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Echographie thoracique : *les outils de demain*

Le futur de l'échocardiographie en 2019

Le futur de l'échocardiographie en 2019 :

1. Reconnaître avec une bonne sécurité des phénotypes simples dans les états de choc

Les trois questions hémodynamiques chez le patient critique

100 % de remplissage – 50 % vasopresseur – 15 % d'inotropes

TABLE 4. TREATMENTS ADMINISTERED.*

TREATMENT	HOURS AFTER THE START OF THERAPY		
	0-6	7-72	0-72
Total fluids (ml)			
Standard therapy	3499±2438	10,602±6,216	13,358±7,729
EGDT	4981±2984	8,625±5,162	13,443±6,390
P value	<0.001	0.01	0.73
Red-cell transfusion (%)			
Standard therapy	18.5	32.8	44.5
EGDT	64.1	11.1	68.4
P value	<0.001	<0.001	<0.001
Any vasopressor (%)†			
Standard therapy	30.3	42.9	51.3
EGDT	27.4	29.1	36.8
P value	0.62	0.03	0.02
Inotropic agent (dobutamine) (%)			
Standard therapy	0.8	8.4	9.2
EGDT	13.7	14.5	15.4
P value	<0.001	0.14	0.15
Mechanical ventilation (%)			
Standard therapy	53.8	16.8	70.6
EGDT	53.0	2.6	55.6
P value	0.90	<0.001	0.02
Pulmonary-artery catheterization (%)‡			
Standard therapy	3.4	28.6	31.9
EGDT	0	18.0	18.0
P value	0.12	0.04	0.01

