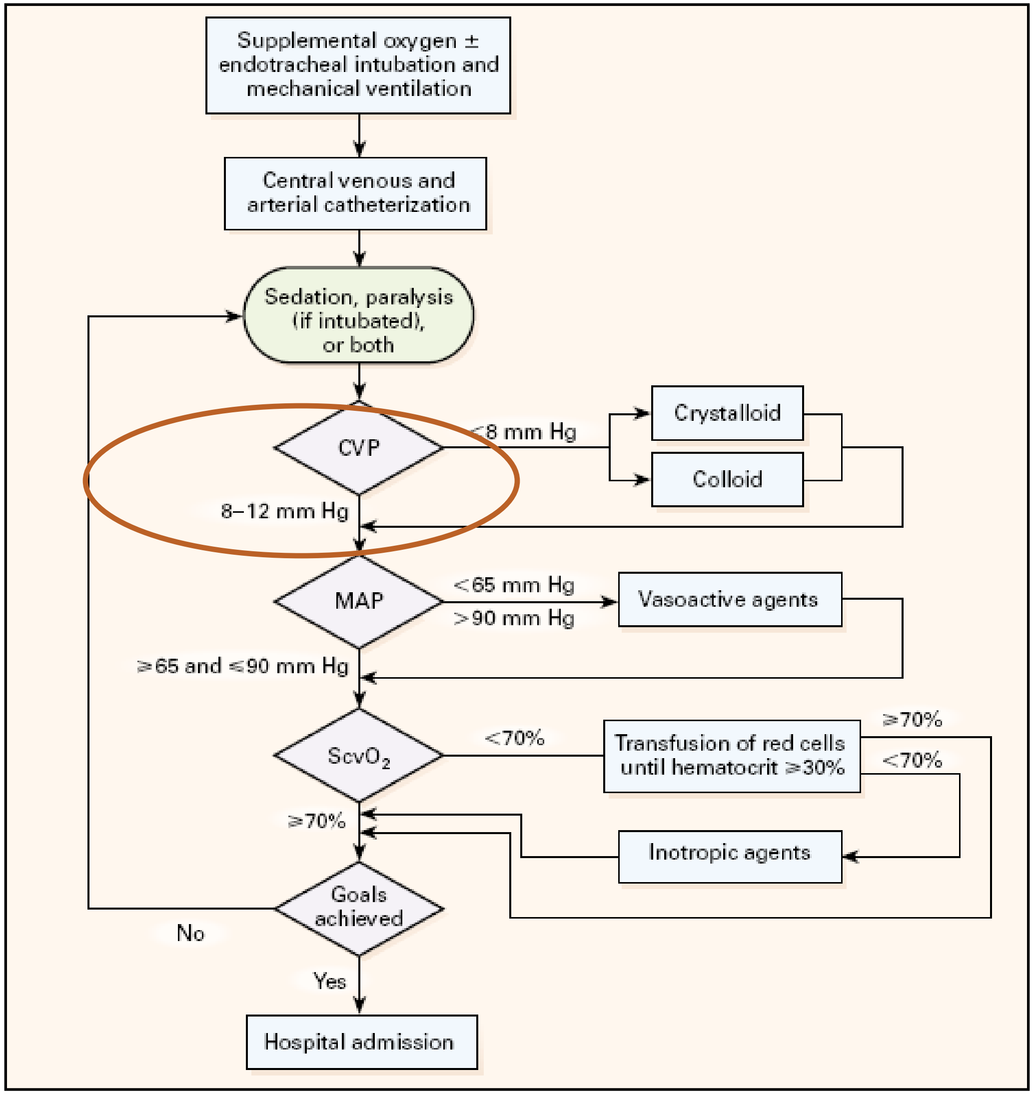
« Indicateurs du remplissage vasculaire au cours de l'insuffisance circulatoire »

une valeur de PVC ou de pression auriculaire droite (POD) inférieure à 5 mmHg et/ou de PAPO inférieure à 5 mmHg laissent augurer d'une réponse positive au remplissage vasculaire (***accord fort***).

pas de consensus pour définir une valeur supérieure de PVC et PAPO au-dessus desquelles, l'inefficacité du RV est hautement prévisible

Réanimation 13 (2004) 255–263

EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK



Rivers et al. NEJM 2001

(CHEST 2008; 134:172–178)

CHEST Special Feature

Does Central Venous Pressure Predict Fluid Responsiveness?*

A Systematic Review of the Literature and the Tale of Seven Mares

Paul E. Marik, MD, FCCP; Michael Baram, MD, FCCP; and Bobbak Vahid, MD

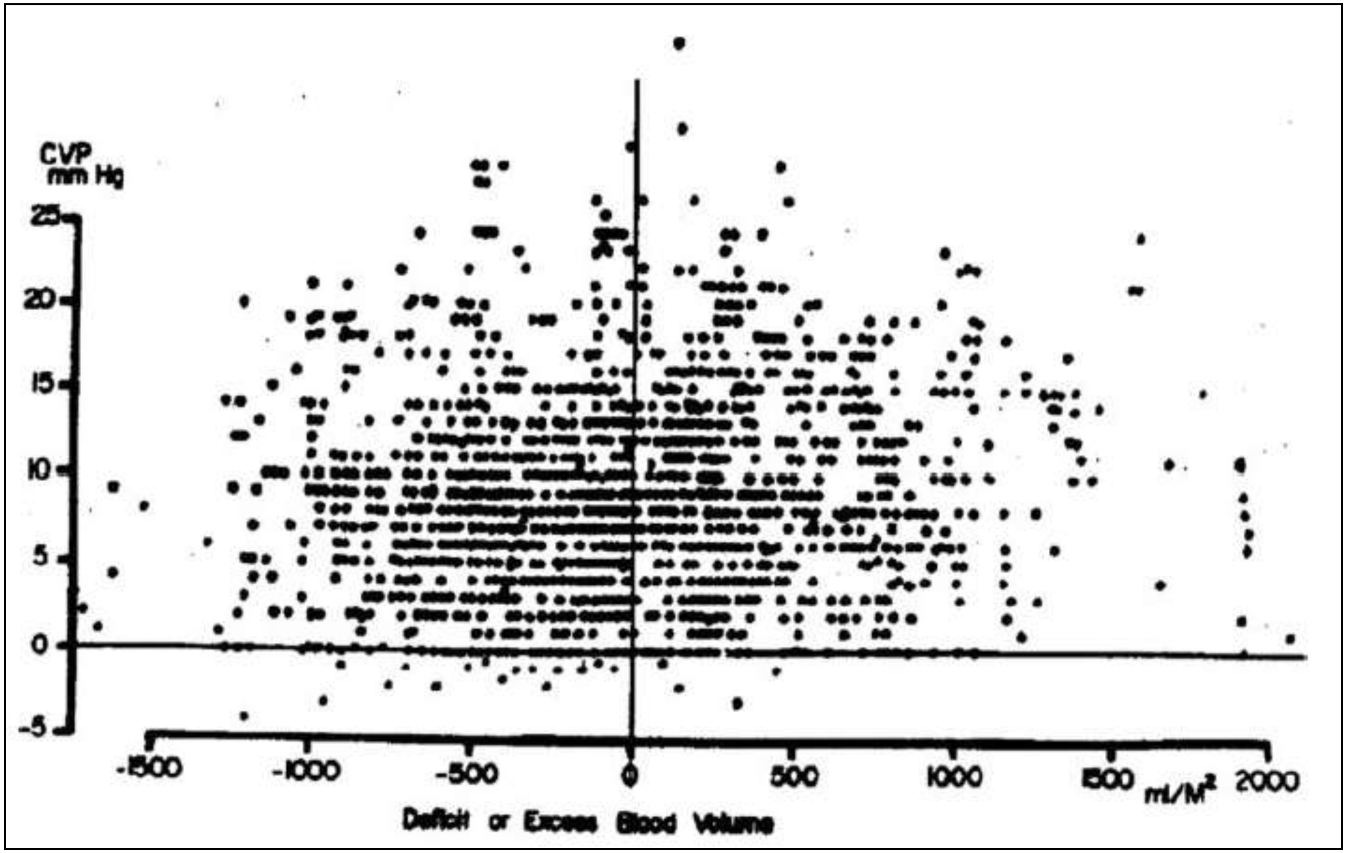


Table 2—*Summary of Studies of Volume Challenge**

Source	Setting	Type	Patients, No.	Methodology	AUC†	r, CVP/SI	r, ΔCVP/SI	CVP-R	CVP-NR
Calvin et al,[15] 1981	ICU	Mixed ICU	28	PAC/Scint		0.16	0.26	4.7	4.8
Reuse et al,[16] 1990	ICU	ICU	41	PAC		0.21		8.5	8.4
Godje et al,[17] 1998	ICU	CABC	30	PAC, COLD system‡			0.09		
Wagner and Leatherman,[18] 1998	ICU	ICU	25	PAC		0.44		7.4	10.1
Wiesenack et al,[19] 2001	OR	CABC	18	PAC, TPT			0.09		
Berkenstad et al,[20] 2001	OR	Neurosurgery	15	TPT	0.49	0.05	0.08	9.3	9.3
Michard et al,[21] 2000	ICU	ICU	40	PAC	0.51				
Reuter et al,[22] 2002	ICU	CABC	20	TPT	0.42				
Reuter et al,[23] 2003	ICU	CABC	26	PAC, TEE	0.71				
Barbier et al,[24] 2004	ICU	Sepsis	20	TEE	0.57			10	9
Kramer et al,[25] 2004	ICU	CABC	21	PAC	0.49	0.13		13.5	13.3
Marx et al,[26] 2004	ICU	Sepsis	10	PAC, TPT		0.41	0.28		
Preisman et al,[27] 2005	OR	CABC	18	TPT, TEE	0.61			8.7	10
Perel et al,[28] 2005	ICU	Vascular surgery	14	TEE		0.27		9.6	12.2
Hofer et al,[29] 2005	OR	CABC	40	PAC, TEE	0.54	0.02	0.2		
De Backer et al,[30] 2005	ICU	ICU	60	PAC	0.54			10	12
Kumar et al,[31] 2004	ICU	Healthy volunteers	12	PAC/Scint		0.32	0.22		
Osman et al,[32] 2007	ICU	Septic	96	PAC	0.58			8	9
Magder and Bafaqeeh,[33] 2007	ICU	CABC	66	PAC		0.36		5.9	8.7
Pooled					0.56	0.18	0.11	8.7	9.7

Conclusions: **This systematic review demonstrated a very poor relationship between CVP and blood volume as well as the inability of CVP/ΔCVP to predict the hemodynamic response to a fluid challenge. CVP should not be used to make clinical decisions regarding fluid management.**

Cardiac filling pressures are not appropriate to predict hemodynamic response to volume challenge*

David Osman, MD; Christophe Ridel, MD; Patrick Ray, MD; Xavier Monne ... uel, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

Analyse des expansions volémiques consécutives ... patients sous VM, en sepsis sévère/choc septique monitoré ... el pulmonaire

Neither baseline PAOP nor baseline CVP

Predicted volume responsiveness

Figure 2. I... *ed circles)* of pre-infusion central venous pressure (C... y) in responders (*R*) and nonresponders (*NR*).

PVC ... g prédit une réponse à l'expansi... olémique avec **Se = 62 %; Sp = 54 %; VPP = 51 % ; VPN = 65 %**

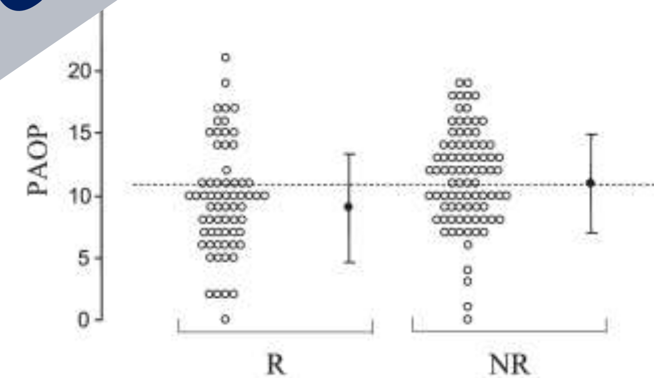
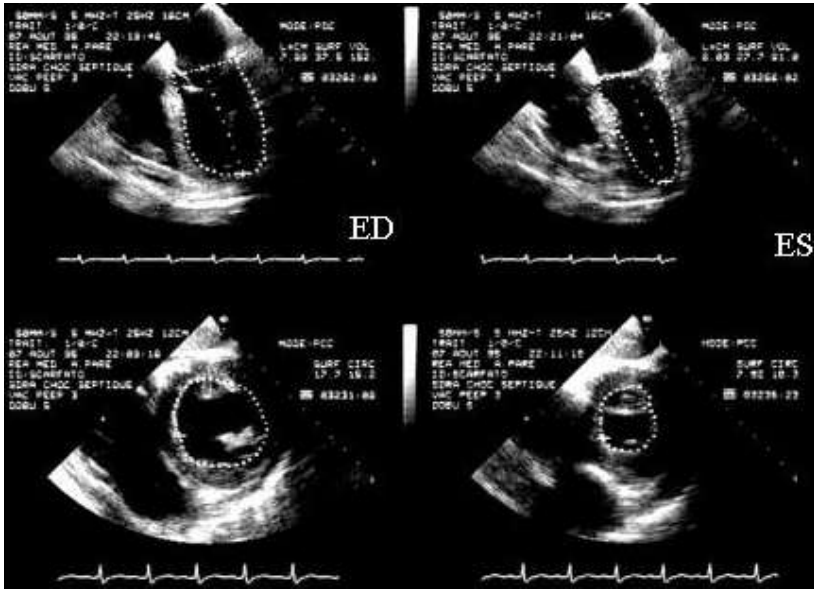
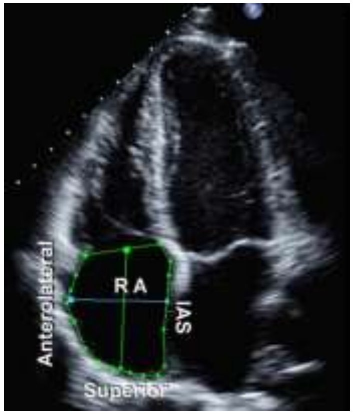


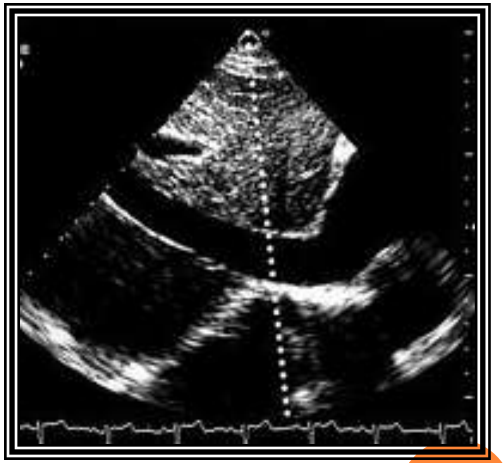
Figure 3. Individual values (*open circles*) and mean ± SD (*closed circles*) of pre-infusion pulmonary artery occlusion pressure (*PAOP*) (both expressed in millimeters of mercury) in responders (*R*) and nonresponders (*NR*).

PAPO < 12 mmHg prédit une réponse à l'expansion volémique avec **Se = 77 % ; Sp = 51 % ; VPP = 54 % ; VPN = 74 %**

- Comment estimer la précharge ?
  - Par les pressions de remplissage : PVC, PAPO ? ***NON***
  - Par les dimensions : VTDVDi; VTDVGi; STDVGi, VCI ?







