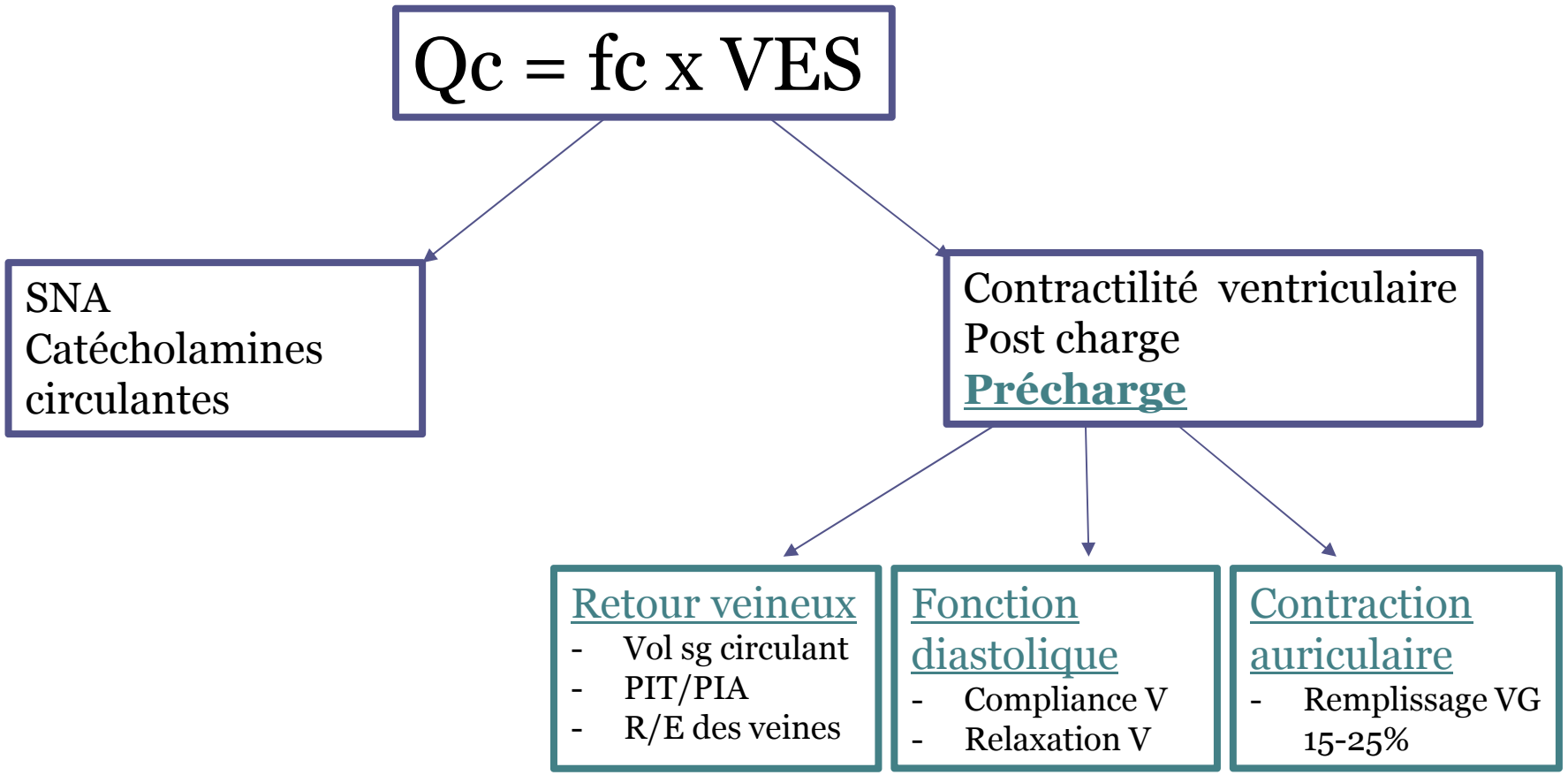
Quels outils prédictifs du remplissage ? La variation de la veine cave inférieure