100 % de fluides

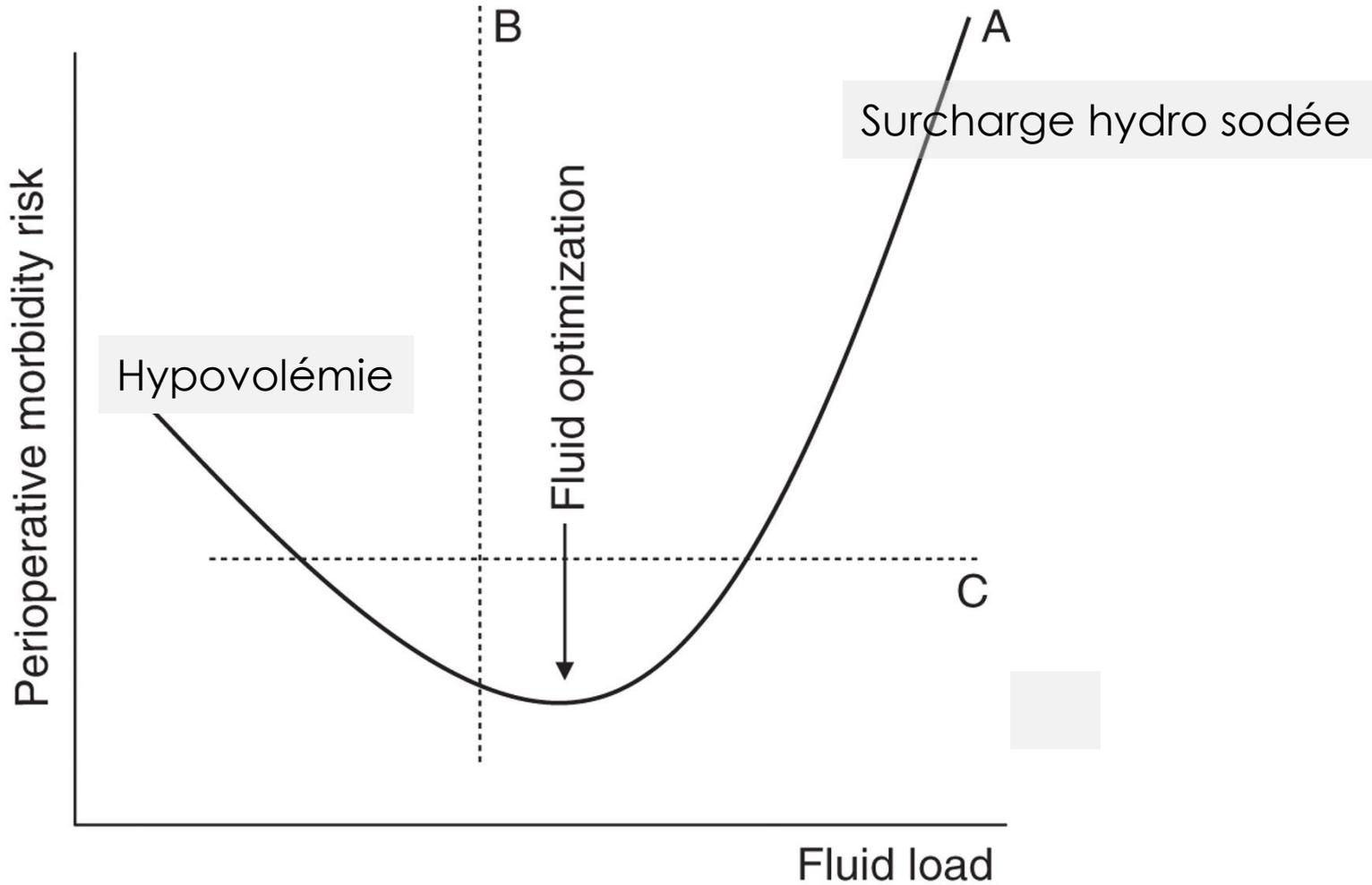
30 à 50 % de vasopresseurs

15 % d'inotropes

Rivers et al N Engl J Med 2001
 Myburgh et al NEJM 2012
 Mouncey et al NEJM 2015

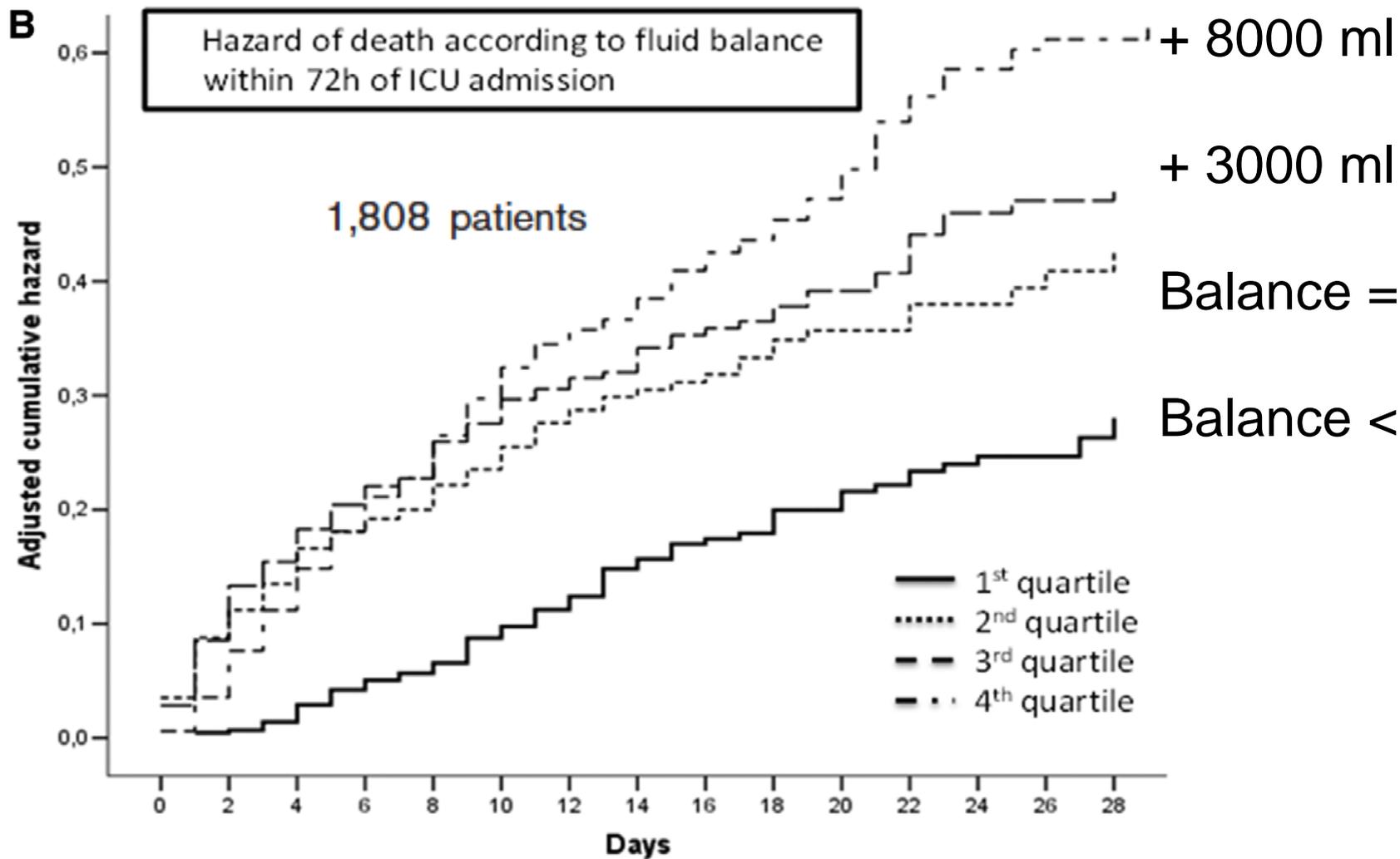
Wet, dry or something else ?

Bellamy et al Br J Anaesth 2006



Remplissage vasculaire :

Balance hydro sodée positive = surmortalité (Post hoc ICON study)



Effect of an Early Resuscitation Protocol on In-hospital Mortality Among Adults With Sepsis and Hypotension

A Randomized Clinical Trial



Mortality

48.1 %

33.0 %

$p < 0.01$

	Sepsis Protocol (n = 106)	Usual Care (n = 103)	P Value
Intravenous fluid administration, median (IQR), L ³			
6 h	3.5 (2.7 to 4.0)	2.0 (1.0 to 2.5)	<.001
24 h	4.0 (3.0 to 5.0)	3.0 (2.0 to 4.3)	<.001
72 h	5.0 (3.5 to 6.5)	4.0 (3.0 to 6.0)	.33

Choc septique, Zambie, accueil urgences CH de proximité, pas de service de réanimation

=> Pas plus de 2000 ml sans monitoring ?