Recommandations d'experts de la SRLF

« Indicateurs du remplissage vasculaire au cours de l'insuffisance circulatoire »

revanche, une valeur de STDVG inférieure à 5 cm^2/m^2 est très spécifique (***accord fort***) ;

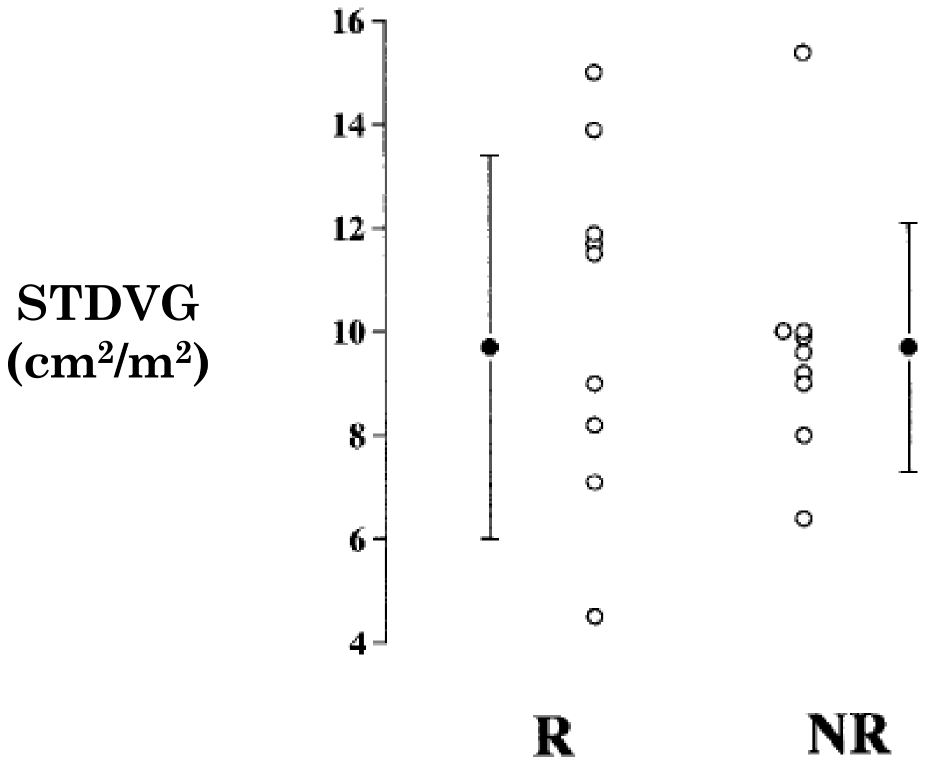
lorsque la mesure du diamètre de la VCI est très basse (< 12 mm ou 8 mm/m^2) le bénéfice d'un remplissage est probable (***accord fort***) ;

Réanimation 13 (2004) 255–263

Respiratory Changes in Aortic Blood Velocity as an Indicator of Fluid Responsiveness in Ventilated Patients With Septic Shock*

Marc Feissel, MD; Frédéric Michard, MD; Isabelle Mangin, MD; Olivier Ruyer, MD; Jean-Pierre Faller, MD; and Jean-Louis Teboul, MD, PhD

(CHEST 2001; 119:867–873)



- Comment estimer la précharge ?
  - Par les pressions de remplissage : PVC, PAPO ? ***NON***
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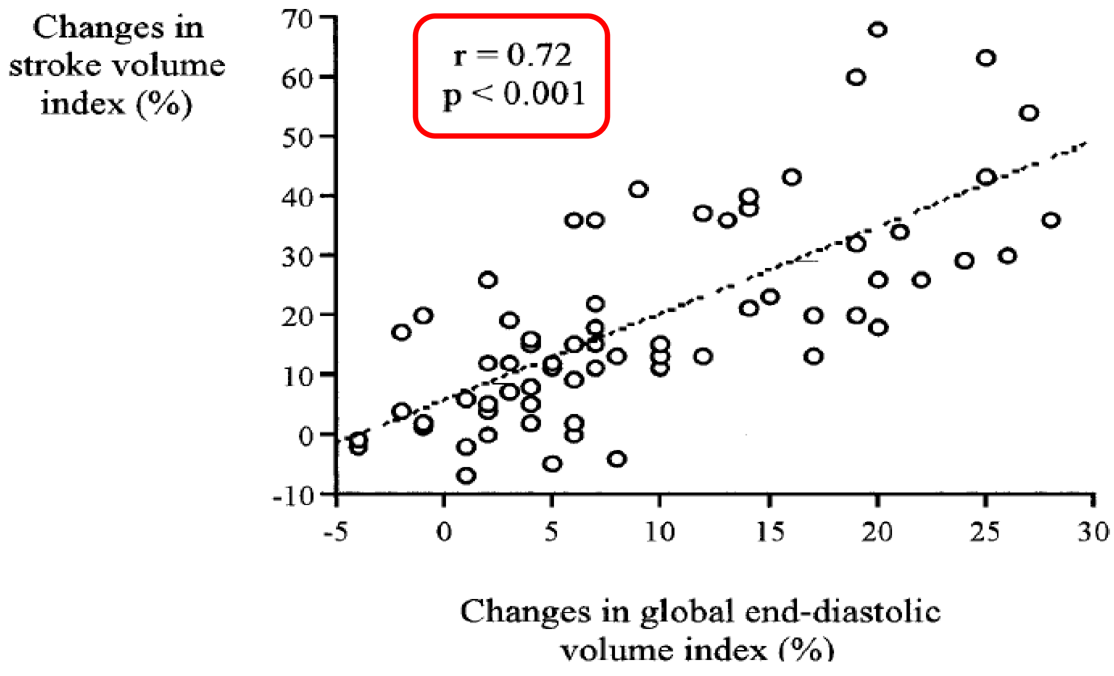
  - *Par les volumes: VTDVG?*
  - Par les biomarqueurs : BNP ?

Global End-Diastolic Volume as an Indicator of Cardiac Preload in Patients With Septic Shock*

Frédéric Michard, MD, PhD; Sami Alaya, MD; Véronique Zarka, MD; Mabrouk Bahloul, MD; Christian Richard, MD; and Jean-Louis Teboul, MD, PhD

(CHEST 2003; 124:1900–1908)

-36 patients, étude prospective
-évaluer l'intérêt du VTDVG (PICCO) comme indicateur de précharge



Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: A systematic review of the literature*

Paul E. Marik, MD, FCCM; Rodrigo Cavallazzi, MD; Tajender Vasu, MD; Amyn Hirani, MD

Crit Care Med 2009 Vol. 37, No. 9

Table 2 Predictive value of techniques used to determine fluid responsiveness [15]

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)

- Comment estimer la précharge ?
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  - *Par les volumes: VTDVG?* ***NON***
  - Par les biomarqueurs : BNP ?

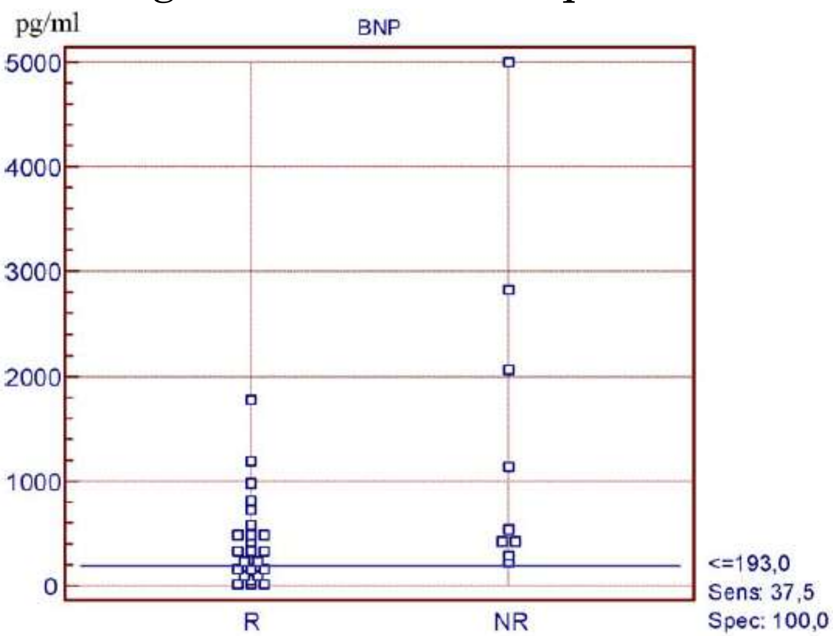
Could B-type Natriuretic Peptide (BNP) plasma concentration be useful to predict fluid in critically ill patients with acute circulatory failure?

annales françaises d'ANESTHÉSIE et de RÉANIMATION

L. Muller [a], G. Louart [a], J.-L. Teboul [b], A. Mahamat [c], A. Polge [d], J.-P. Bertinchant [e], J. Ripart [a], J.-E. de La Coussaye [a], J.-Y. Lefrant [a,*]

Principe : Le BNP est sécrété par les cellules myocardiques en réponse à un étirement

Etude prospective interventionnelle a inclus 33 patients sédatés et ventilés mécaniquement en insuffisance circulatoire aigue, nécessitant un RV avec un monitorage du débit cardiaque



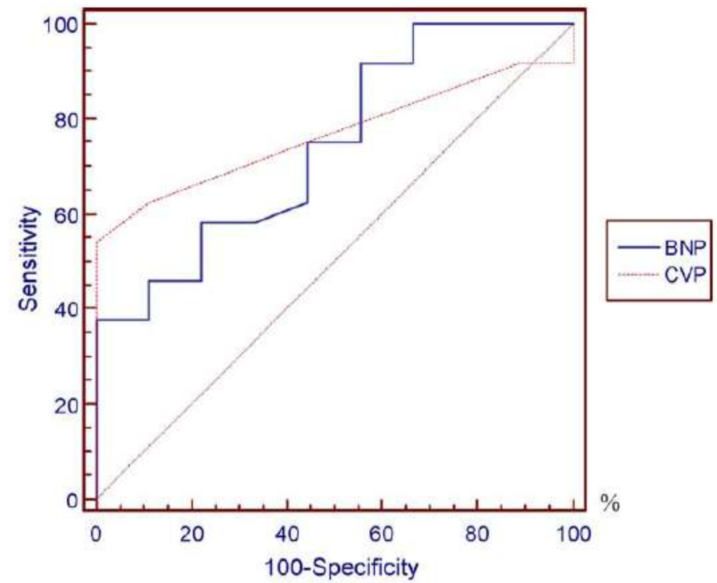


Fig. 2. Receiver operating characteristic (ROC) curves of B-type Natriuretic Peptide (BNP) (0.74 ± 0.11) and central venous pressure (CVP) (0.77 ± 0.10) ($p = 0.87$).

Annales Françaises d'Anesthésie et de Réanimation 28 (2009) 531–536

- Comment estimer la précharge ?
  - Par les pressions de remplissage : PVC, PAPO ? ***NON***
  - Par les dimensions : VTDVDi; VTDVGi; STDVGi, VCI ? ***NON***
  - *Par les volumes: VTDVG?* ***NON***
  - Par les biomarqueurs : BNP ? ***NON***

Marik et al. Annals of Intensive Care 2011, 1:1
http://www.annalsofintensivecare.com/content/1/1/1

Annals of Intensive Care
a SpringerOpen Journal

REVIEW Open Access

Hemodynamic parameters to guide fluid therapy

Paul E Marik[1*], Xavier Monnet[2], Jean-Louis Teboul[2]

Table 2 Predictive value of techniques used to determine fluid responsiveness [15]

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Central venous pressure (CVP)	Central venous catheter	0.55 (0.48-0.62)

des indices dynamiques sont proposés

pour détecter directement

la *réserve de précharge*

Patients sous ventilation mécanique

Marik et al. Annals of Intensive Care 2011, 1:1
http://www.annalsofintensivecare.com/content/1/1/1

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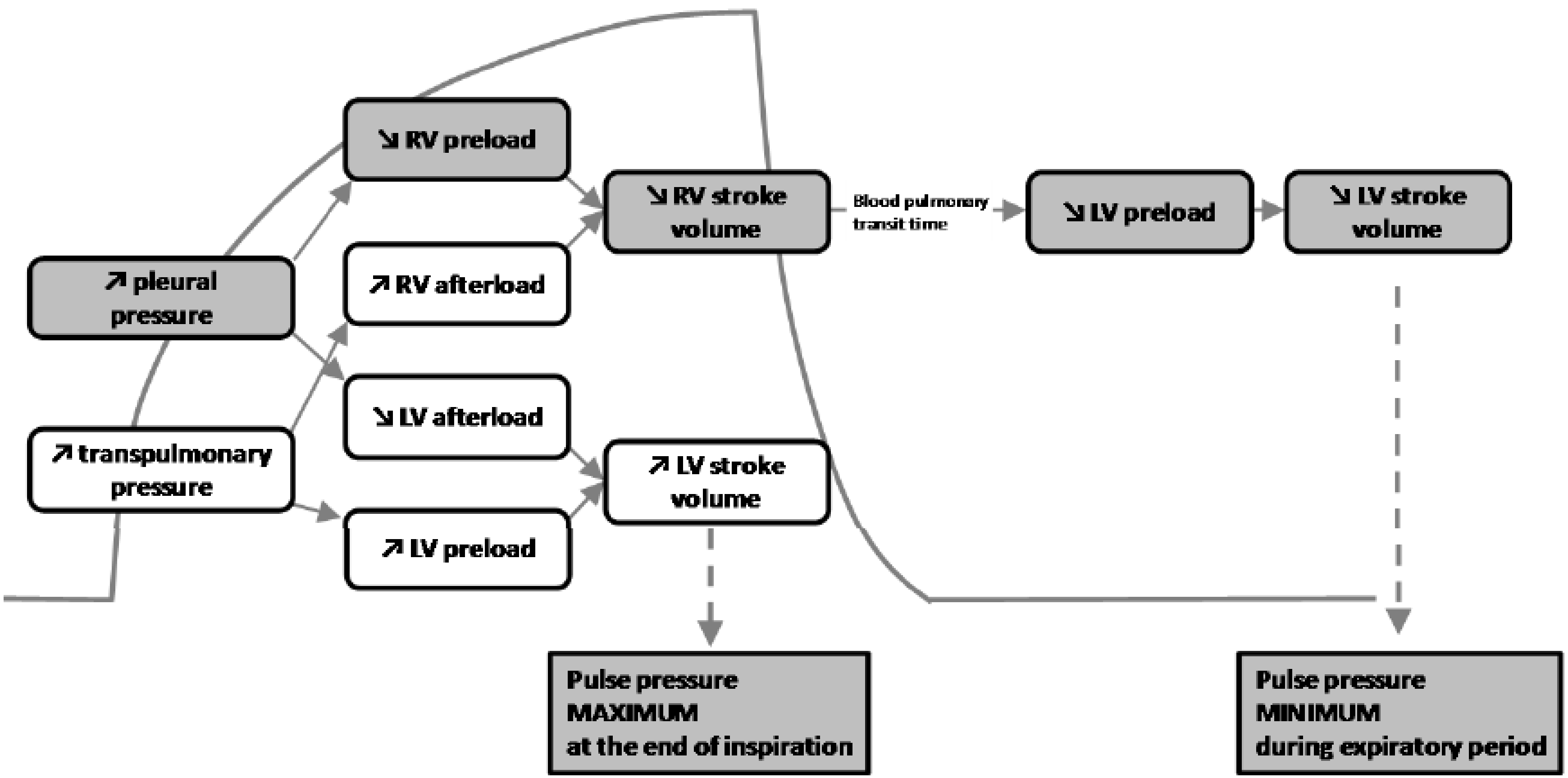


Figure 2 Heart-lung interactions. Hemodynamic effects of mechanical ventilation. The cyclic changes in left ventricular (LV) stroke volume are mainly related to the expiratory decrease in LV preload due to the inspiratory decrease in right ventricular (RV) filling. Reproduced with permission from Critical Care/Current Science Ltd [24].