Etudiant : Ophélie Fourdinier
Tuteur : Pr Julien Maizel

DESC de Réanimation
21 octobre 2016 - Caen

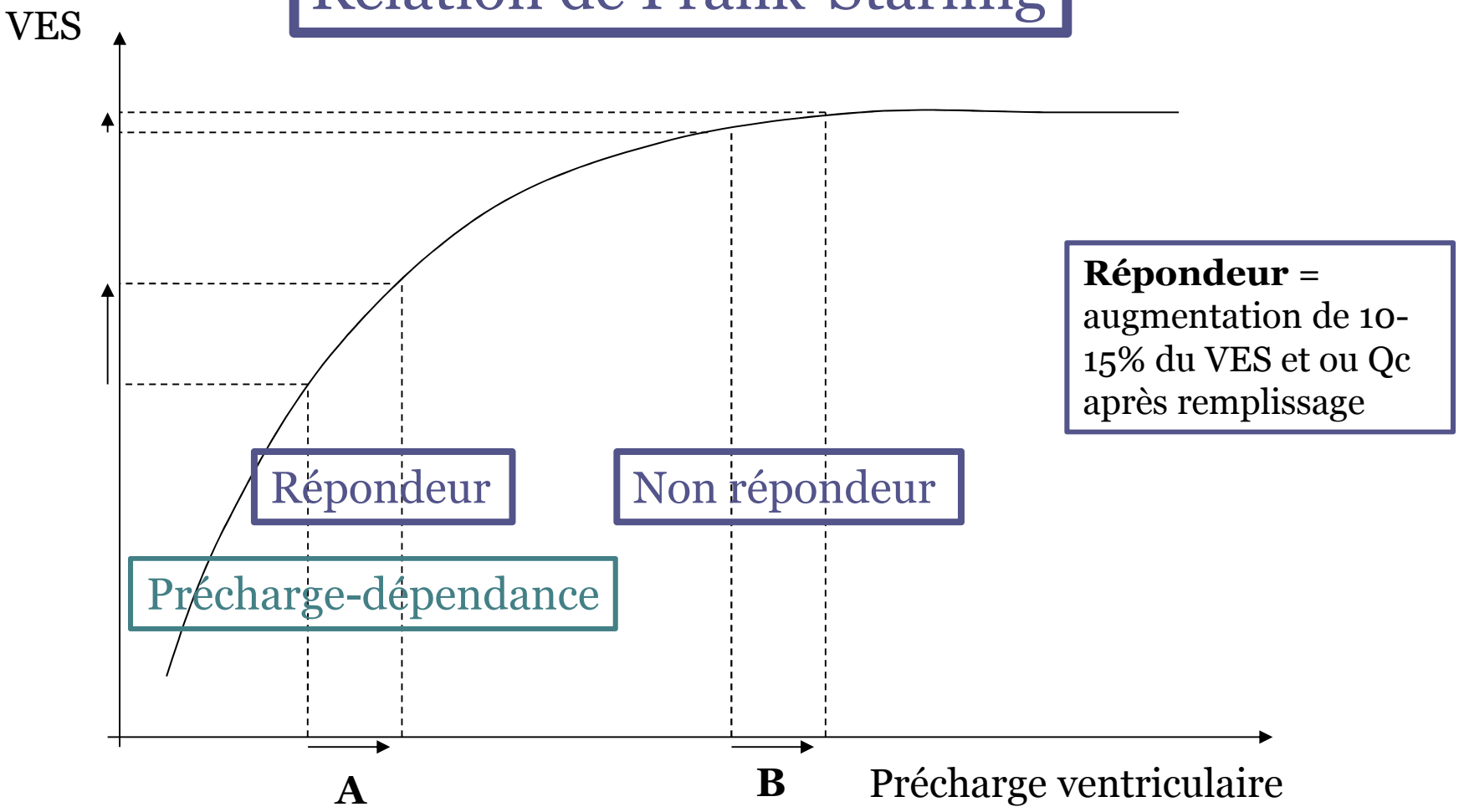
CHU AMIENS PICARDIE

Introduction



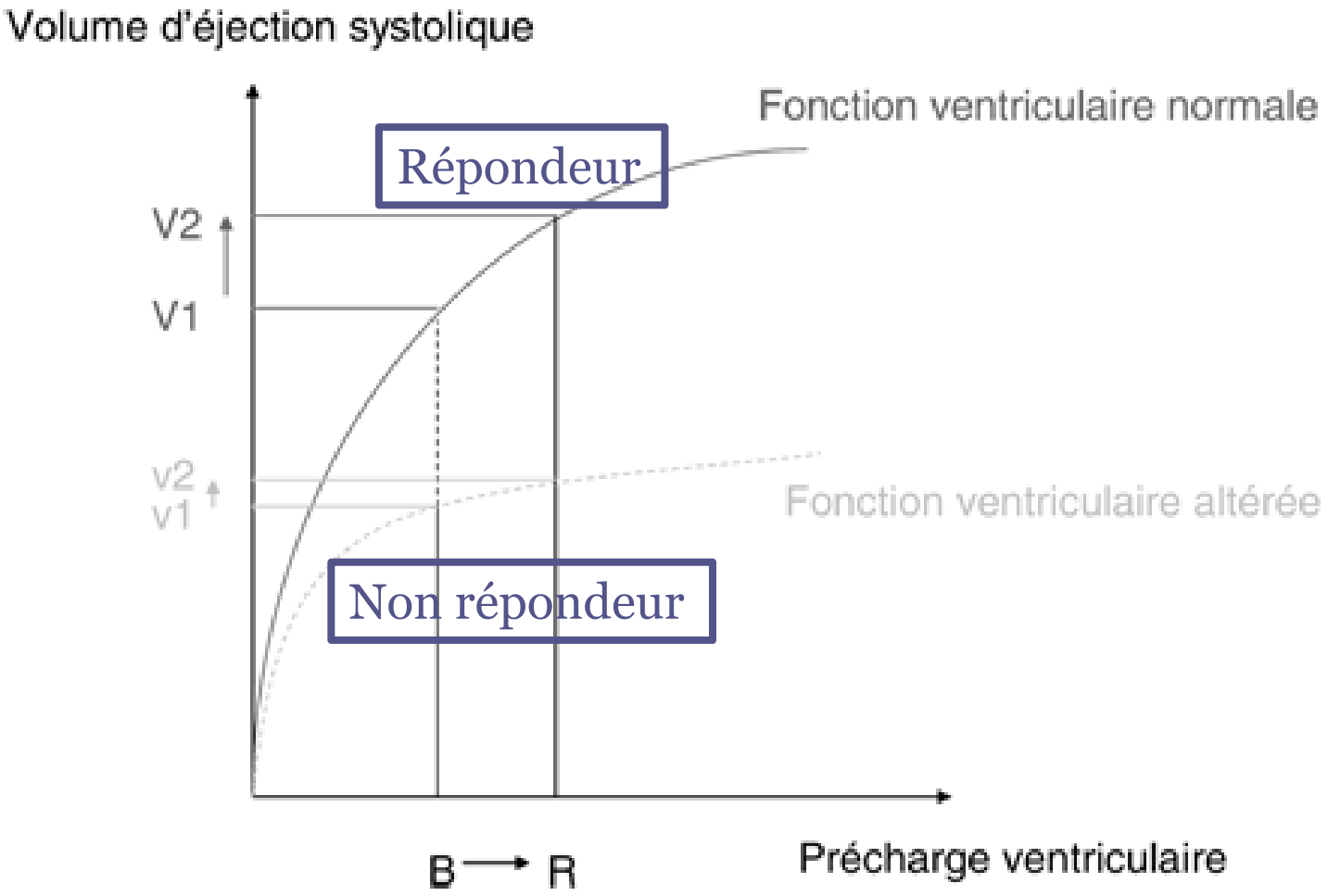
Précharge-dépendance

Relation de Frank-Starling



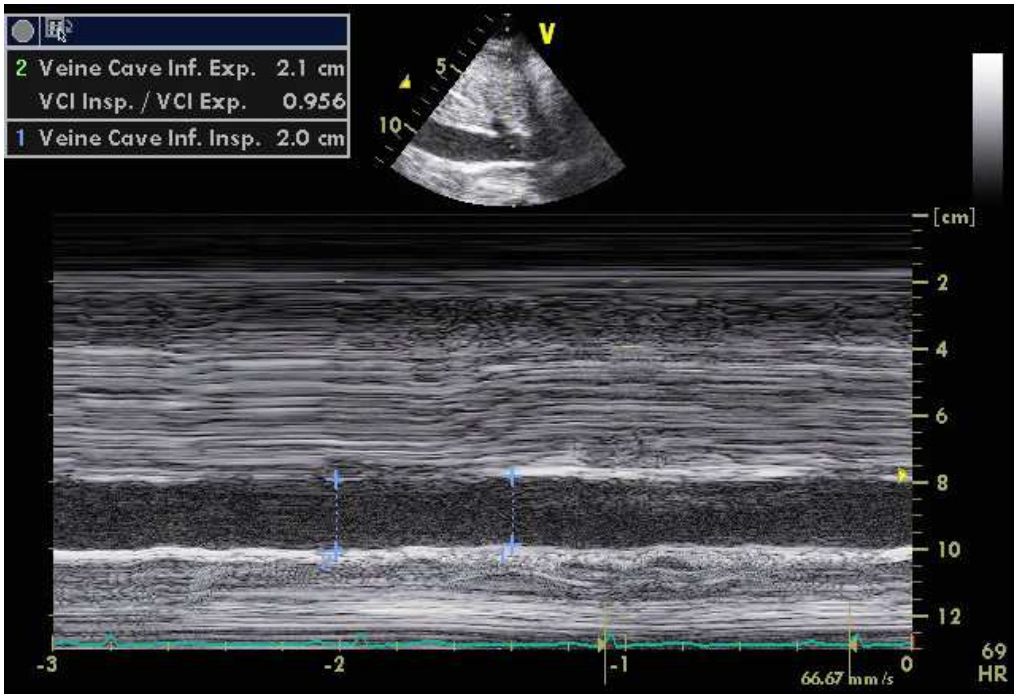
Répondeur = augmentation de 10-15% du VES et ou Qc après remplissage