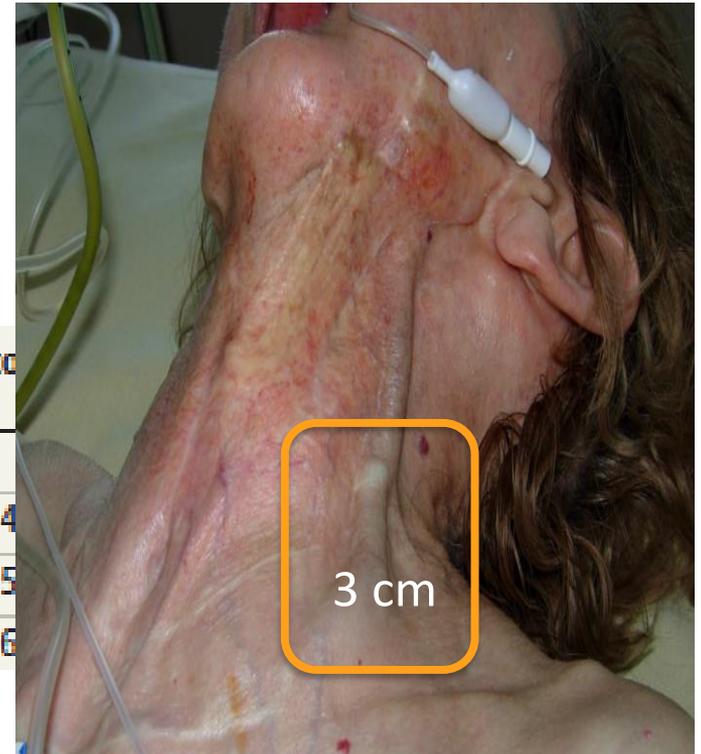
Effect of an Early Resuscitation Protocol on In-hospital Mortality Among Adults With Sepsis and Hypotension

A Randomized Clinical Trial

Mortality

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72 h	5.0 (3.5 to 6.0)



Choc septique, Zambie, accueil urgences CH de proximité, pas de service de réanimation
Monitoring de la volémie = taille clinique de la veine jugulaire externe

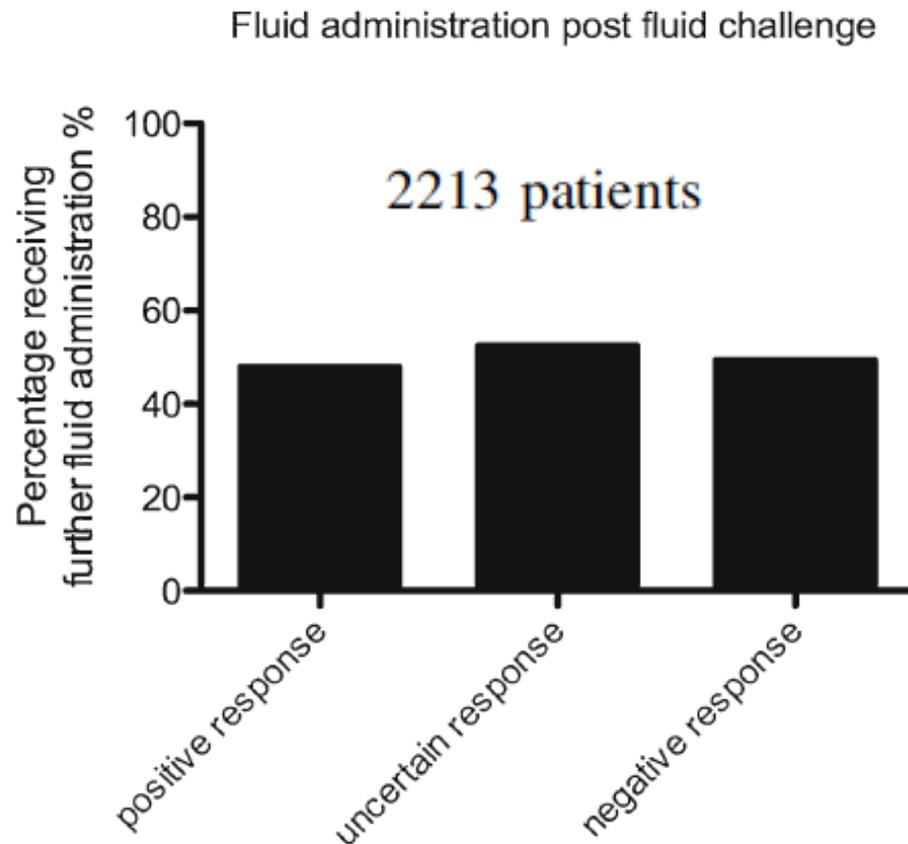
Outils d'évaluation de la volémie :

Le remplissage est poursuivi quelle que soit la réponse

Maurizio Cecconi
Christoph Hofer
Jean-Louis Teboul
Ville Pettila
Erika Wilkman
Zsolt Molnar
Giorgio Della Rocca
Cesar Aldecoa
Antonio Artigas
Sameer Jog
Michael Sander
Claudia Spies
Jean-Yves Lefrant
Daniel De Backer

Fluid challenges in intensive care: the FENICE study

A global inception cohort study



Le quotidien en hémodynamique :