Comment évaluer la variabilité respiratoire du VES ?

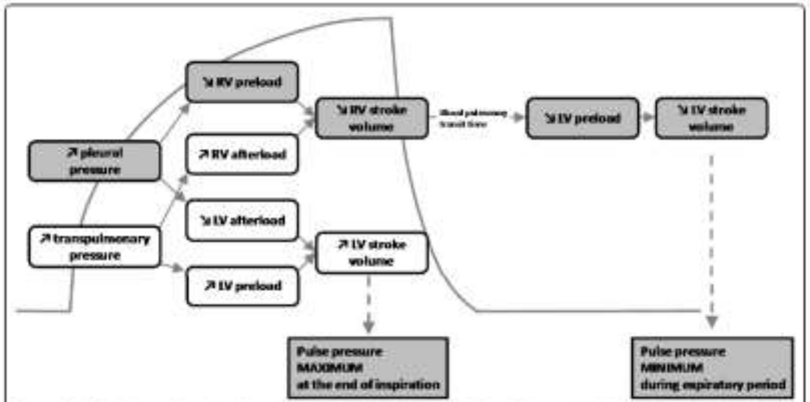
. **Par l'analyse de la variabilité respiratoire de la PA** **(KT artériel)**

- **pulse pressure variation (PPV ou ΔPP)**

$$\text{Pression artérielle pulsée} = k.\ \frac{\text{volume d'éjection VG}}{\text{compliance artérielle}}$$

les variations respiratoires de la pression artérielle pulsée reflètent les variations respiratoires du volume d'éjection systolique VG

les variations respiratoires de la pression pulsée (ΔPP)
devraient prédire la réponse au remplissage



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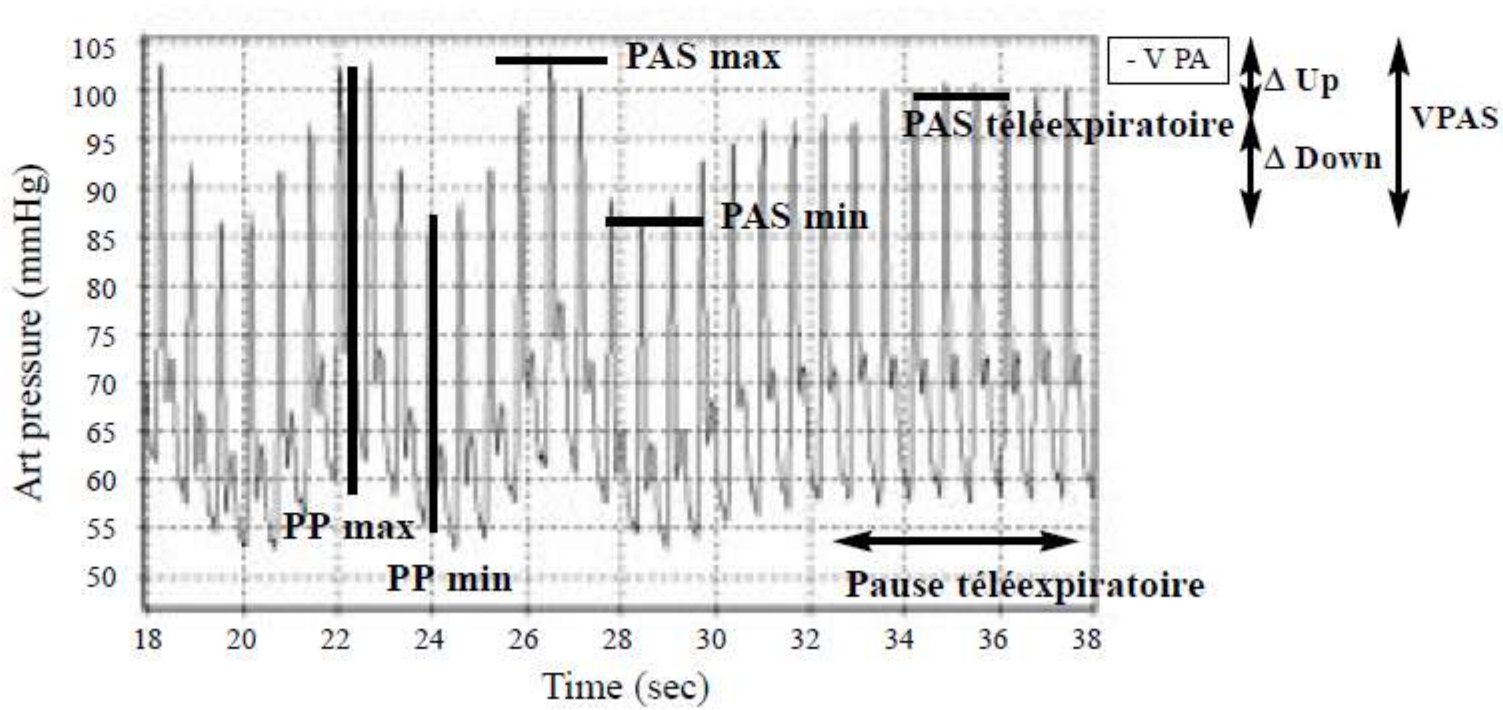
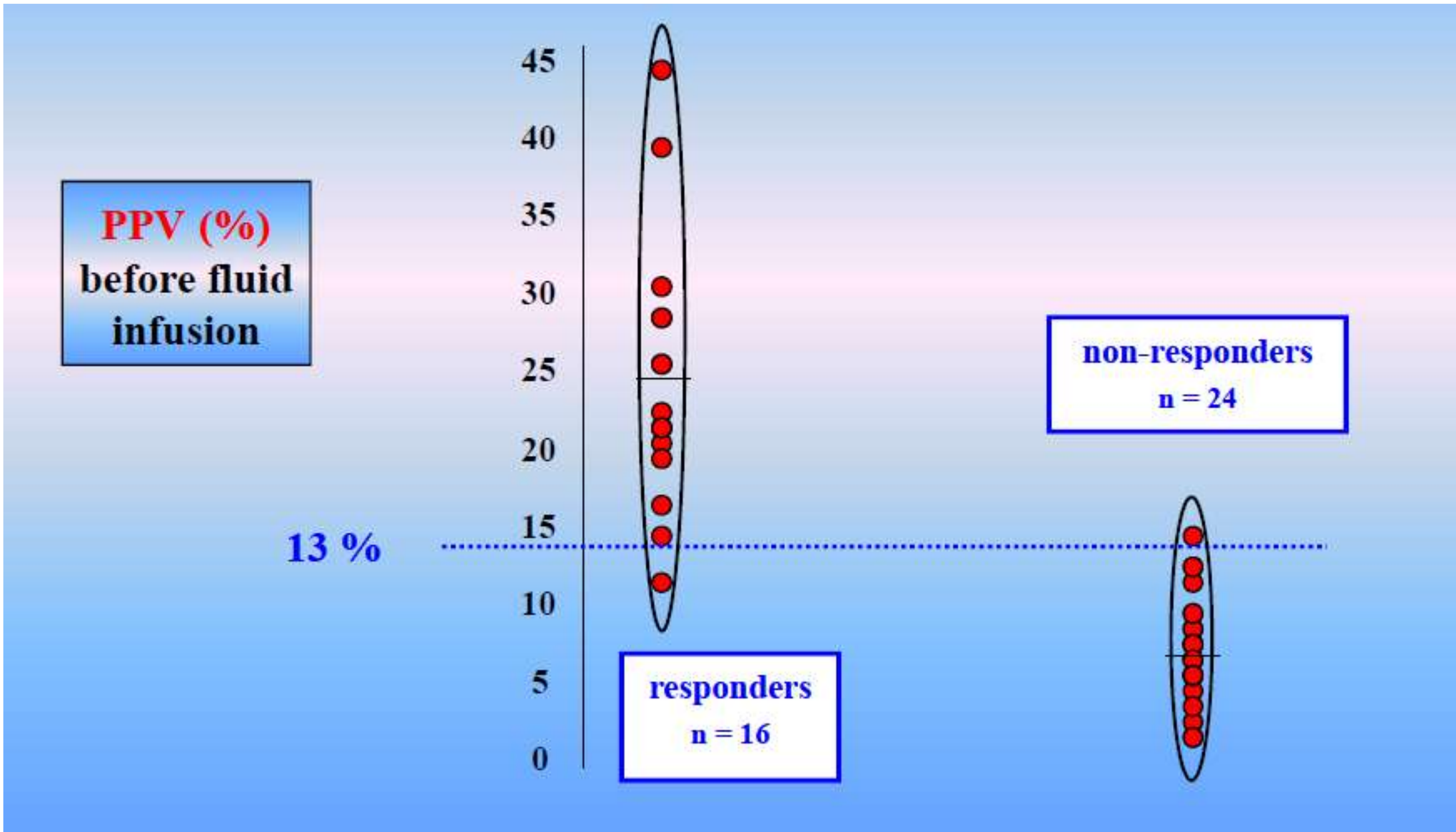


$$\Delta\ PP\ (\%) = (PPmax - PPmin)/[(PPmax + PPmin)/2]*100$$

Relation between Respiratory Changes in Arterial Pulse Pressure and Fluid Responsiveness in Septic Patients with Acute Circulatory Failure

FRÉDÉRIC MICHARD, SANDRINE BOUSSAT, DENIS CHEMLA, NADIA ANGUEL, ALAIN MERCAT, YVES LECARPENTIER, CHRISTIAN RICHARD, MICHAEL R. PINSKY, and JEAN-LOUIS TEBOUL

Am J Respir Crit Care Med 2000; 162:134-8



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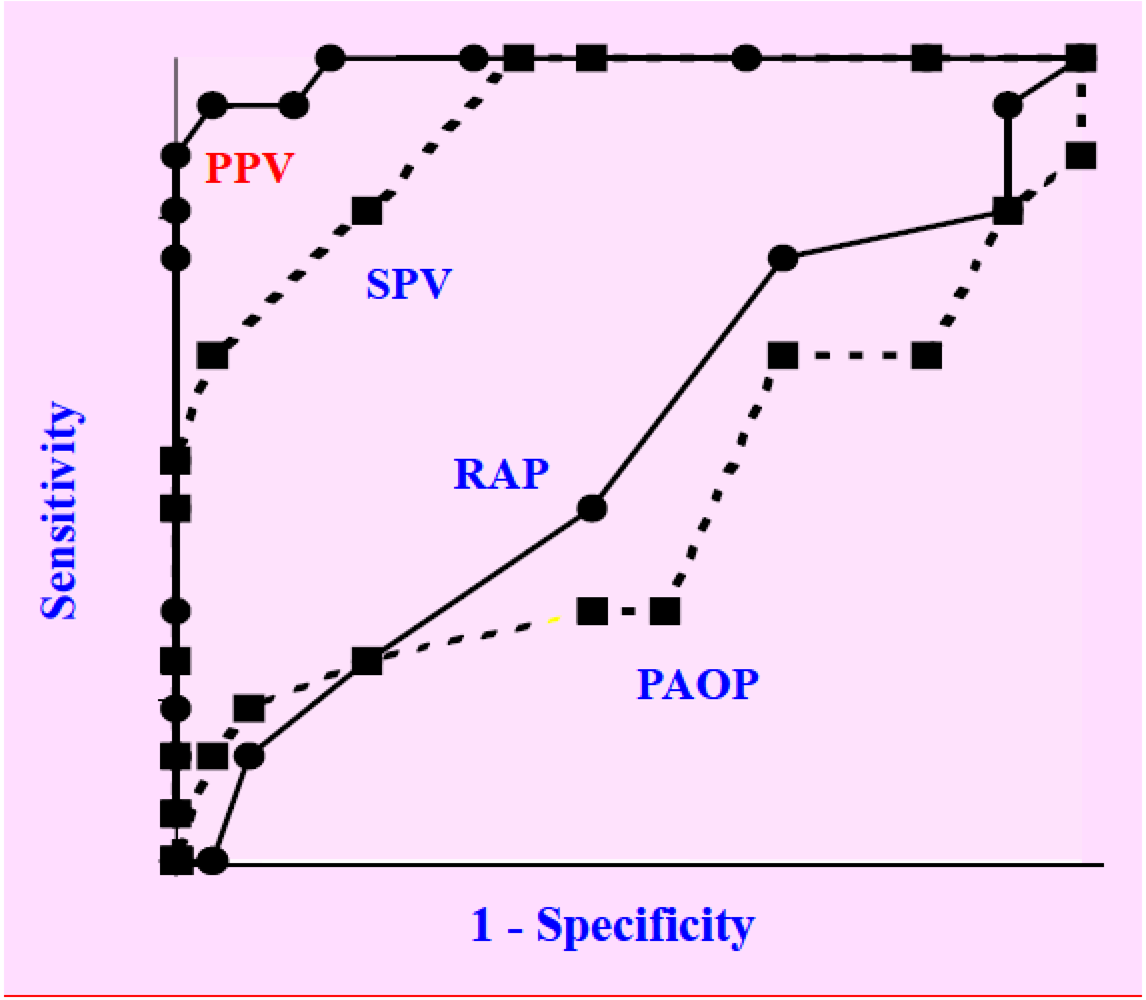


Volume responsiveness
Xavier Monnet and Jean-Louis Teboul

Current Opinion in Critical Care 2007, 13:549 553

Table 1 Studies that have investigated the arterial pulse pressure variation (PPV) for predicting volume responsiveness and the respective threshold value for diagnosis

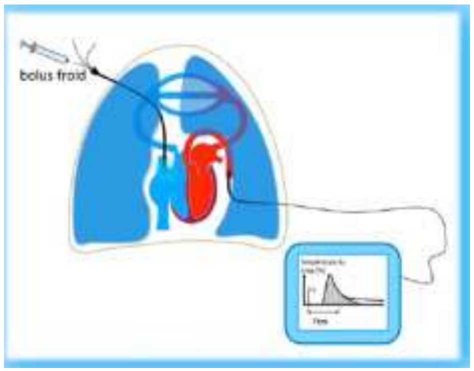
Reference	Year of publication	Clinical setting	PPV threshold value (%)
Michard *et al.* [22]	2000	Medical ICU patients	13
Vieillard-Baron *et al.* [20]	2004	Medical ICU patients	12
Kramer *et al.* [23]	2004	Coronary artery bypass grafting	11
Preisman *et al.* [19]	2005	Coronary artery bypass grafting	9
Hofer *et al.* [21]	2005	Coronary artery bypass grafting	13
Feissel *et al.* [24]	2005	Mix of surgical and medical ICU patients	17
De Backer *et al.* [25]	2005	Mix of surgical and medical ICU patients	12
Cannesson *et al.* [9]	2006	Coronary artery bypass grafting	12
Solus-Biguenet *et al.* [10•]	2006	Hepatic resection	14
Lafanéchère *et al.* [17•]	2006	Medical ICU patients	12
Monnet *et al.* [18••]	2006	Medical ICU patients	12
Charron *et al.* [26]	2006	Surgical ICU patients	10
Natalini *et al.* [27•]	2006	Mix of surgical and medical ICU patients	15
Feissel *et al.* [30•]	2007	Medical ICU patients	12
Cannesson *et al.* [31•]	2007	Coronary artery bypass grafting	11

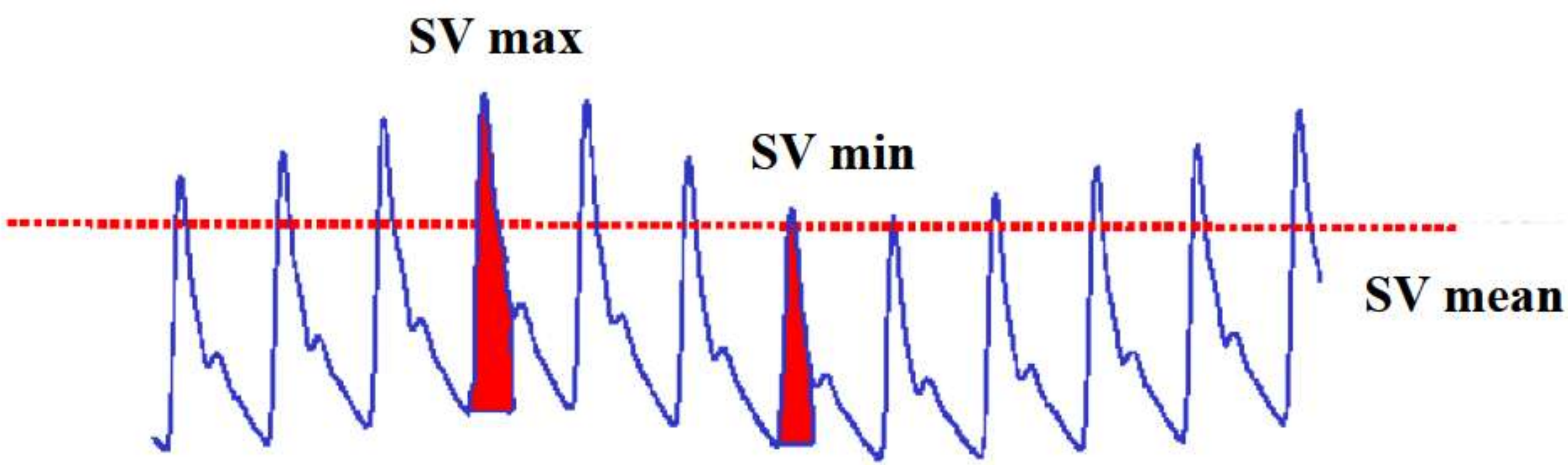
Comment évaluer la variabilité respiratoire du VES ?