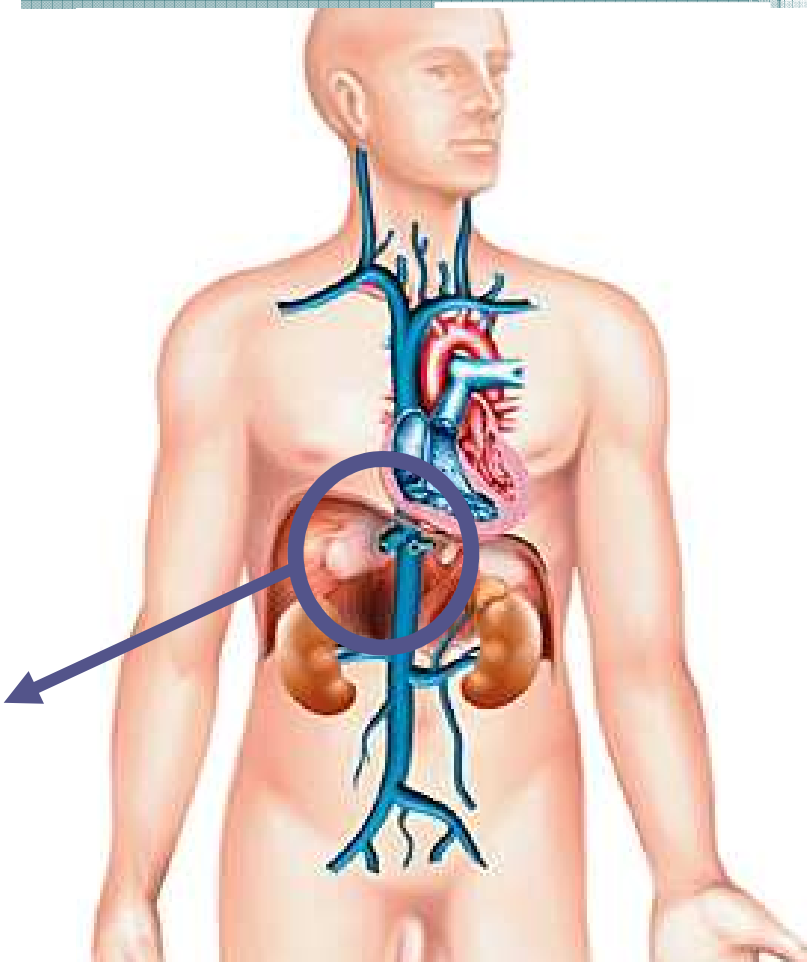
Relation de Frank-Starling



Introduction

- ETT
- Voie sous-costale
- Mode TM
- 1 à 2 cm avant l'OD





Introduction

- Diamètre VCI dépend de :
  - Pression intra-murale du vaisseau
    - Varie en fonction du volume sanguin circulant
  - Pression extra-murale du vaisseau
    - Dépendante de la pression intra-abdominale

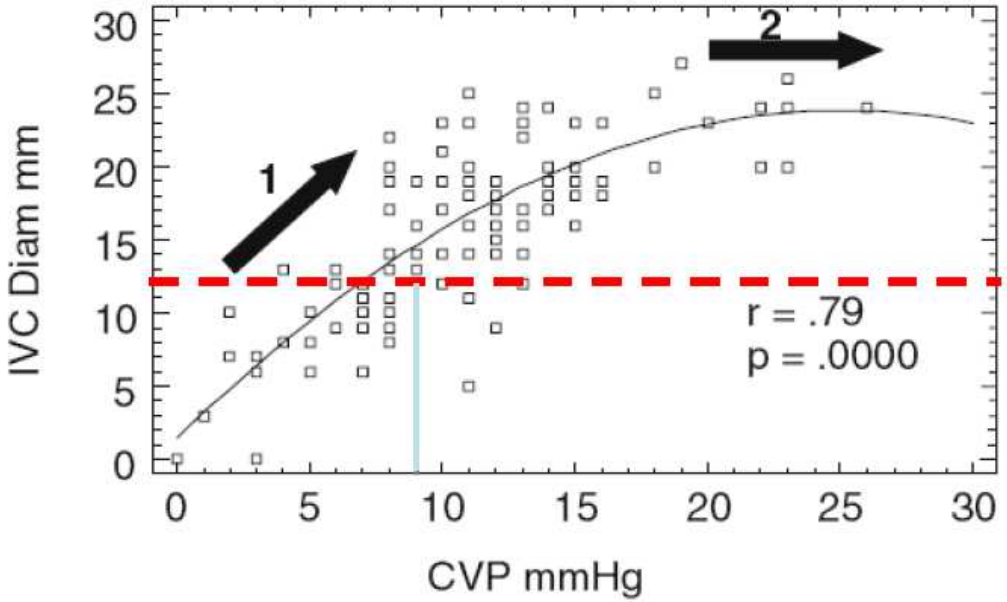
Les variations de la VCI en…

Ventilation Contrôlée

Ventilation contrôlée

Paramètre statique

- Pression veineuse centrale
  - Estimée par mesure du diamètre de la VCI
    - Ø < 10-12 mm = +/- prédictif d'une réponse au remplissage



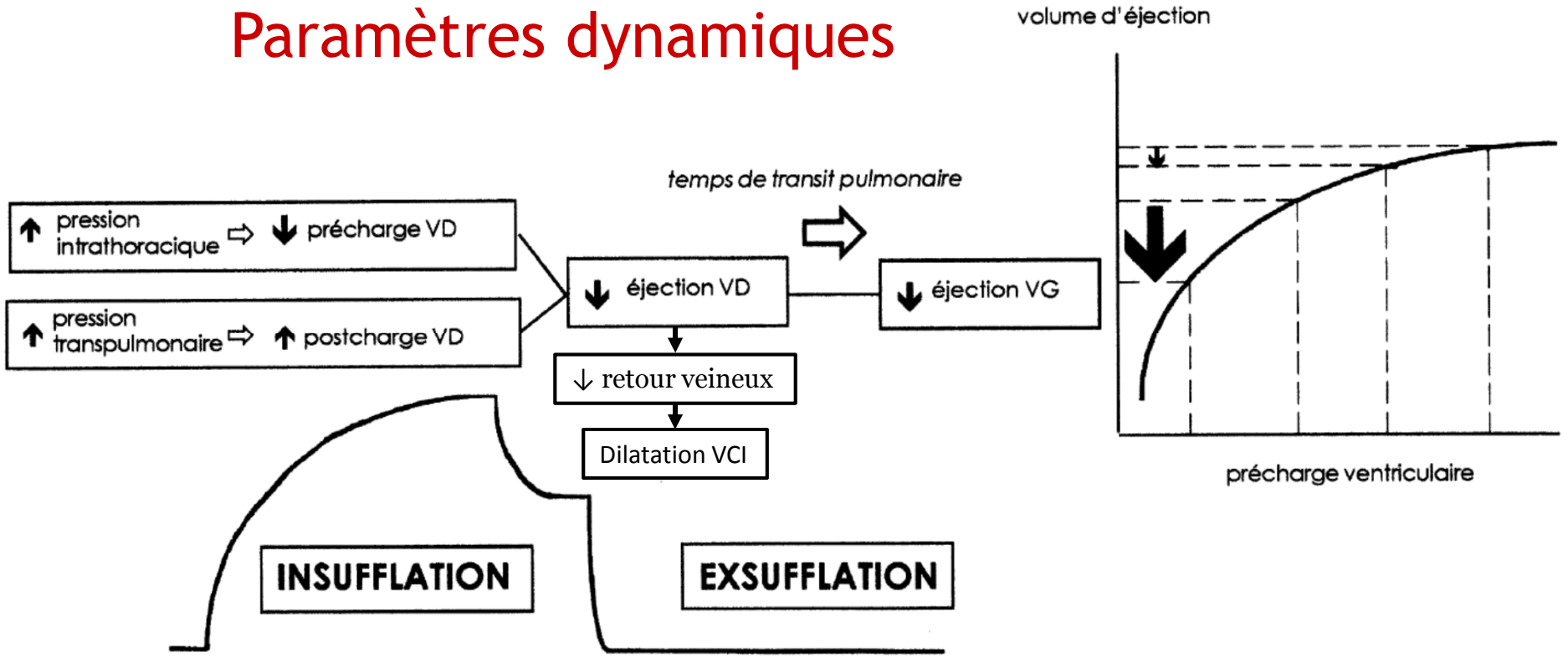
Ø VCI < 12 mm = POD < 10 mmHg
(Se = 100% ; Sp = 25%)