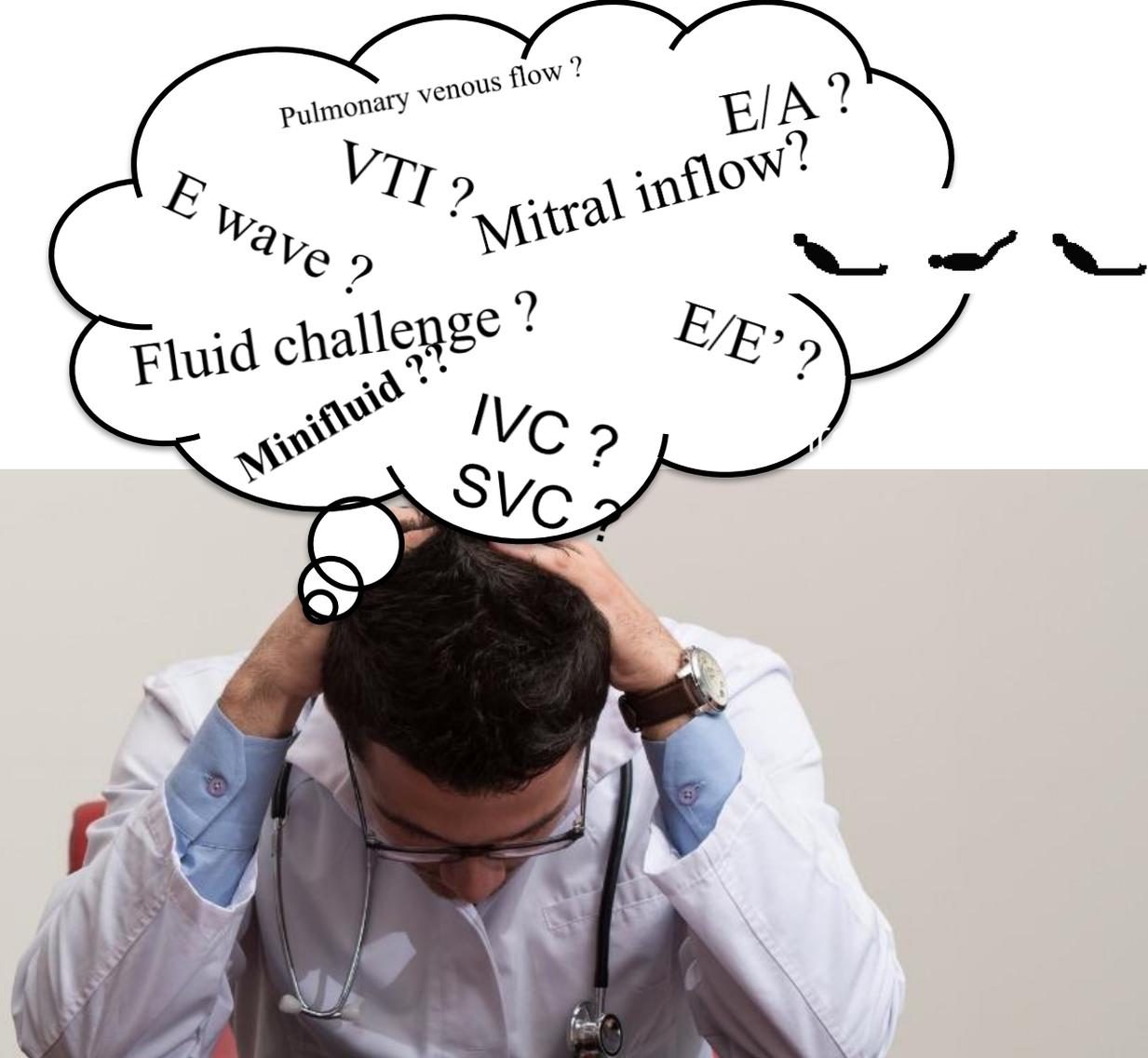
... garder en tête les 3 profils fondamentaux

Pressions de
remplissage

Débit cardiaque

SvO₂

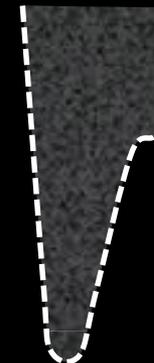
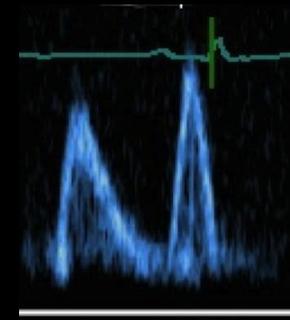
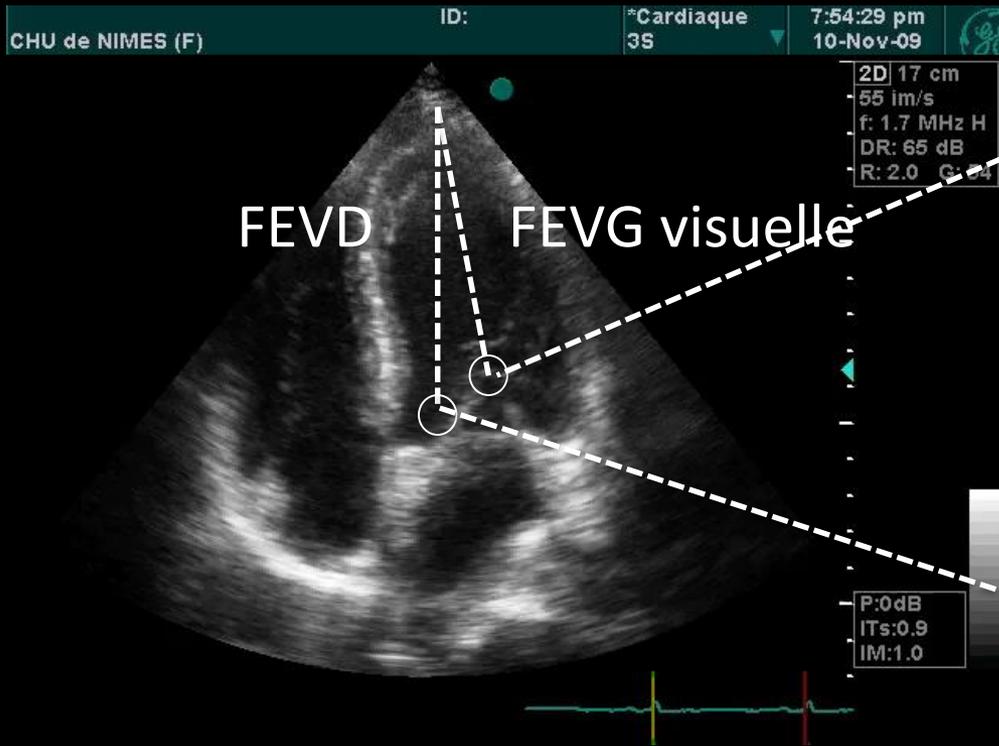
Volume d'éjection
systolique (ITV)