. Par l'analyse de la variabilité respiratoire de la PA (KT artériel)

. Par l'analyse de la variabilité respiratoire du VES « pulse contour » (SVV)

Variabilité respiratoire du VES

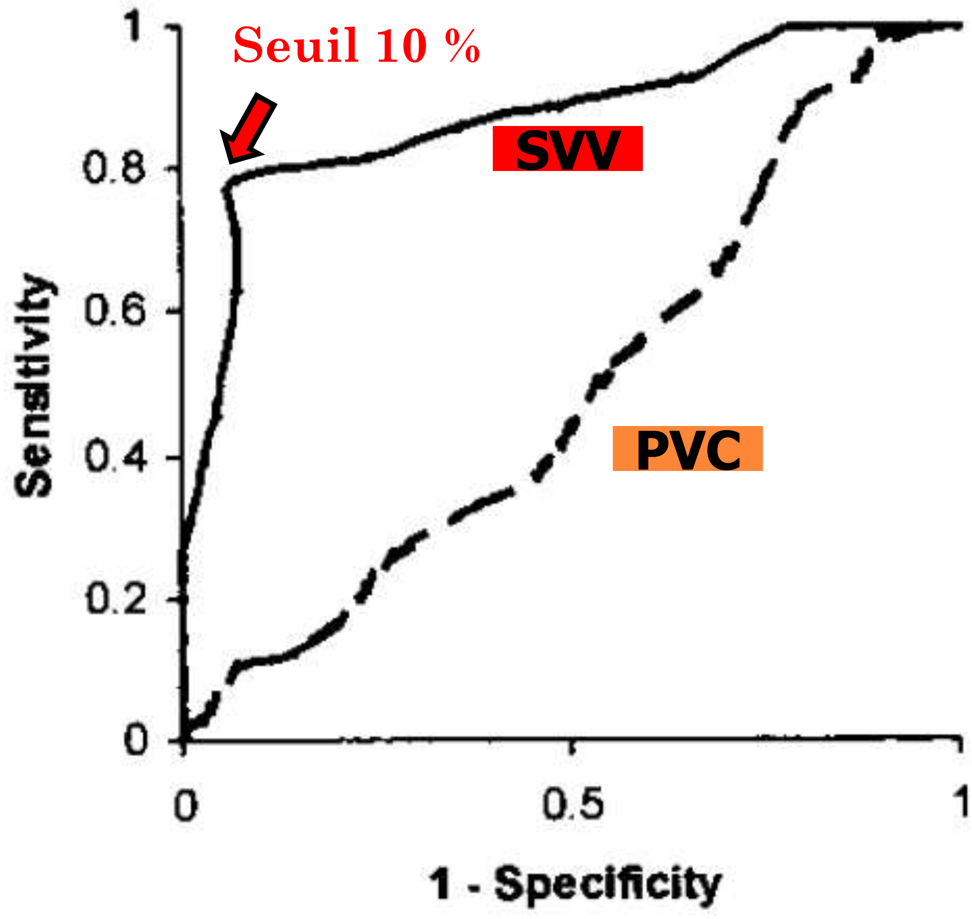




$$SVV = \frac{SV\ max + SV\ min}{2}$$

Stroke Volume Variation as a Predictor of Fluid Responsiveness in Patients Undergoing Brain Surgery

(Anesth Analg 2001;92:984–9)



Sensibilité 79 %
Spécificité 93 %

Comment évaluer la variabilité respiratoire du VES ?

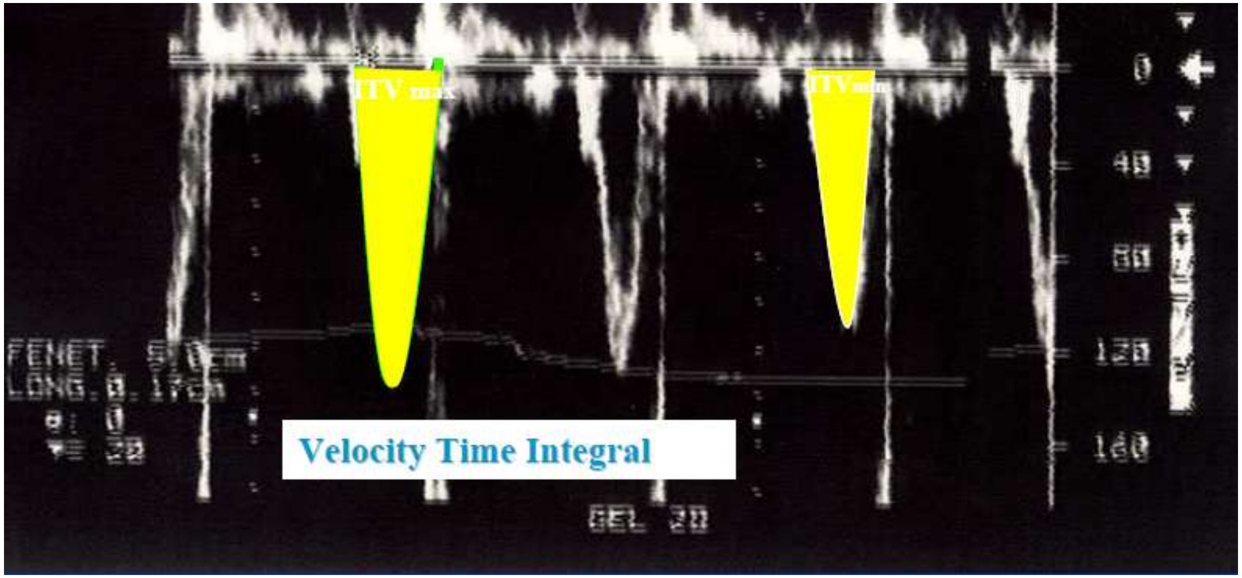
. Par l'analyse de la variabilité respiratoire de la PA (KT artériel)

. Par l'analyse de la variabilité respiratoire du VES « pulse contour » (SVV)

. Par l'analyse de la variabilité respiratoire de la vélocité aortique Doppler

- Echocardiographie

- Doppler oesophagien



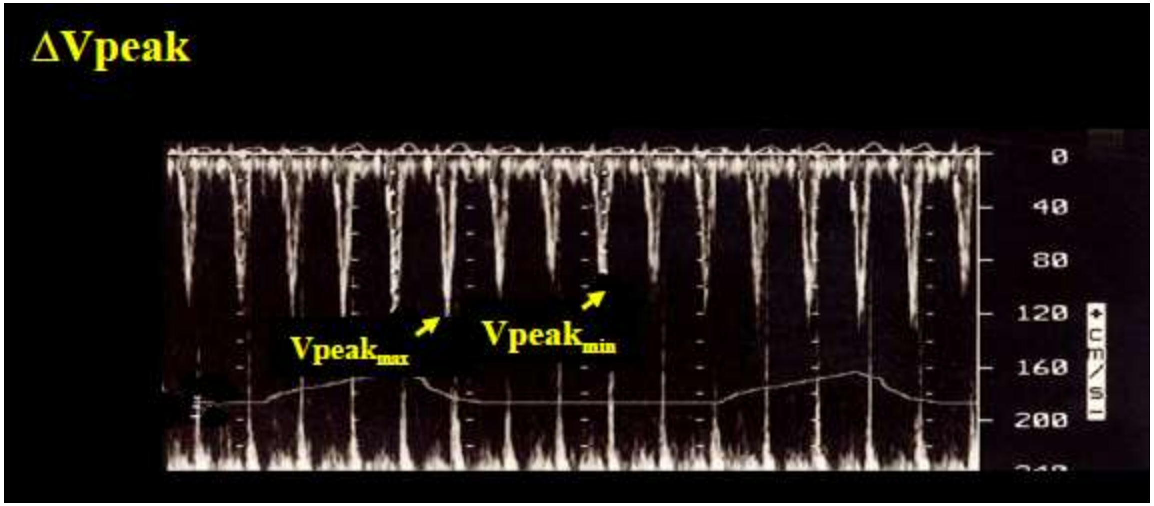
ΔITV > 12%

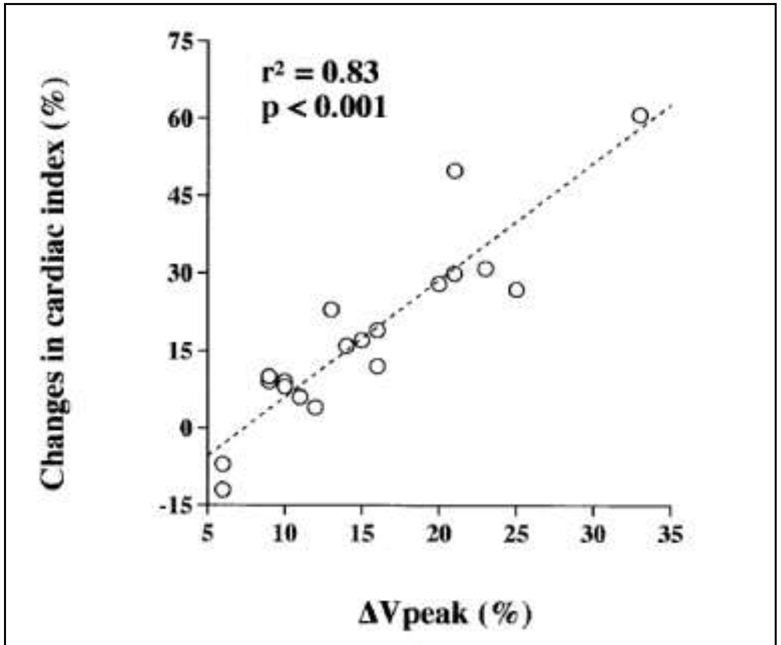
Volume d 'éjection = ITV x surface aortique

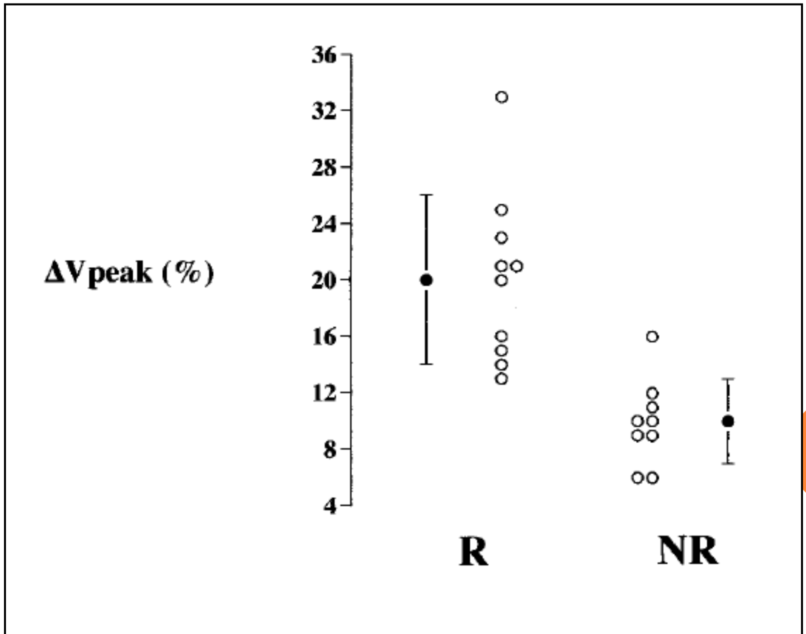
$$\Delta ITV\ \% = \frac{ITV\ max\ -\ ITV\ min}{(ITV\ max\ +\ ITV\ min)/2}$$

Respiratory Changes in Aortic Blood Velocity as an Indicator of Fluid Responsiveness in Ventilated Patients With Septic Shock*

Marc Feissel, MD; Frédéric Michard, MD; Isabelle Mangin, MD; Olivier Ruyer, MD; Jean-Pierre Faller, MD; and Jean-Louis Teboul, MD, PhD







Comment évaluer la variabilité respiratoire du VES ?