Ø VCI > 12 mm = NON prédictif

Jue et al. J Am Soc Echocardiogr, 1992

Ventilation contrôlée

Paramètres dynamiques



- Variabilité respiratoire importante ≈ retentissement important de la ventilation sur le retour veineux systémique ≈ précharge-dépendance

Barbier C et al. Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients. Intensive Care Med. 2004

Ventilation contrôlée

Paramètres dynamiques

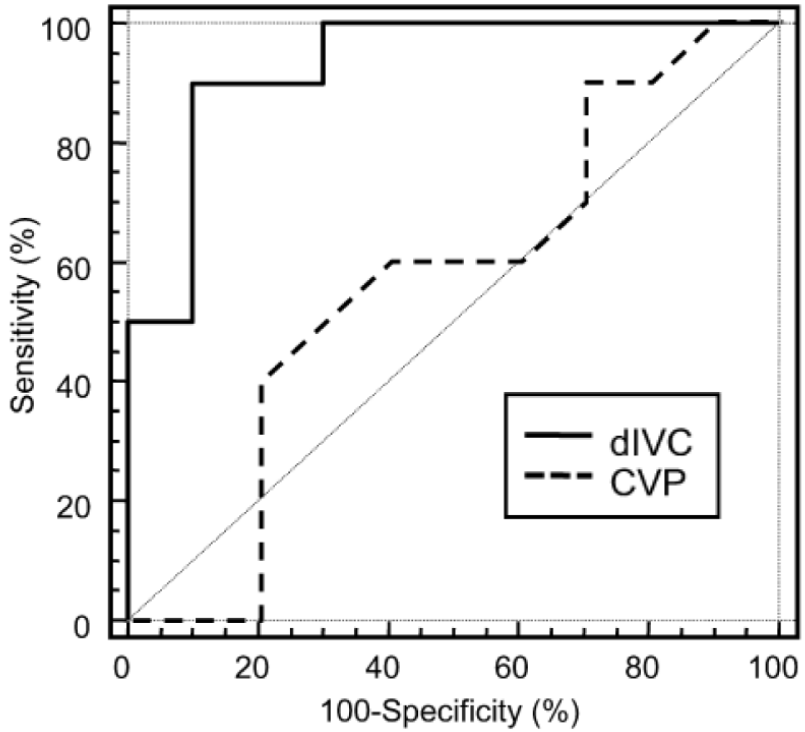
$$\text{"Indice de distensibilité"}\quad dIVC = \frac{IVCmax - IVCmin}{IVCmin} > 18\ \%$$

$$\Delta IVC = \frac{IVCmax - IVCmin}{0{,}5(IVCmax + IVCmin)} > 12\ \%$$

Slama et Maizel, Hemodynamic monitoring using echocardiography in the critically ill, 2011

Ventilation contrôlée

Paramètres dynamiques

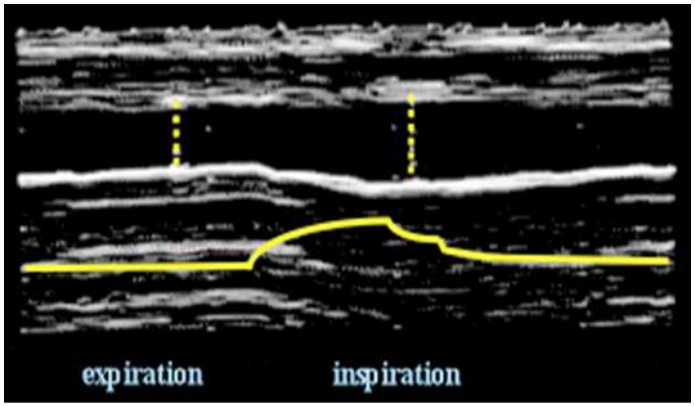


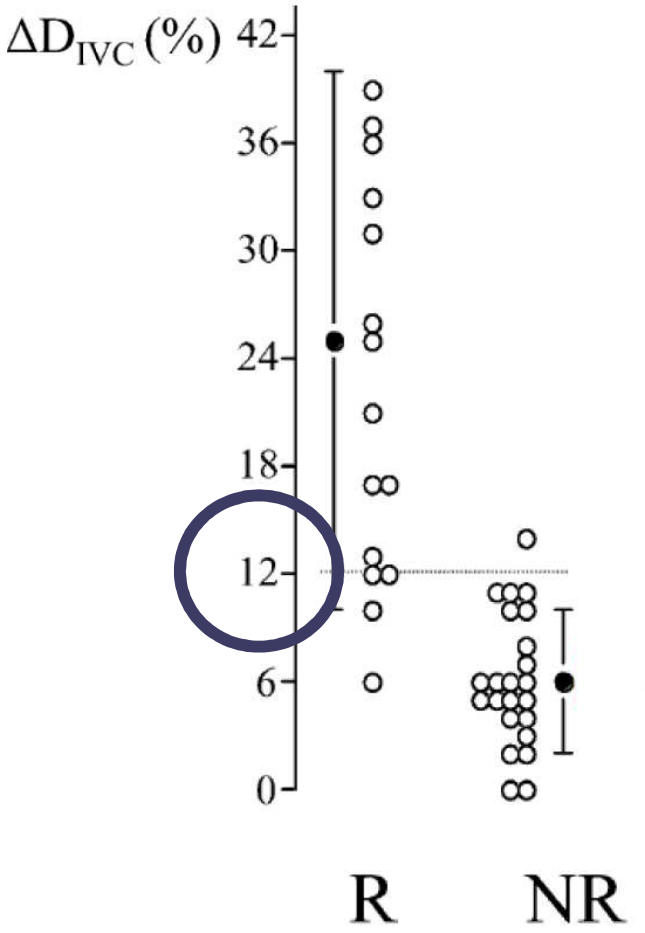
dIVC > 18%
Se = 90%
Sp = 90%
AUC = 0,91

Barbier C et al. Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients. Intensive Care Med 2004.