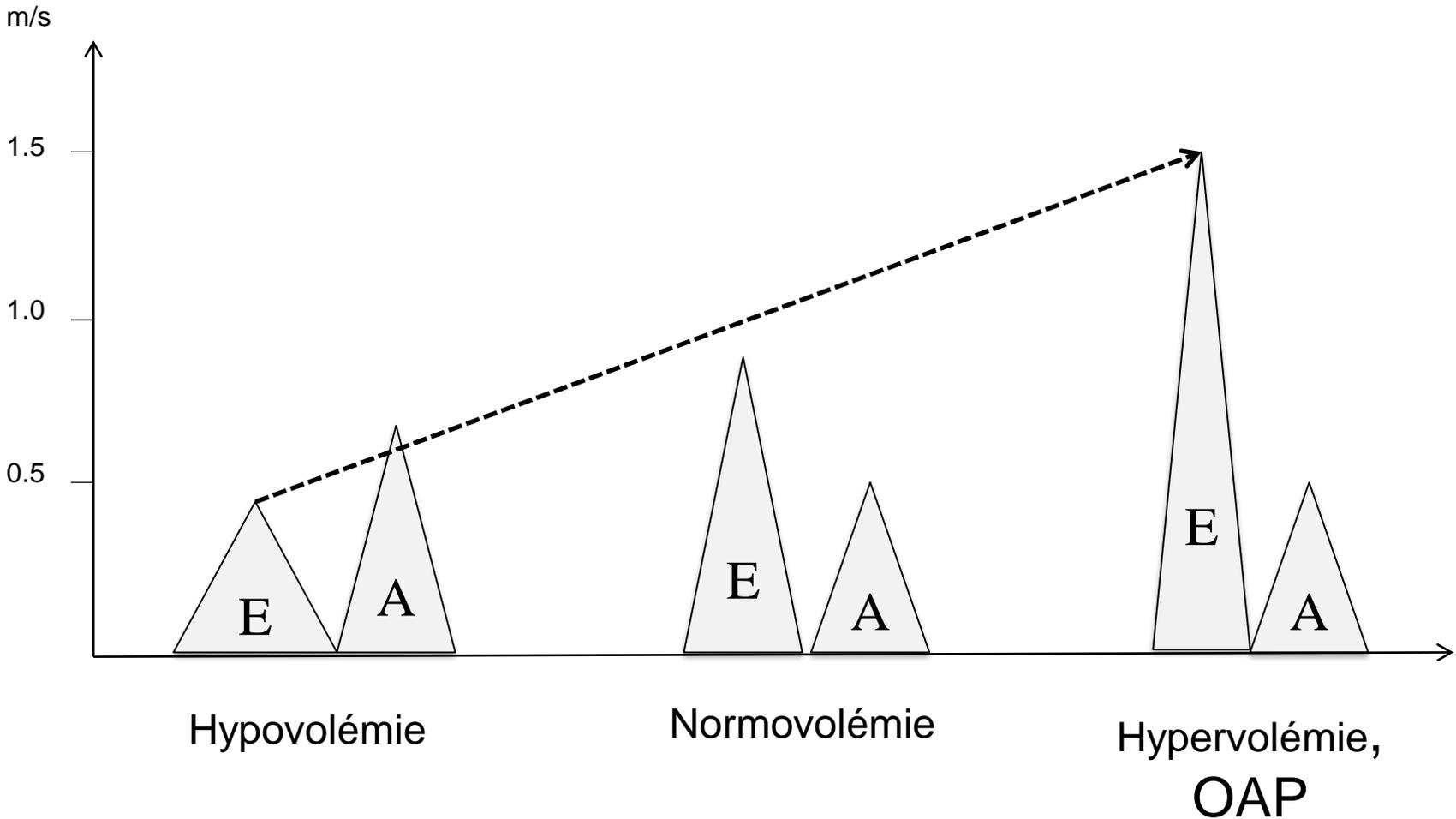
Nécessité d'une approche pas à pas !