. Par l'analyse de la variabilité respiratoire de la PA (KT artériel)

. Par l'analyse de la variabilité respiratoire du VES « pulse contour » (SVV)

. Par l'analyse de la variabilité respiratoire de la vélocité aortique Doppler

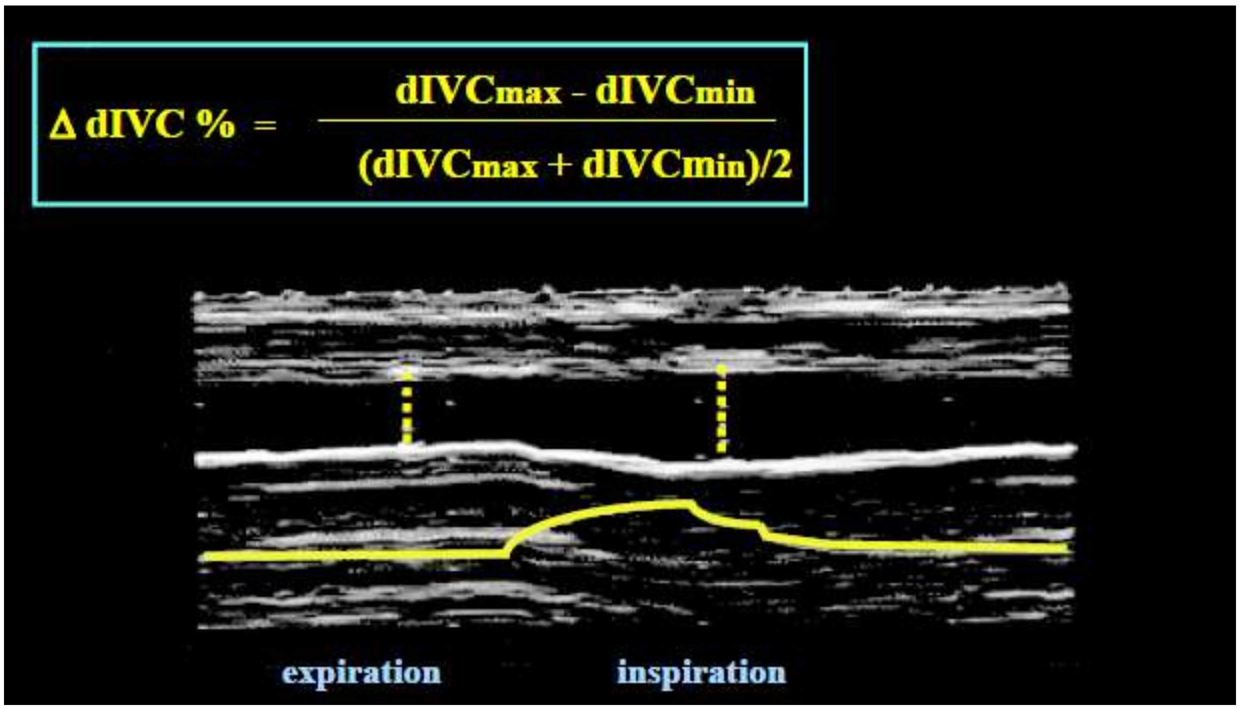
. **Par l'analyse de la variabilité respiratoire du diamètre de veine cave**

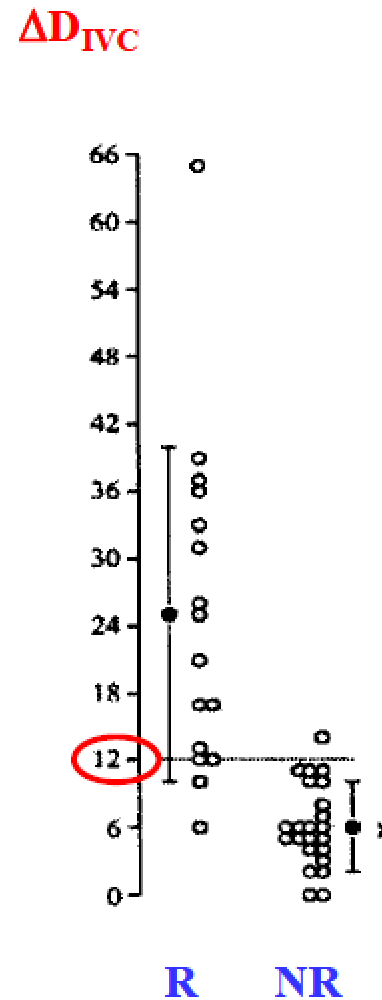
Intensive Care Med (2004) 30:1834–1837
DOI 10.1007/s00134-004-2233-5

BRIEF REPORT

Marc Feissel
Frédéric Michard
Jean-Pierre Faller
Jean-Louis Teboul

The respiratory variation in inferior vena cava diameter as a guide to fluid therapy





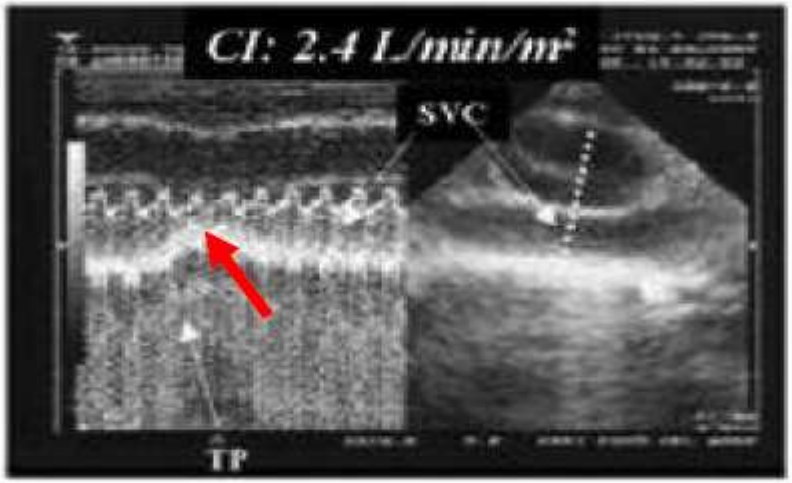
Intensive Care Med (2004) 30:1734–1739
DOI 10.1007/s00134-004-2361-y

ORIGINAL

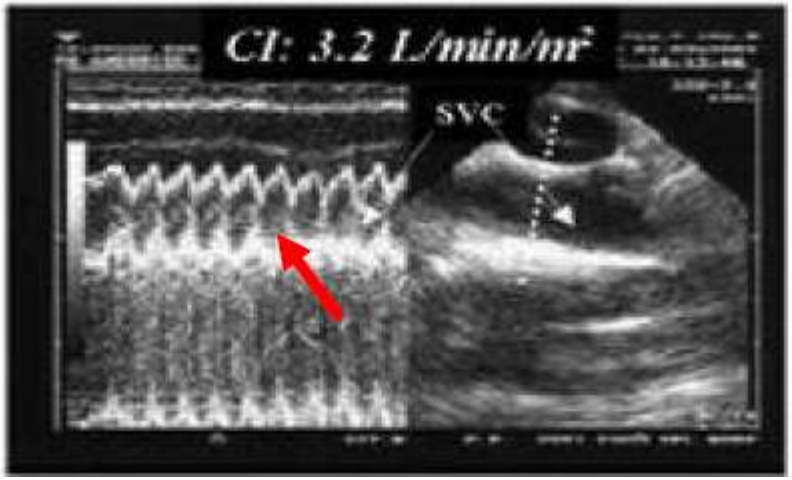
Superior vena caval collapsibility as a gauge of volume status in ventilated septic patients

Antoine Vieillard-Baron
Karim Chergui
Anne Rabiller
Olivier Peyrouset
Bernard Page
Alain Beauchet
François Jardin

Before VE



After VE



Comment évaluer la variabilité respiratoire du VES ?

. Par l'analyse de la variabilité respiratoire de la PA (KT artériel)

. Par l'analyse de la variabilité respiratoire du VES « pulse contour » (SVV)

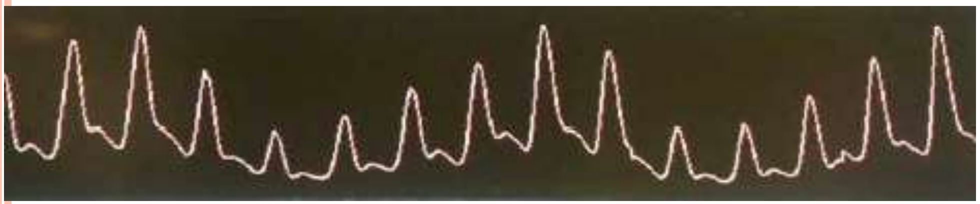
. Par l'analyse de la variabilité respiratoire de la vélocité aortique Doppler

. Par l'analyse de la variabilité respiratoire du diamètre de veine cave

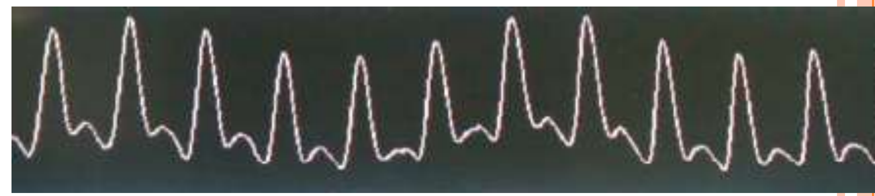
. Par l'analyse de la variabilité respiratoire du signal d'oxymétrie de pouls

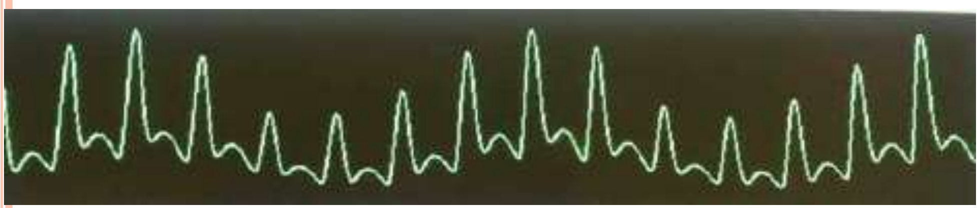
Variabilité respiratoire de la PP et de la PPleth avant et après un RV suivie d ’une augmentation de 25% du DC

Ppleth avant R

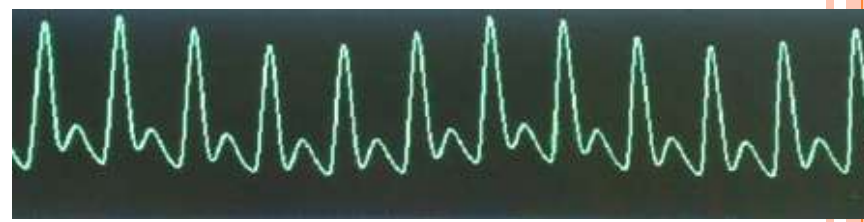


Ppleth après R





Pression pulsée avant R



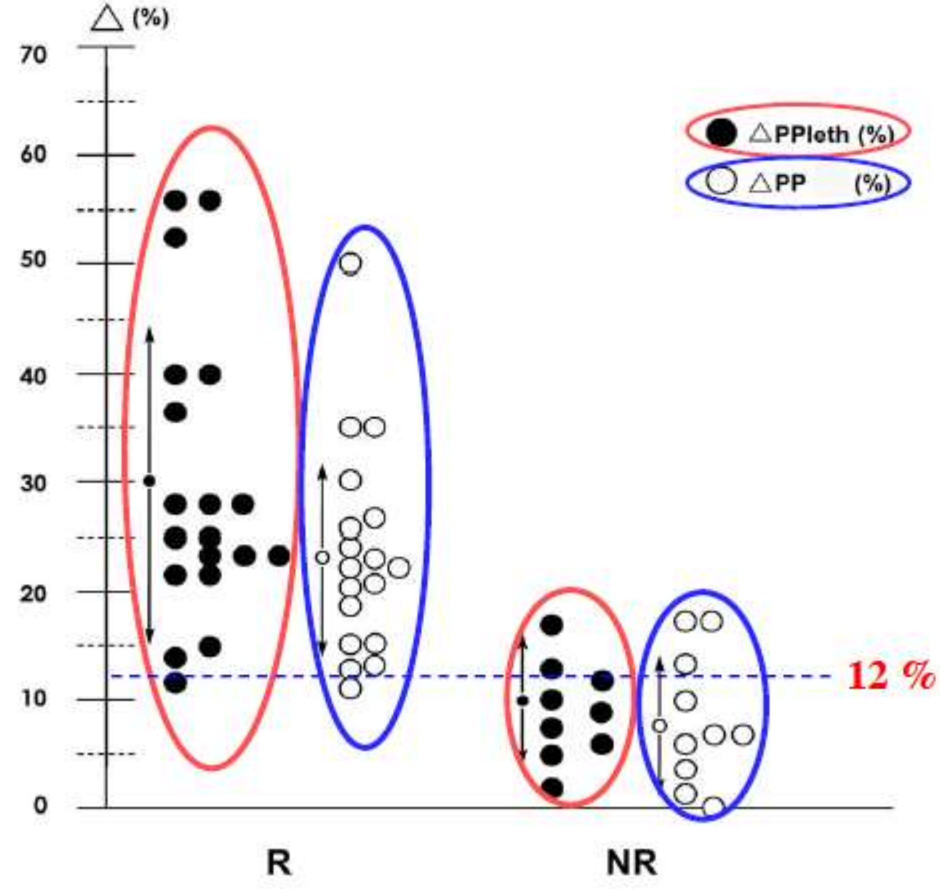
Pression pulsée après R

Intensive Care Med (2007) 33:993–999
DOI 10.1007/s00134-007-0602-6

ORIGINAL

Marc Feissel
Jean-Louis Teboul
Paolo Merlani
Julio Badie
Jean-Pierre Faller
Karim Bendjelid

Plethysmographic dynamic indices predict fluid responsiveness in septic ventilated patients



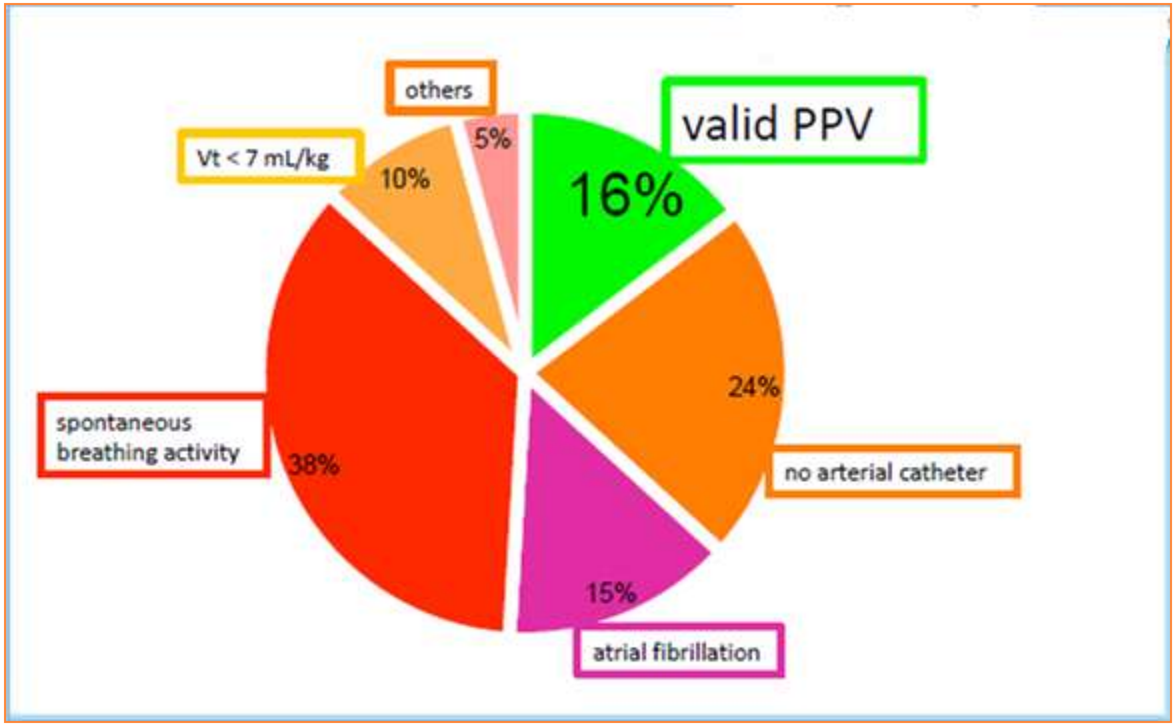
Quels sont les limites d'utilisation des indices de variabilité respiratoire ?