Ventilation contrôlée

Paramètres dynamiques





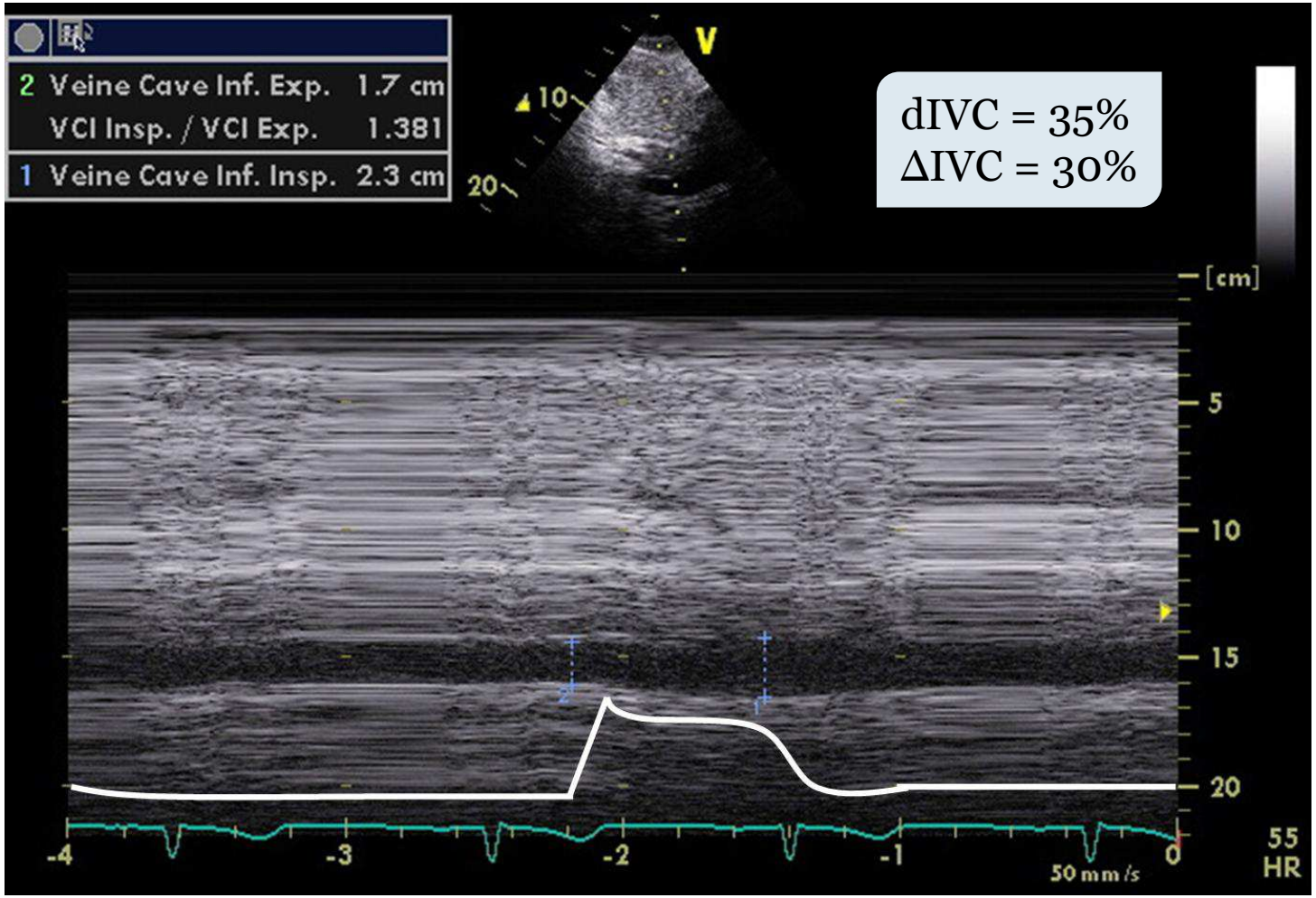
ΔIVC > 12%
Se = 93%
Sp = 92%
AUC = 0,91

- 39 patients
- Choc septique
- VM
- Vt > 7 ml/kg

Feissel M et al. The respiratory variation in inferior vena cava diameter as a guide to fluid therapy. Intensive Care Med 2004.

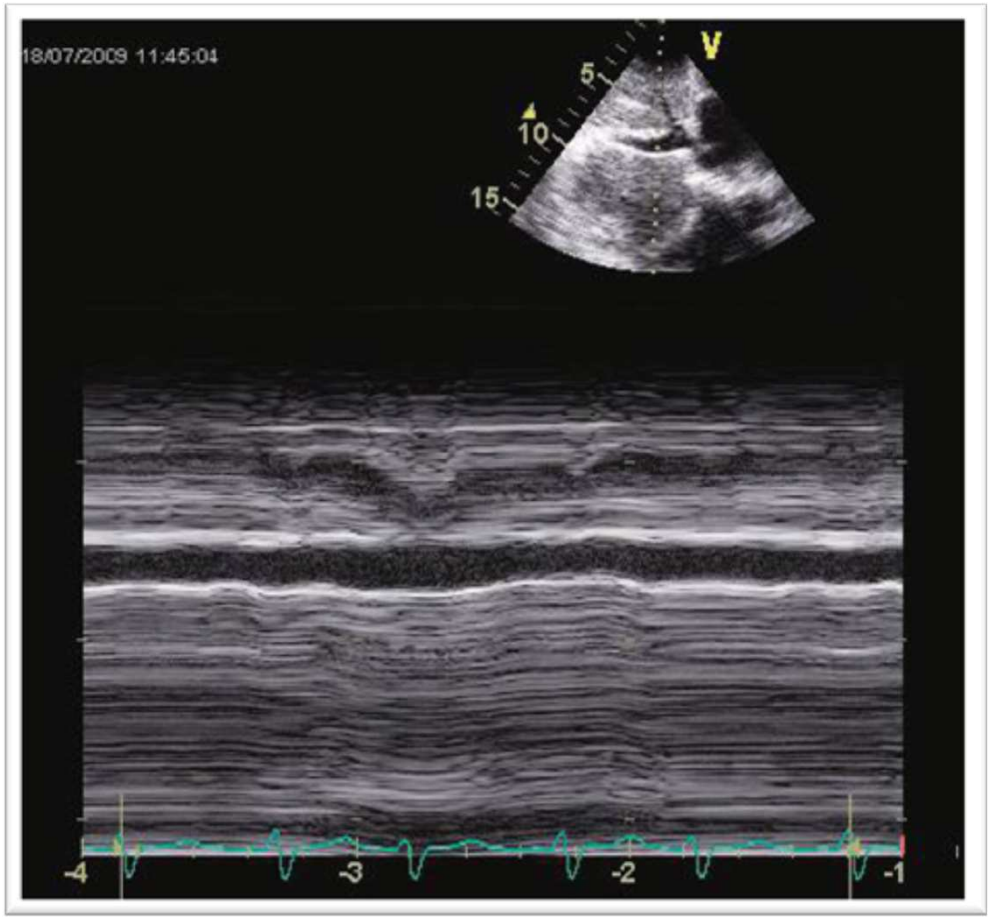
Ventilation contrôlée

Paramètres dynamiques



Ventilation contrôlée

Paramètres dynamiques



Slama et Maizel, Hemodynamic monitoring using echocardiography in the critically ill, 2011