Echocardiographie

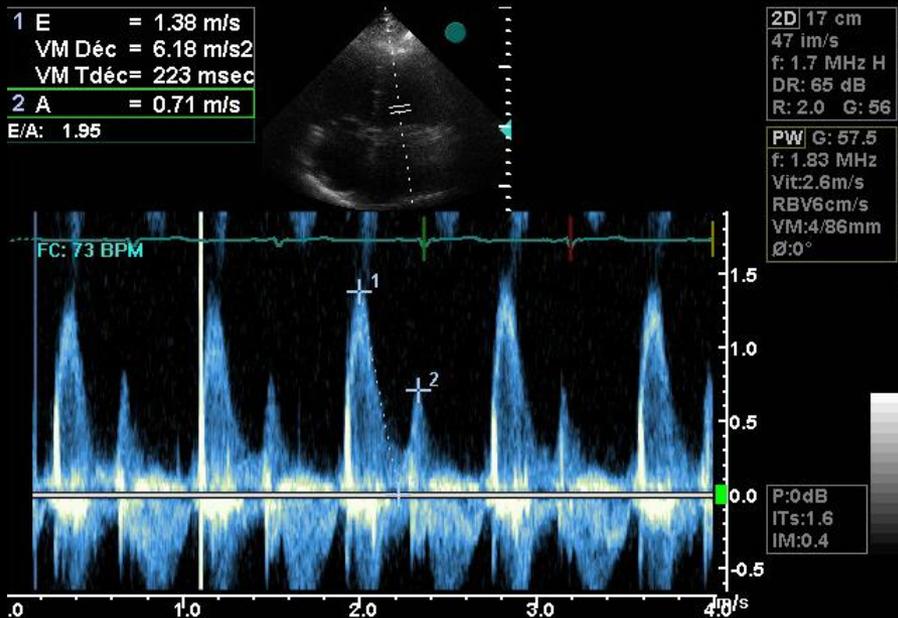
... raisonner avec des valeurs simples



Evaluation statique de la PTDVG:
Evolution du profil mitral avec le volémie



Le Doppler mitral pour arrêter de remplir :
Un bon marqueur de pressions hautes si $E/A > 2$