Validés seulement

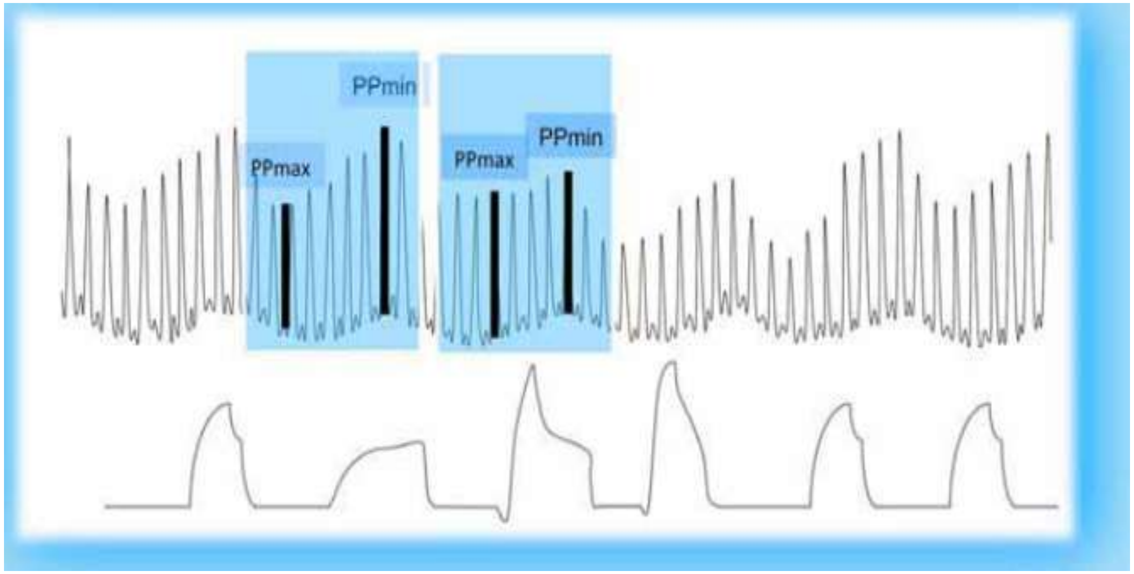
- en cas de VM avec adaptation parfaite au ventilateur
- avec un Vt > 7 mL/kg
- en l'absence d'arythmie cardiaque
- en cas de thorax et péricarde fermés

Pulse pressure cannot be used in a large majority of ICU patients for predicting fluid responsiveness

Jozwiak M, Teboul JL, Richard C, Monnet X



VPP EN CAS DE RESPIRATION SPONTANÉE

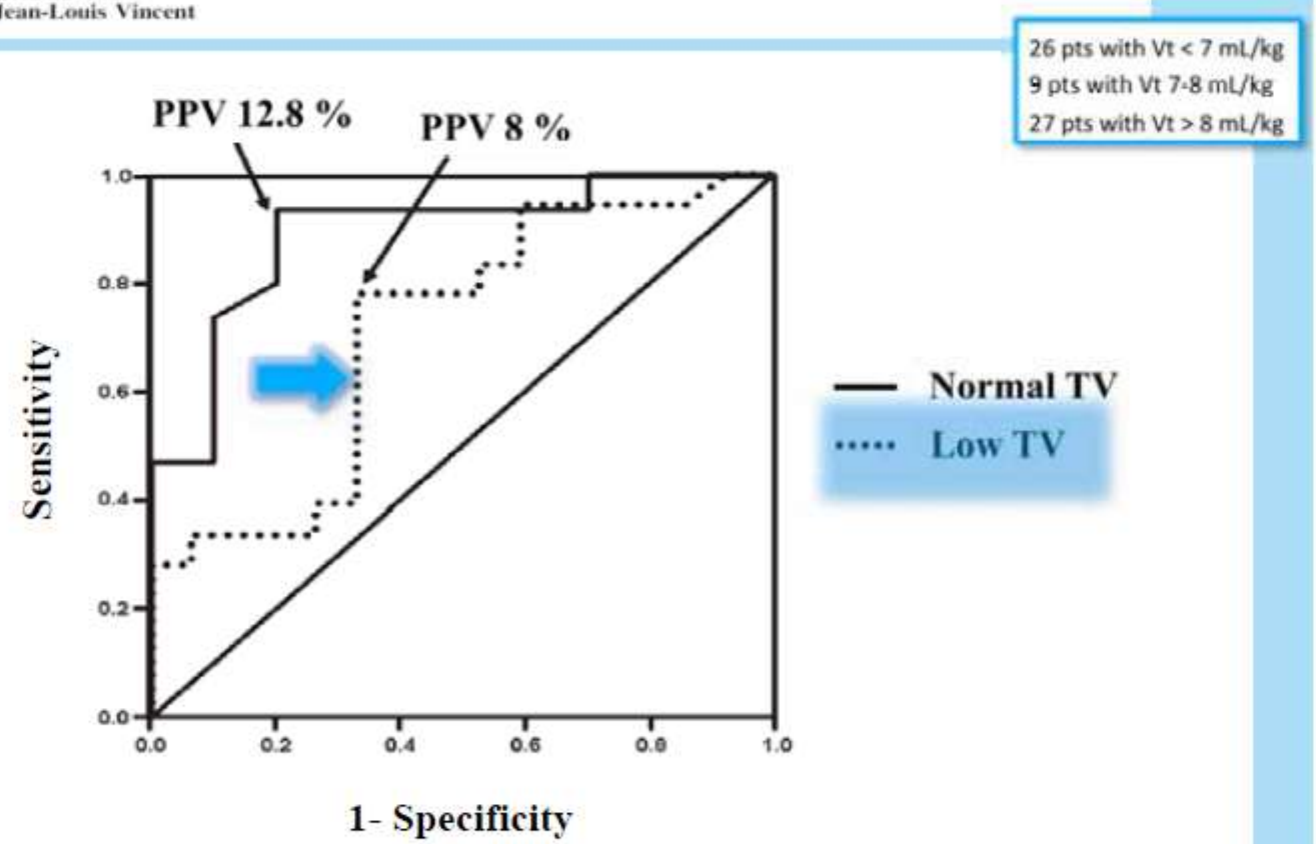


Intensive Care Med (2005) 31:517–523
DOI 10.1007/s00134-005-2586-4

ORIGINAL

Daniel De Backer
Sarah Heenen
Michael Piagnerelli
Marc Koch
Jean-Louis Vincent

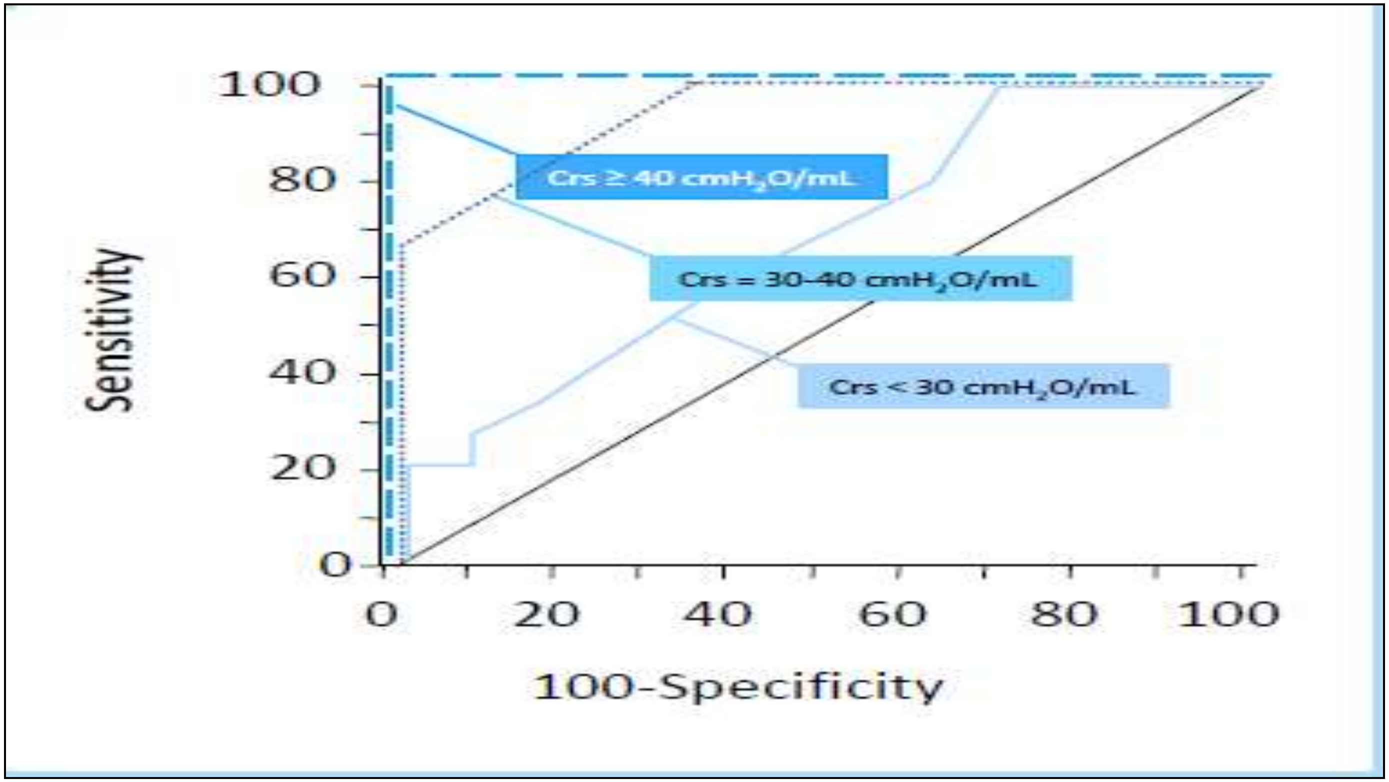
Pulse pressure variations to predict fluid responsiveness: influence of tidal volume



Passive leg-raising and end-expiratory occlusion tests perform better than pulse pressure variation in patients with low respiratory system compliance*

Xavier Monnet, MD, PhD; Alexandre Bleibtreu, MD; Alexis Ferré, MD; Martin Dres, MD; Rim Gharbi, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

Crit Care Med 2012 Vol. 40, No. 1



Jacques et al. Critical Care 2011, 15:R33
http://ccforum.com/content/15/1/R33

CRITICAL CARE

RESEARCH Open Access

Pulse pressure variation and stroke volume variation during increased intra-abdominal pressure: an experimental study

Didier Jacques[1*], Karim Bendjelid[2], Serge Duperret[3], Joëlle Colling[3], Vincent Piriou[4], Jean-Paul Viale[5]

In this study, a PPV value of 41% separated responders and non-responders, suggesting that PPV threshold value identifying responders and non-responders could be higher in case of IAH.

Conclusions: In intra-abdominal hypertension, respiratory variations in stroke volume and arterial pressure remain indicative of fluid responsiveness, even if threshold values identifying responders and non-responders might be higher than during normal intra-abdominal pressure. Further studies are required in humans to determine these thresholds in intra-abdominal hypertension.

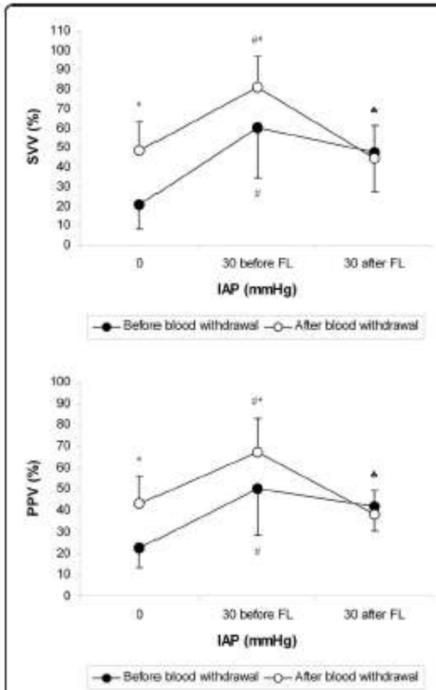


Figure 2 Effects of alterations in IAP and volemia on SVV and PPV. Definition of abbreviations: FL, fluid loading; IAP, intra-abdominal pressure; PPV, pulse pressure variation; SVV, stroke volume variation. #: $P < 0.05$ vs IAP 0; *: $P < 0.05$ vs before blood withdrawal; ♦: $P < 0.05$ vs IAP 30 before FL for the animals after blood withdrawal. Before blood withdrawal, $n = 9$ at IAP 0, 30 before FL and 30 after FL; after blood withdrawal, $n = 9$ at IAP 0, $n = 7$ at IAP 30 before FL and 30 after FL.

Arterial pressure allows monitoring the changes in cardiac output induced by volume expansion but not by norepinephrine*

Xavier Monnet, MD, PhD; Alexia Letierce, PhD; Olfa Hamzaoui, MD; Denis Chemla, MD, PhD; Nadia Anguel, MD; David Osman, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

Crit Care Med 2011 Vol. 39, No. 6

-228 patients
-Objectif: tester si la VPP est corrélée à une augmentation de l'IC ≥ 15% après remplissage vasculaire

Table 4. Diagnostic ability of the fluid-induced changes in arterial pressure values to detect a fluid-induced increase in cardiac index of ≥15% in patients receiving fluid infusion (group 1)

Variable	Area Under the Receiver Operating Characteristic Curve	p vs. .500	Best Cutoff Value	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Youden Index
Changes in arterial pulse pressure	0.784 ± 0.03	.0001	17%	65 [56–72]	85 [76–92]	88 [80–93]	59 [50–68]	0.50
Changes in systolic arterial pressure	0.757 ± 0.03	.0001	8%	74 [66–81]	67 [57–77]	79 [71–85]	61 [51–71]	0.41
Changes in mean arterial pressure	0.692 ± 0.04^a	.001	13%	46 [38–55]	84 [74–91]	82 [72–90]	49 [40–57]	0.30
Changes in diastolic arterial pressure	0.598 ± 0.04^a	.01	11%	37 [29–45]	83 [73–90]	78 [66–87]	44 [37–52]	0.50

Conclusions: **Pulse pressure and systolic arterial pressure could be used for detecting the fluid-induced changes in cardiac output, in spite of a significant proportion of false-negative cases. By contrast, the changes in pulse pressure and systolic arterial pressure were unable to detect the changes in cardiac output induced by norepinephrine.**

Quelles alternatives?