Ventilation contrôlée

Paramètres dynamiques

- Limites d'utilisation
  - PEP haute (> 12) et/ou Vt bas (< 7-8 ml/kg)
  - VSAI/VNI/CPAP/VS
  - Compliance pulmonaire basse – asthme - exacerbation de BPCO
  - Dysfonction VD/IT
  - Infarctus myocardique, tamponnade
  - HTIA/syndrome du compartiment abdominal
  - Sténose/thrombose/masse compressive/filtre cave/canule d'ECMO

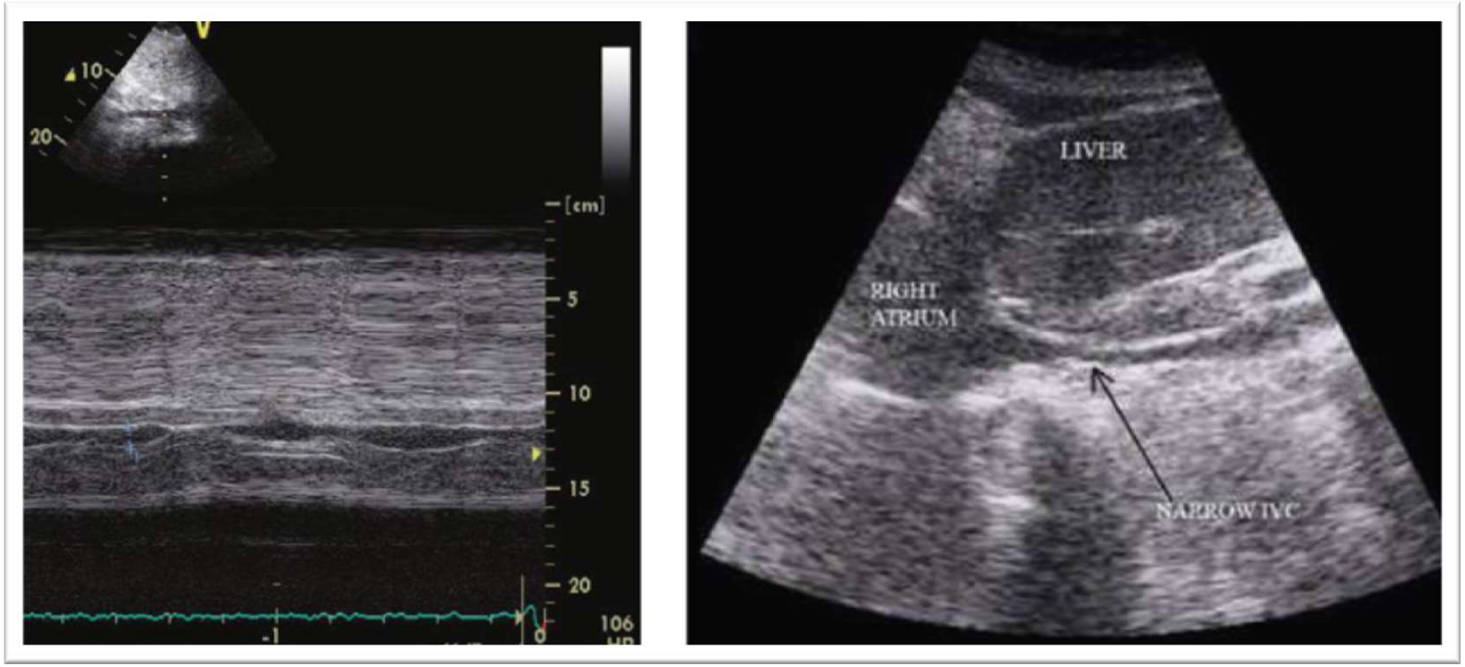
Les variations de la VCI en…

Ventilation Spontanée

Ventilation spontanée

Paramètre statique

- Diamètre VCI télé-expiratoire < 10 mm
  - = POD < 10 mmHg



Slama et Maizel, Hemodynamic monitoring using echocardiography in the critically ill, 2011