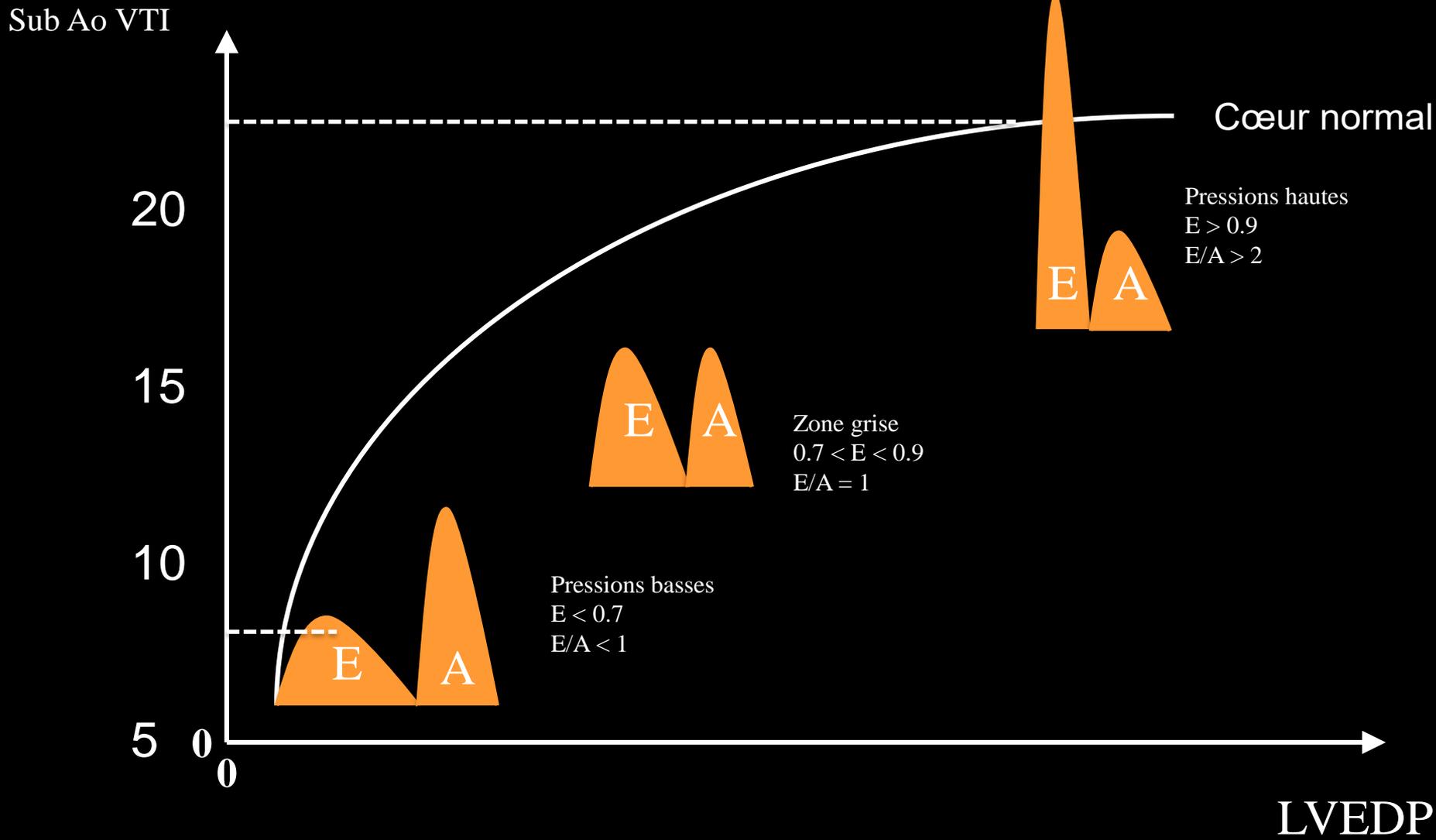
E/A ratio > 2

=> PAPO > 18 mmHg

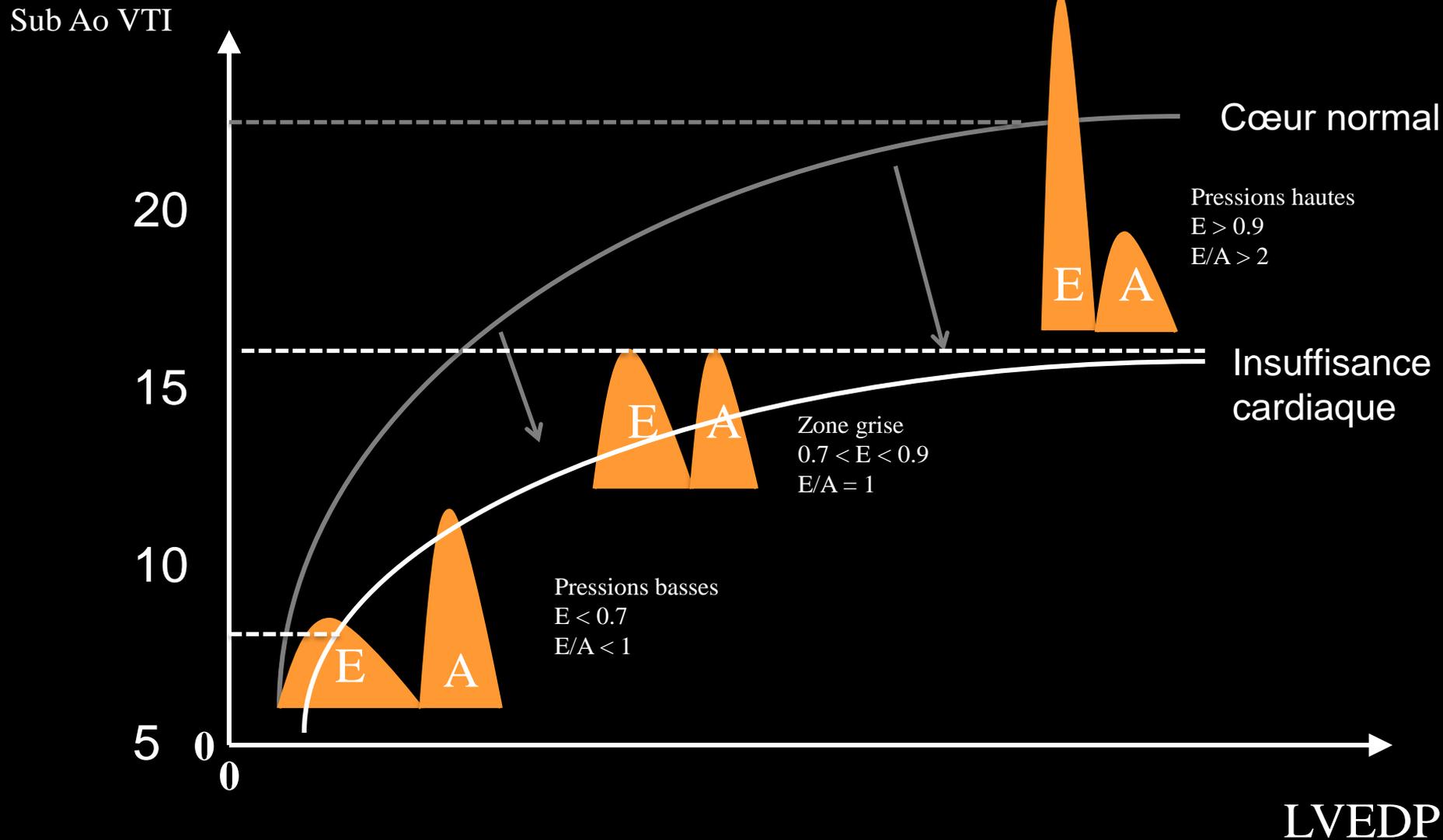
=> PP value = 100 %

Evolution du profil mitral et du débit cardiaque avec la volémie

Coupler ITV et profil mitral



Evolution du profil mitral et du débit cardiaque avec la volémie



Identification de 5 phénotypes de choc :

Hypovolémique, vasoplégique, cardiaque G, cardiaque Dt, « bien réanimés »