- Épreuve lever de jambe
- Test d'occlusion téléexpiratoire
- Le mini remplissage
- Le CO2 téléexpiratoire

L'ÉPREUVE LEVER DE JAMBE

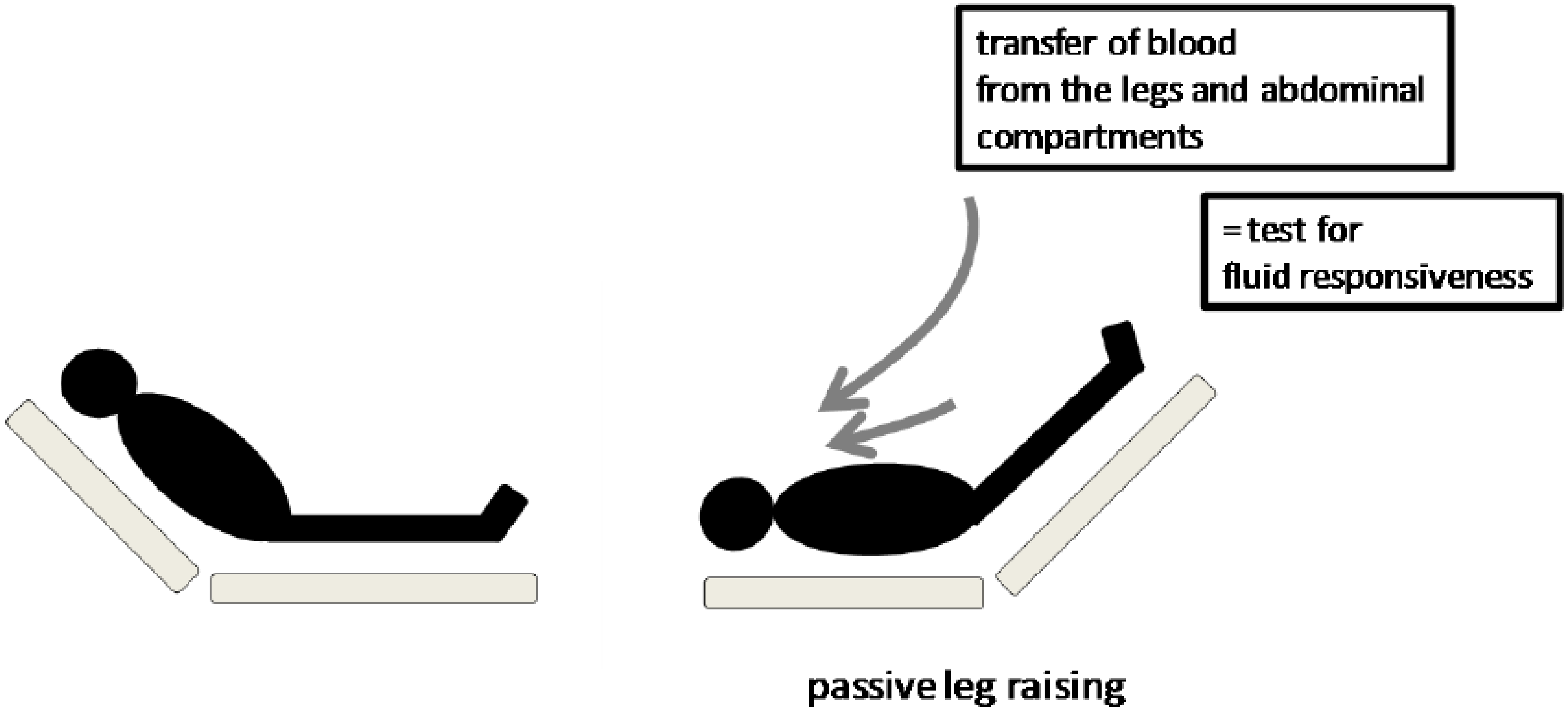


Figure 4 Passive leg raising. The passive leg raising test consists in measuring the hemodynamic effects of a leg elevation up to 45°. A simple way to perform the postural maneuver is to transfer the patient from the semirecumbent posture to the passive leg raising position by using the automatic motion of the bed.

-Augmentation de la precharge ventriculaire droite (Thomas et al 1965)

-Augmentation de la precharge ventriculaire gauche (Rocha 87, Takagi 89,De Hert 99)

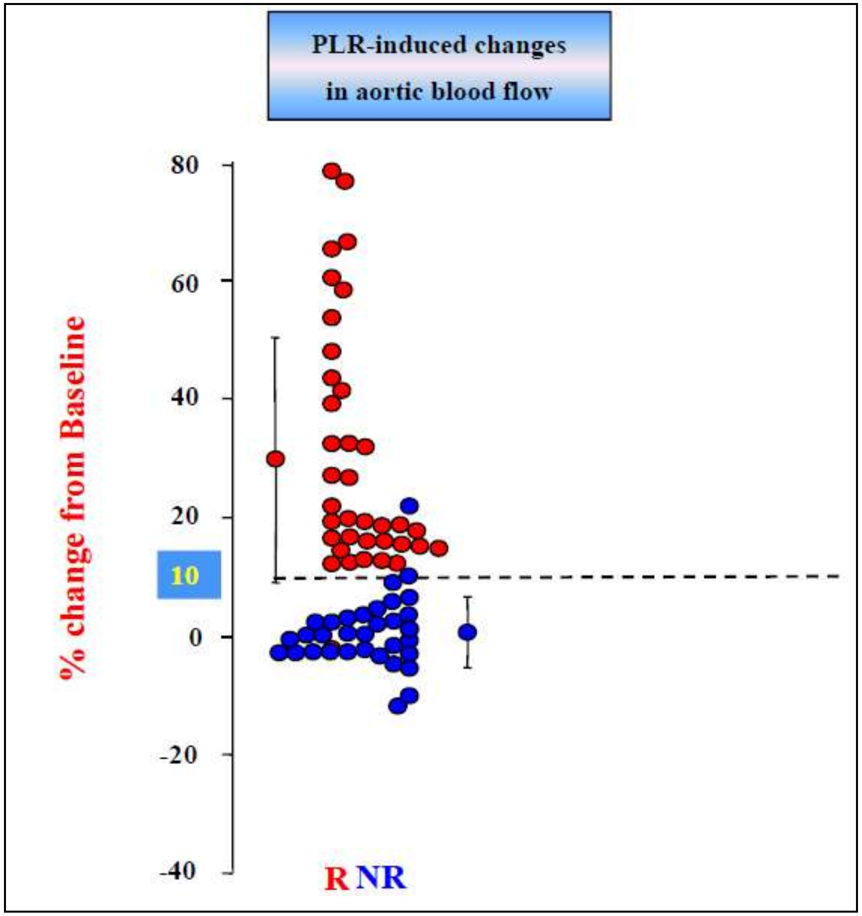
-Augmentation de débit cardiaque de 6-10 % chez les volontiers (Gaffney 82, Wong 89, Paelinck 03)

-Augmentation de débit cardiaque de plus 10 % chez seulement 16 % des malades de réanimation (Wong 1988)

Passive leg raising predicts fluid responsiveness in the critically ill*

Xavier Monnet, MD, PhD; Mario Rienzo, MD; David Osman, MD; Nadia Anguel, MD; Christian Richard, MD; Michael R. Pinsky, MD, Dr hc; Jean-Louis Teboul, MD, PhD

Crit Care Med 2006; 34:1402–1407



sensitivity : 97 %

specificty : 94 %

Intensive Care Med (2010) 36:1475–1483
DOI 10.1007/s00134-010-1929-y

REVIEW

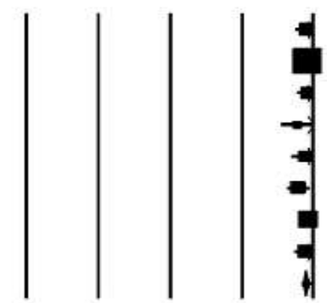
Fabio Cavallaro
Claudio Sandroni
Cristina Marano
Giuseppe La Torre
Alice Mannocci
Chiara De Waure
Giuseppe Bello
Riccardo Maviglia
Massimo Antonelli

Diagnostic accuracy of passive leg raising for prediction of fluid responsiveness in adults: systematic review and meta-analysis of clinical studies

PLR-cCO

Model	Study name	Sample size	Point estimate	Standard error
	Lafanechére CC 2006 (18)	22	0,950	0,040
	Monnet CCM 2006 (19)	71	0,960	0,020
	Lamia ICM 2007 (20)	24	0,960	0,040
	Maizel ICM 2007 (21)	34	0,889	0,060
	Monnet CCM 2009 (22)	34	0,937	0,049
	Thiel Kollef CC 2009 (13)	102	0,890	0,040
	Biais CC 2009 (23)	30	0,960	0,030
	Preau CCM 2010 (24)	34	0,940	0,040
Random		351	0,947	0,012

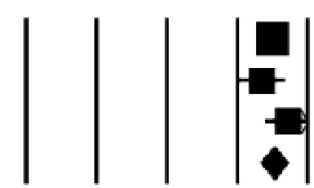
Point estimate and 95% CI



PLR-cPP

Model	Study name	Sample size	Point estimate	Standard error
	Monnet CCM 2006 (19)	71	0,750	0,060
	Monnet CCM 2009 (22)	34	0,675	0,085
	Preau CCM 2010 (24)	34	0,860	0,080
Random		139	0,762	0,048

Point estimate and 95% CI



Intensive Care Med (2010) 36:1475–1483
DOI 10.1007/s00134-010-1929-y

REVIEW

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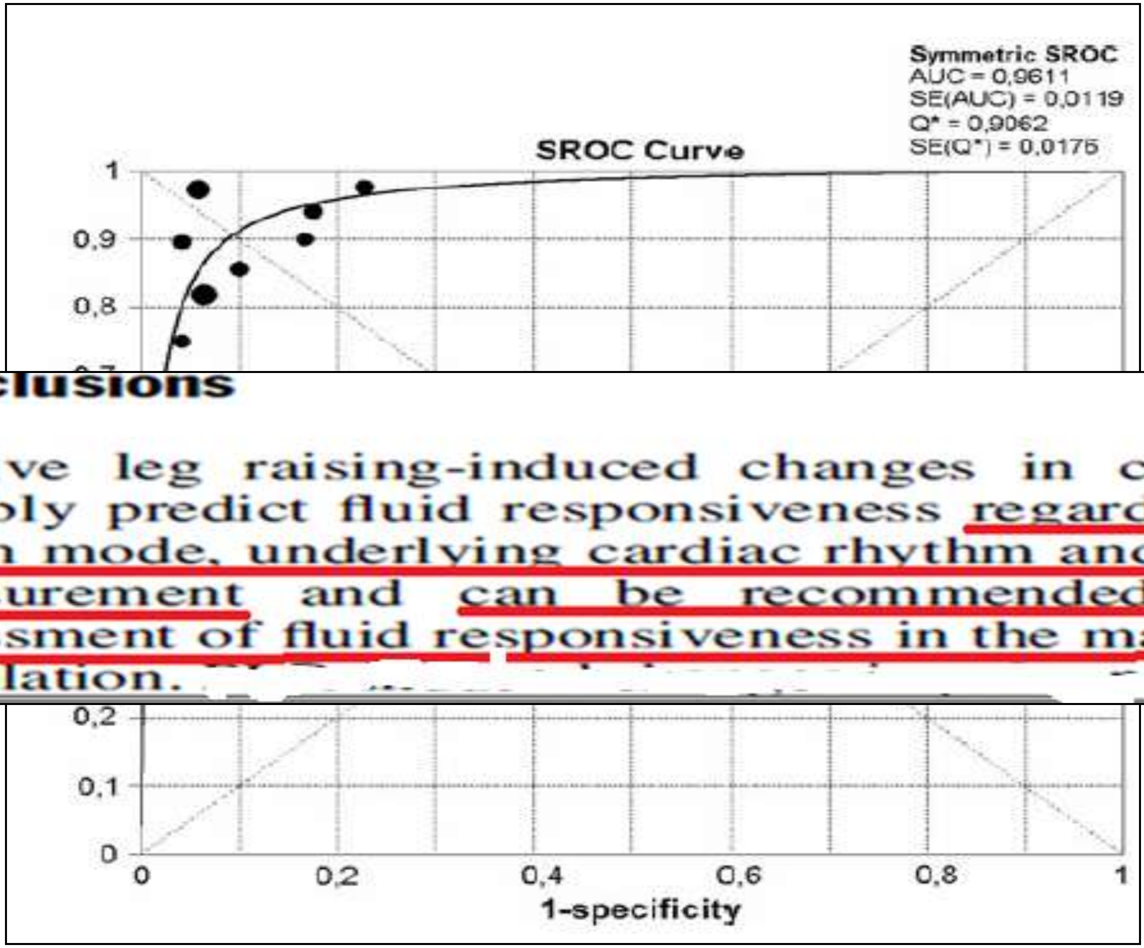
Massimo Antonelli

Diagnostic accuracy of passive leg raising for prediction of fluid responsiveness in adults: systematic review and meta-analysis of clinical studies



Conclusions

Passive leg raising-induced changes in cardiac output reliably predict fluid responsiveness regardless of ventilation mode, underlying cardiac rhythm and technique of measurement and can be recommended for routine assessment of fluid responsiveness in the majority of ICU population.

QUELLES ALTERNATIVES?

- Épreuve lever de jambe
- Test d’occlusion télé expiratoire
- La mini remplissage
- Le CO2 télé expiratoire

Predicting volume responsiveness by using the end-expiratory occlusion in mechanically ventilated intensive care unit patients

Xavier Monnet, MD, PhD; David Osman, MD; Christophe Ridel, MD; Bouchra Lamia, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

Crit Care Med 2009 Vol. 37, No. 3

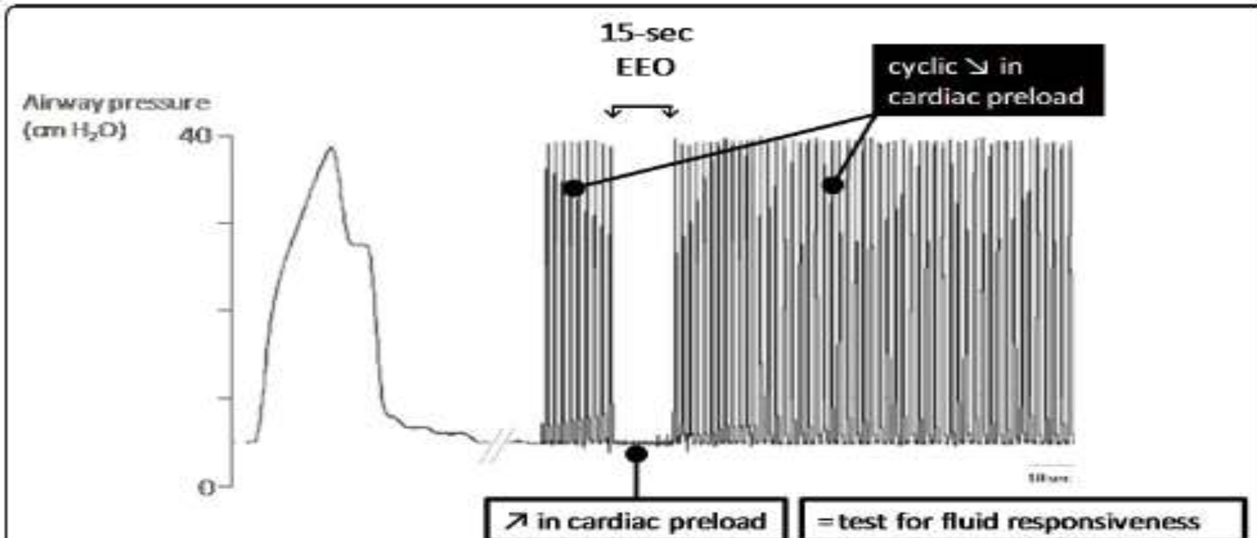
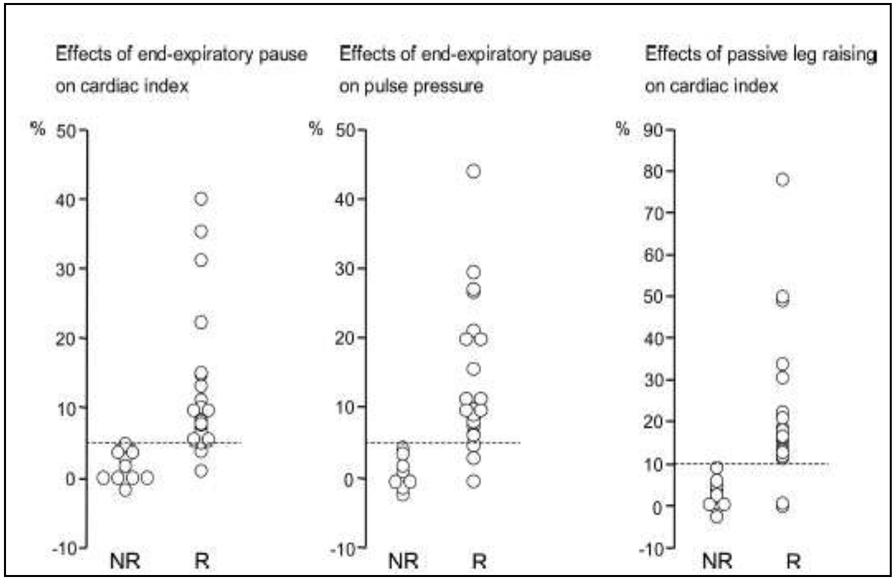