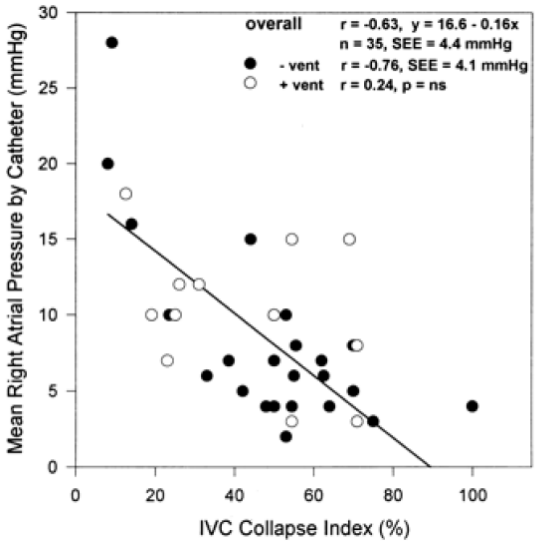
Ventilation spontanée

Paramètre dynamique

- Diminution inspiratoire de la VCI = **index de collapsibilité**

$$cIVC = \frac{IVCmax - IVCmin}{IVCmin}$$

  - cVCI > 50% = PVC (POD) < 10 mmHg
    - Se = 87 % ; Sp = 82 %



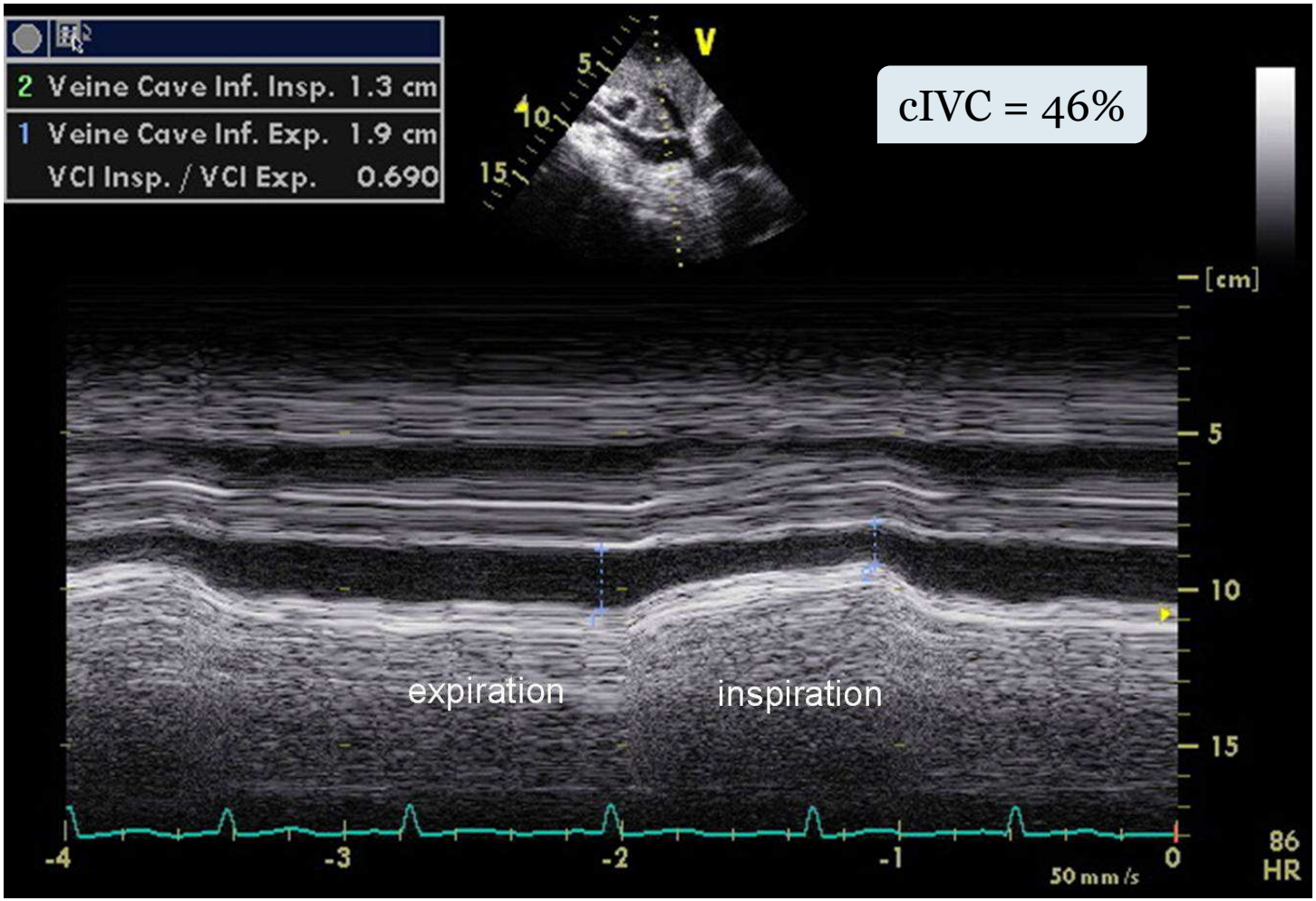
Nagueh et al. Circulation, 1996

- Attention :
  - Prédictif du remplissage avec bonne Sp mais mauvaise Se
  - Non applicable si dysfonction VD ou péricardite constrictive

Kirscher et al. Noninvasive estimation of right atrial pressure from the inspiratory collapse of the inferior vena cava. Am J Cardiol, 1990

Ventilation spontanée

Paramètre dynamique

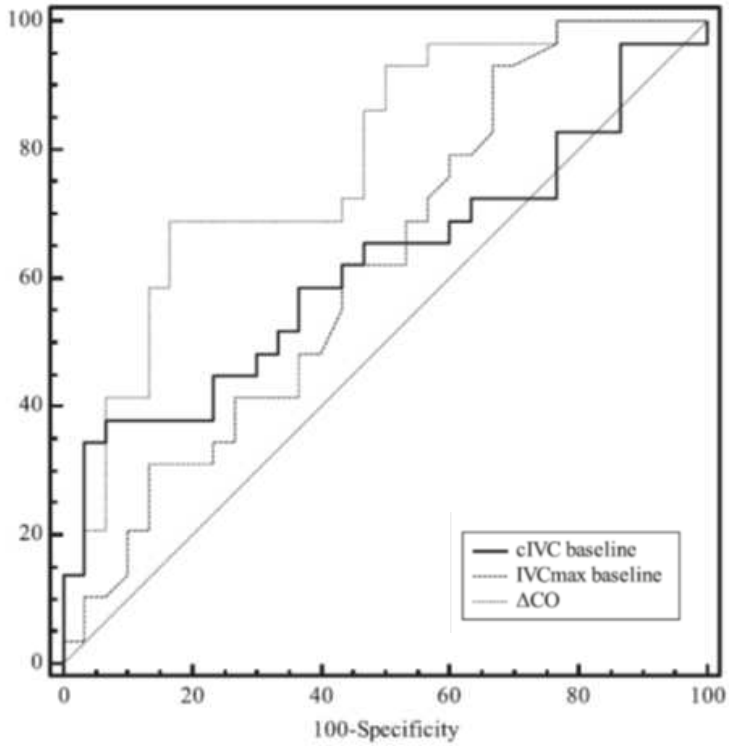


Ventilation spontanée

- 59 patients en VS
- ETT : ITV, VES, Qc, cIVC.
  - Initial - Après manœuvre de levée de jambe (PLR) - Après 500 ml NaCl 0,9%

	Responders ($n = 29$)	Nonresponders ($n = 30$)	p
IVCmin, mm			
Baseline	11 ± 5	14 ± 5	0.04
PLR	16 ± 4*	15 ± 6	0.52
Volume expansion	12 ± 5	16 ± 5*	0.004
IVCmax, mm			
Baseline	17 ± 4	19 ± 4	0.07
PLR	19 ± 4	19 ± 5	0.90
Volume expansion	16 ± 4	19 ± 5	0.01
cIVC, %			
Baseline	35 ± 16	27	
PLR	19 ± 10*	28	
Volume expansion	18 ± 10*	28	

Values are expressed as the mean ± SD
IVCmax maximum inferior vena cava diameter, *PLR* passive leg raising, *IVCmin* minimum inferior vena cava diameter, *cIVC* inferior vena cava collapsibility index
* = $p < 0.05$ vs. baseline



	Se	Sp	LR+	LR-	PPV	NPV
cIVC > 42 %	31 %	97 %	9	0.7	90 %	59 %
IVCmax at baseline < 2.1 cm	93 %	33 %	1.4	0.2	57 %	83 %
ΔCO > 10 %	52 %	87 %	4	0.6	79 %	65 %

Airapetian, Maizel et al. Does inferior vena cava respiratory variability predict fluid responsiveness in spontaneously breathing patients? Critical Care, 2015

Ventilation spontanée

Diagnostic Accuracy of the Inferior Vena Cava Collapsibility to Predict Fluid Responsiveness in Spontaneously Breathing Patients With Sepsis and Acute Circulatory Failure

Sebastien Preau, MD, PhD[1]; Perrine Bortolotti, MD[2,3]; Delphine Colling, MD[2,3]; Florent Dewavrin, MD[3]; Vincent Colas, MD[3]; Benoit Voisin, MD[2]; Thierry Onimus, MD[2]; Elodie Drumez, BST[2]; Alain Durocher, MD[2]; Alban Redheuil, MD, PhD[4]; Fabienne Saulnier, MD[2]