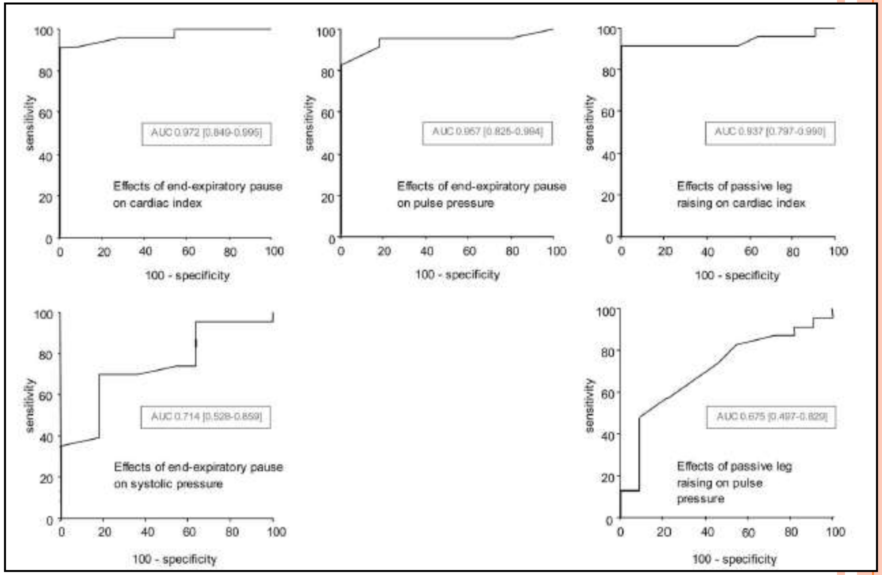
Figure 3 End-expiratory occlusion test. The end-expiratory occlusion (EEO) test consists in interrupting mechanical ventilation at the end of expiration during 15 seconds. This suppresses the cyclic decrease in cardiac preload, which normally occurs at each mechanical insufflation. Therefore, this brief procedure should increase cardiac preload and can serve as a test to assess preload responsiveness and hence to predict the response to a subsequent fluid infusion.

Predicting volume responsiveness by using the end-expiratory occlusion in mechanically ventilated intensive care unit patients

Xavier Monnet, MD, PhD; David Osman, MD; Christophe Ridel, MD; Bouchra Lamia, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD

Crit Care Med 2009 Vol. 37, No. 3





Fluid responsiveness was predicted by an increase in pulse pressure ≥5% during the end-expiratory occlusion with a sensitivity and a specificity of 87% and 100%, respectively, and by an increase in cardiac index ≥5% during the end-expiratory occlusion with a sensitivity and a specificity of 91% and 100%, respectively

QUELLES ALTERNATIVES?

- Épreuve lever de jambe
- Test d’occlusion téléexpiratoire
- Le mini remplissage
- Le co2 télé expiratoire

"The general concept is … that the response to fluid challenge can be evaluated rapidly after a very limited amount of fluid . . ."

"Let's Give Some Fluid and See What Happens" *versus* the "Mini-fluid Challenge"

Anesthesiology 2011; 115:455–6

Jean-Louis Vincent

CRITICAL CARE MEDICINE

An Increase in Aortic Blood Flow after an Infusion of 100 ml Colloid over 1 Minute Can Predict Fluid Responsiveness

The Mini-fluid Challenge Study

Anesthesiology 2011; 115:541–7

Muller et al.

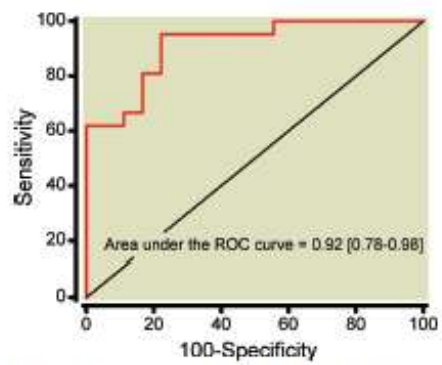


Fig. 1. Receiver operator characteristic (ROC) curves for variation of velocity time index (VTI) (cm) after infusion of 100 ml fluid over 1 min (ΔVTI_{100}) (%).

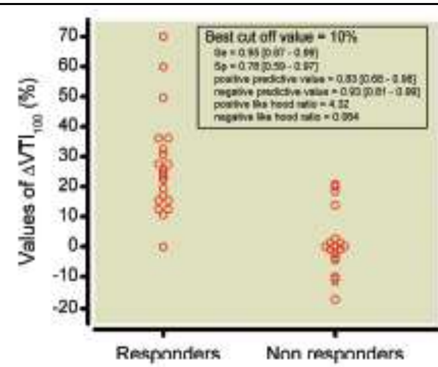
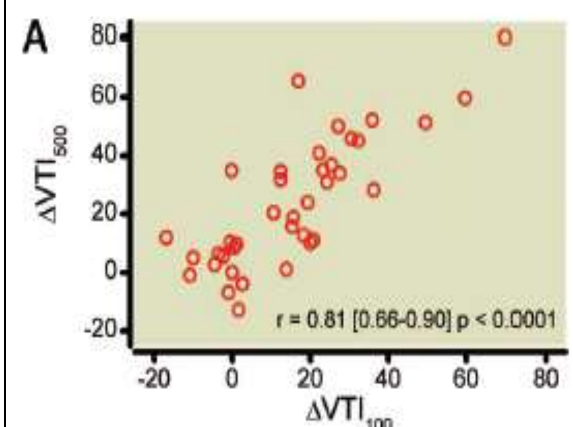


Fig. 2. Individual values of variation of velocity time index (VTI) after infusion of 100 ml fluid over 1 min (ΔVTI_{100}) (%) with the best cutoff value. Sp = specificity; Se = sensitivity.



Conclusion: In patients with low volume mechanical ventilation and acute circulatory failure, ΔVTI_{100} accurately predicts fluid responsiveness.

QUELLES ALTERNATIVES?

- Épreuve lever de jambe
- Test d'occlusion téléexpiratoire
- Le mini remplissage
- Le CO_2 télé expiratoire

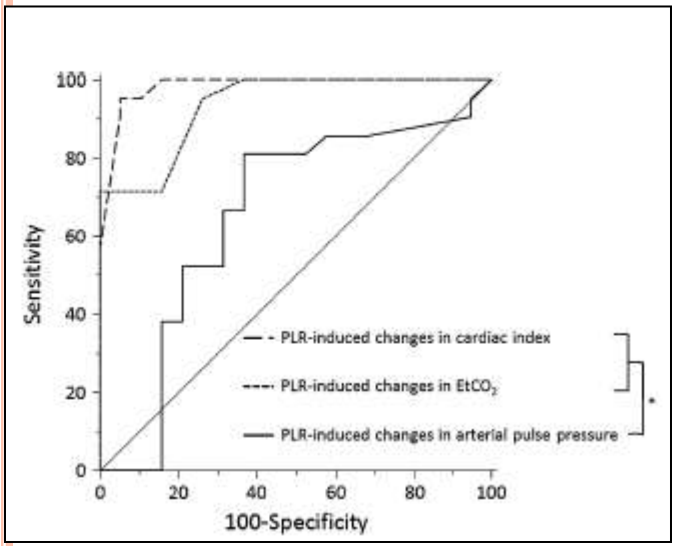
Intensive Care Med (2013) 39:93–100
DOI 10.1007/s00134-012-2693-y

ORIGINAL

Xavier Monnet
Aurélien Bataille
Eric Magalhaes
Jérôme Barrois
Marine Le Corre
Clément Gosset
Laurent Guerin
Christian Richard
Jean-Louis Teboul

End-tidal carbon dioxide is better than arterial pressure for predicting volume responsiveness by the passive leg raising test

-65 patients
- Tester la performance de la EtCO2 de prédire la variation de l'IC après ELV et la comparer à celle de la PP



Variable	AUC	p-Value versus 0.50	Best cutoff value	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Positive likelihood ratio	Negative likelihood ratio	Youden index
PLR-induced changes in cardiac index	0.98 (0.88–1.00)	<0.0001	10 %	95 (76–100)	95 (74–100)	95 (76–100)	95 (74–100)	19.0 (15.7–20.9)	0.1 (0.0–0.7)	0.90
PLR-induced changes in $EtCO_2$	0.93 (0.81–0.99)	<0.0001	5 %	71 (48–89)	100 (82–100)	100 (78–100)	76 (55–91)	4.5 (3.2–6.3)	0.3 (0.1–1.2)	0.71
PLR-induced changes in arterial pulse pressure	0.65 (0.49–0.80)	0.07								

Conclusions

The changes in $EtCO_2$ induced by a PLR test predicted fluid responsiveness with reliability, while the changes in arterial pulse pressure did not. $EtCO_2$ monitoring should thus be regarded as a noninvasive surrogate of CI during PLR when no device is available for measuring CI.

British Journal of Anaesthesia **109** (3): 330–8 (2012)

Prediction of fluid responsiveness by a continuous non-invasive assessment of arterial pressure in critically ill patients: comparison with four other dynamic indices

X. Monnet[1,2*], M. Dres[1,2], A. Ferré[1,2], G. Le Teuff[4], M. Jozwiak[1,2], A. Bleibtreu[1,2], M.-C. Le Deley[4], D. Chemla[1,3], C. Richard[1,2] and J.-L. Teboul[1,2]

	AUC (95% CI)	Sensitivity	Specificity	Youden index	Optimal cut-off	'Grey zone'*	Positive predictive value	Negative predictive value	Positive likelihood ratio	Negative likelihood ratio
Predictors of fluid responsiveness considered alone										
SVV	0.84 (0.71–0.97)	0.76	0.82	0.58	14%	9–19%	0.76	0.82	4.21	0.29
PPVi	0.89 (0.77–1.01)	0.88	0.91	0.79	10%	7–13%	0.88	0.91	9.71	0.13
PPVni	0.89 (0.78–1.01)	0.82	0.91	0.73	11%	8–14%	0.88	0.87	9.06	0.19
PLR	0.95 (0.88–1.03)	1.00	0.91	0.91	11%	9–13%	0.89	1.00	11.00	0.00
EEO	0.97 (0.91–1.03)	1.00	0.91	0.91	5%	4–6%	0.89	1.00	11.00	0.00
GEDV	0.52 (0.51–0.63)†									

	AUC (95% CI)	Sensitivity	Specificity	Youden index	Optimal cut-off	'Grey zone'*	Positive predictive value	Negative predictive value	Positive likelihood ratio	Negative likelihood ratio
Predictors of fluid responsiveness considered in combination†										
PPVi-SVV	0.89 (0.76-1.01)	0.88	0.91	0.79			0.88	0.91	9.70	0.13
SVV-PLR	0.97 (0.92-1.01)	0.94	0.91	0.85			0.89	0.95	10.35	0.06
SVV-EEO	0.97 (0.93-1.02)	1.00	0.91	0.91			0.89	1.00	11.00	0.00
PLR-EEO	0.98 (0.94-1.01)	1.00	0.91	0.91			0.89	1.00	11.00	0.00
PPVi-PLR	0.98 (0.94-1.01)	0.94	0.95	0.89			0.94	0.95	20.70	0.06
PPVi-EEO	0.98 (0.95-1.01)	1.00	0.91	0.91			0.89	1.00	11.00	0.00
PPVi-SVV-PLR	0.98 (0.95-1.01)	0.94	0.95	0.89			0.94	0.95	20.70	0.06
PPVi-SVV-EEO	0.98 (0.95-1.01)	1.00	0.91	0.91			0.89	1.00	11.00	0.00
PPVi-PLR-EEO	0.99 (0.97-10.1)	1.00	0.91	0.91			0.89	1.00	11.00	0.00
SVV-PLR-EEO	0.99 (0.98-1.01)	0.94	1.00	0.94			1.00	0.96	—	0.06

Monnet and Teboul *Critical Care* 2013, 17:217
http://ccforum.com/content/17/2/217

CRITICAL CARE

REVIEW

Assessment of volume responsiveness during mechanical ventilation: recent advances

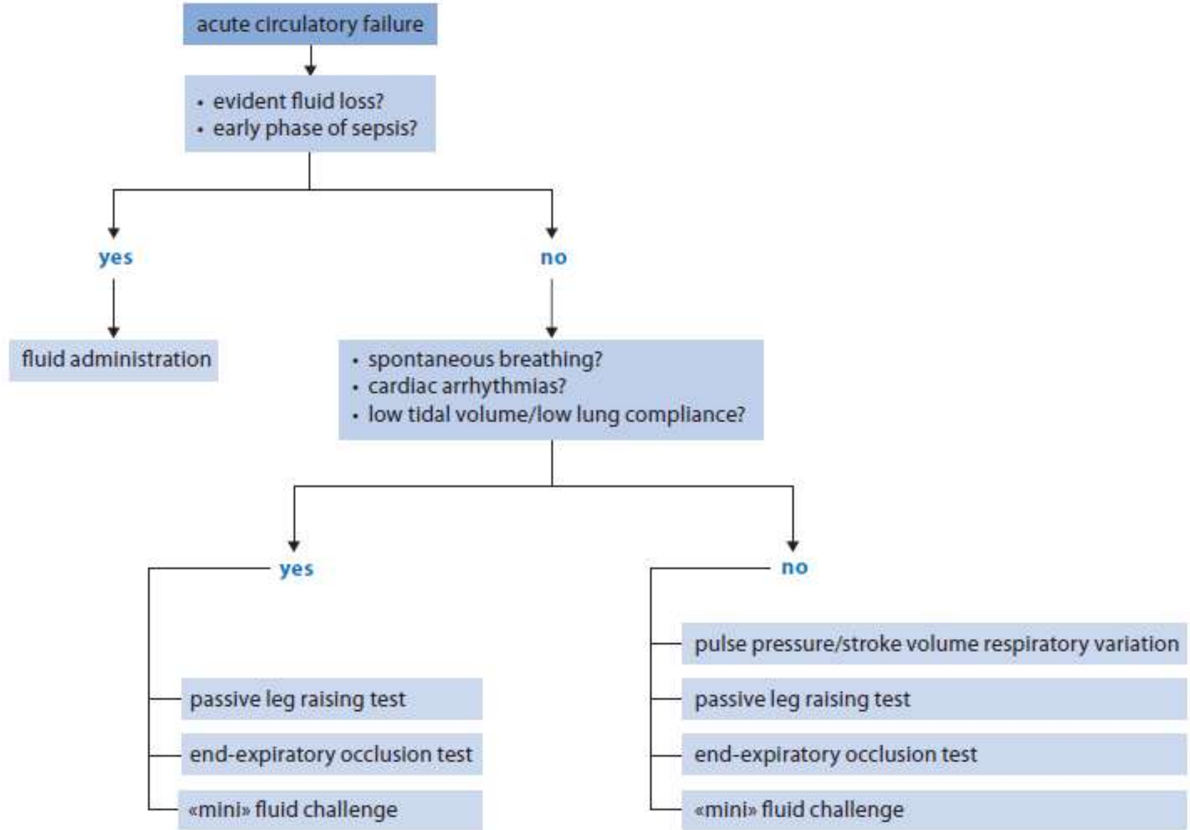


Figure 2. Decision-making process of fluid administration.

MERCI

By Jean Louis Teboul

Just fastening the belt! Is it the future measure for assessing fluid responsiveness?*