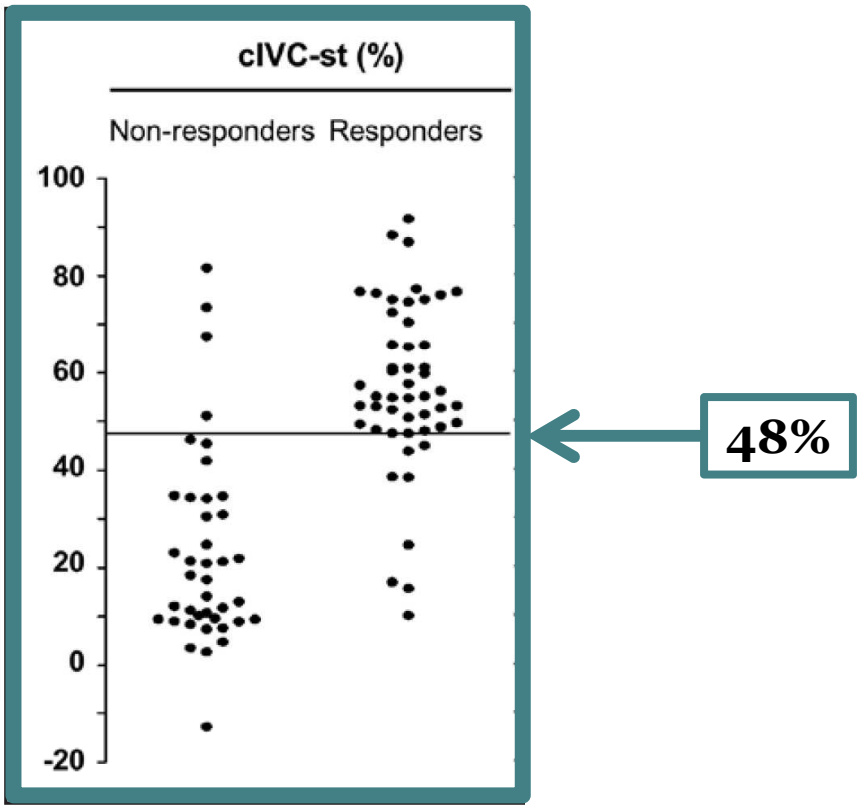
Critical Care Medicine
Society of Critical Care Medicine

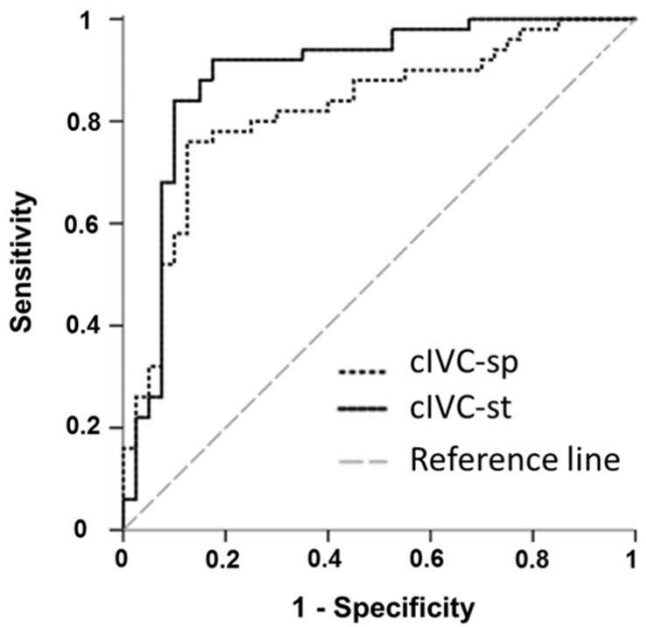
Septembre 2016

90 patients
Non intubés
Choc septique

Etude hémodynamique avant et après remplissage par 500 ml de gélatine 4%

Ventilation spontanée





AUC = 0.89 [0.82-0.97]
Se = 0.84 [0.71-0.93]
Sp = 0.90 [0.76-0.97]

Figure 2. Individual values before volume expansion for each indicator, the collapsibility index of the inferior vena cava under standardized breathing (cIVC-st), collapsibility index of the IVC under spontaneous breathing (cIVC-sp), end-expiratory diameter of the IVC under standardized breathing (eIVC-st), and end-expiratory diameter of the IVC under spontaneous breathing (eIVC-sp) in patients with volume expansion–induced changes in stroke volume index of ≥ 10% (responders) and < 10% (nonresponders).

Table 1 Ten conditions potentially affecting inferior vena cava (IVC) ultrasound reliability in predicting fluid responsiveness (FR)

Physiological determinant	Condition affecting IVC ultrasound reliability for FR	Cause of inaccuracy for FR	Type of inaccuracy for FR
Ventilator settings	1. Mechanical ventilation with high PEEP and/or low tidal volumes	Larger IVC size, potentially with systemic venous congestion and low respiratory variations, but coexisting with FR	FN
Patient's inspiratory efforts	2. Assisted ventilation modalities, NIV, CPAP	Spontaneous breathing activity makes IVC variation unpredictable	FP and FN
	3. Varying respiratory pattern in spontaneous breathing	Significant inspiratory effort, producing markedly negative intrathoracic pressures may induce IVCc in absence of FR	FP
		Shallow breathing, with small intrathoracic pressure changes, may induce absence of IVCc in presence of FR	FN
Lung hyperinflation	4. Asthma/COPD exacerbation	Lung hyperinflation and auto-PEEP simultaneously reduce venous return and induce IVC distension: this may mimic absence of FR	FN
		Forced expiration ("abdominal breathing" causing expiratory collapse) may mimic IVCc	FP
Cardiac conditions impeding venous return	5. Chronic RV dysfunction, severe TR	Chronic enlargement of IVC and reduced IVCc may erroneously rule out FR	FN
	6. RV myocardial infarction	RV dilatation and systemic venous congestion (large IVC) may be associated with FR	FN
	7. Cardiac tamponade	Marked venous return hindrance: fluid challenge may be a beneficial haemodynamic intervention despite IVC plethora	FN
Increased abdominal pressure	8. Intra-abdominal hypertension	Smaller IVC size, IVCd or IVCc abolition (depending on type respiration/ventilation mode)	FP and FN
Other factors	9. Local mechanical factors	Venous return hindrance, IVC dilatation (stenosis, thrombosis)	FN
		IVC compression (masses)	FP
		Hindrance to IVC size change (ECMO cannulae, cava filters)	FN
	10. Patients with pronounced IVC inspiratory lateral displacement	Migration of IVC imaging plane, false inspiratory size reduction	FP

Conclusion

Facteurs prédictifs du remplissage

- Ventilation contrôlée
  - Diamètre VCI < 12 mm
  - dIVC > 18%
  - ΔIVC > 12%
- Ventilation spontanée
  - Diamètre VCI télé-expi < 10 mm
  - cIVC > 48%
- Nombreuses limites +++