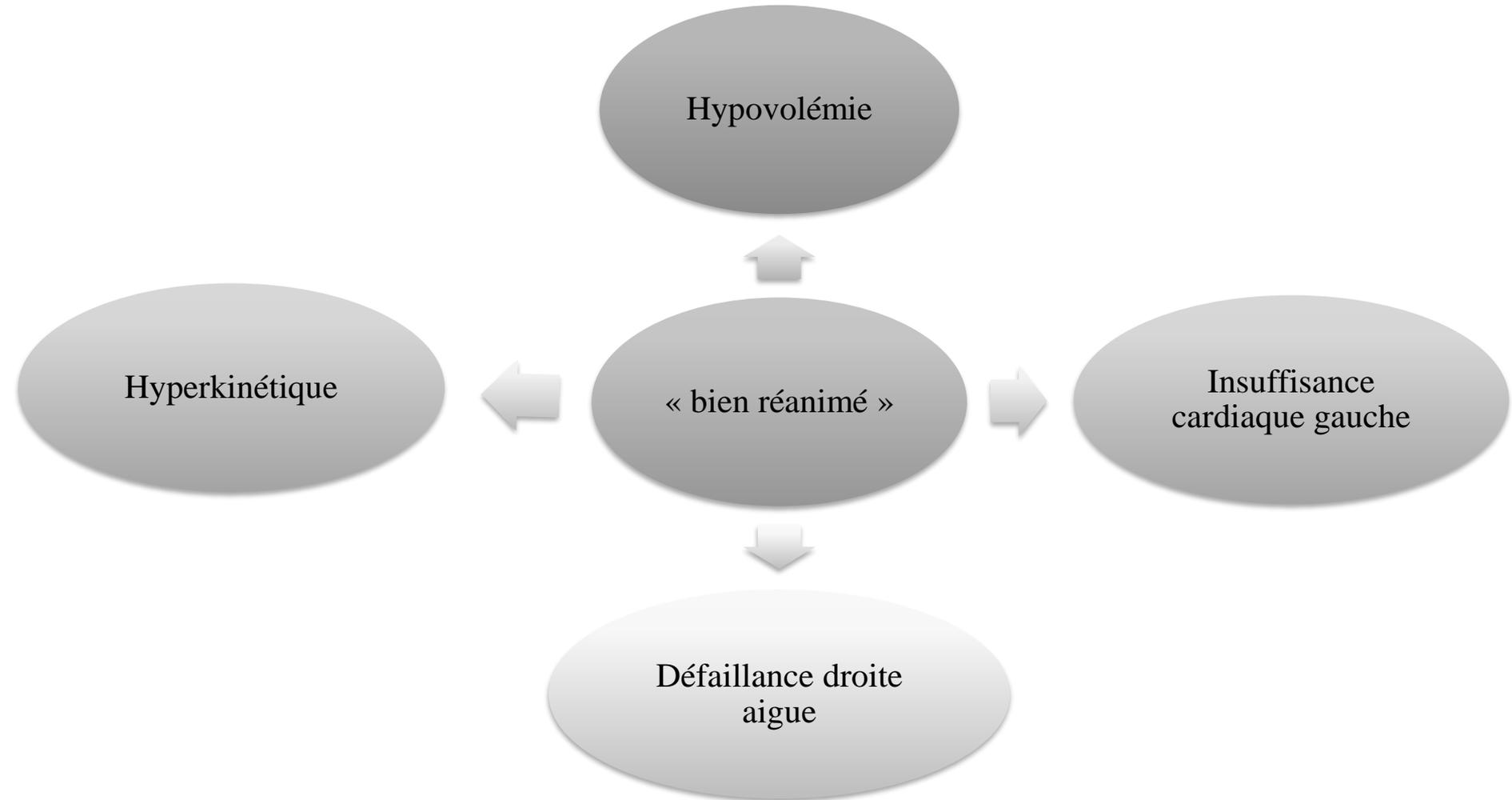
ORIGINAL



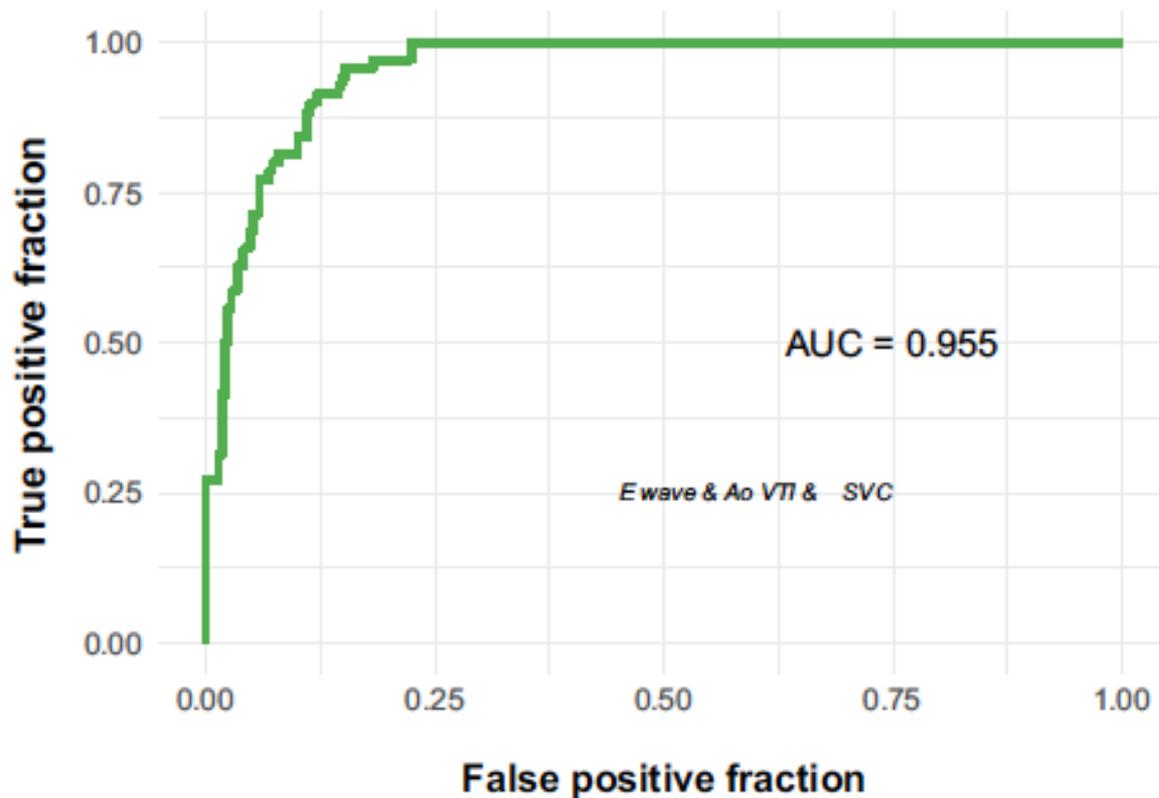
Cardiovascular clusters in septic shock combining clinical and echocardiographic parameters: a post hoc analysis

360 patients

Phénotypes échocardiographiques au cours du choc septique:
... *cinq phénotypes fondamentaux*



Identification de 5 phénotypes de choc : *Profil hypovolémique*



Ao VTI < 16 cm & E wave < 67 cm/s & SVC > 39 %

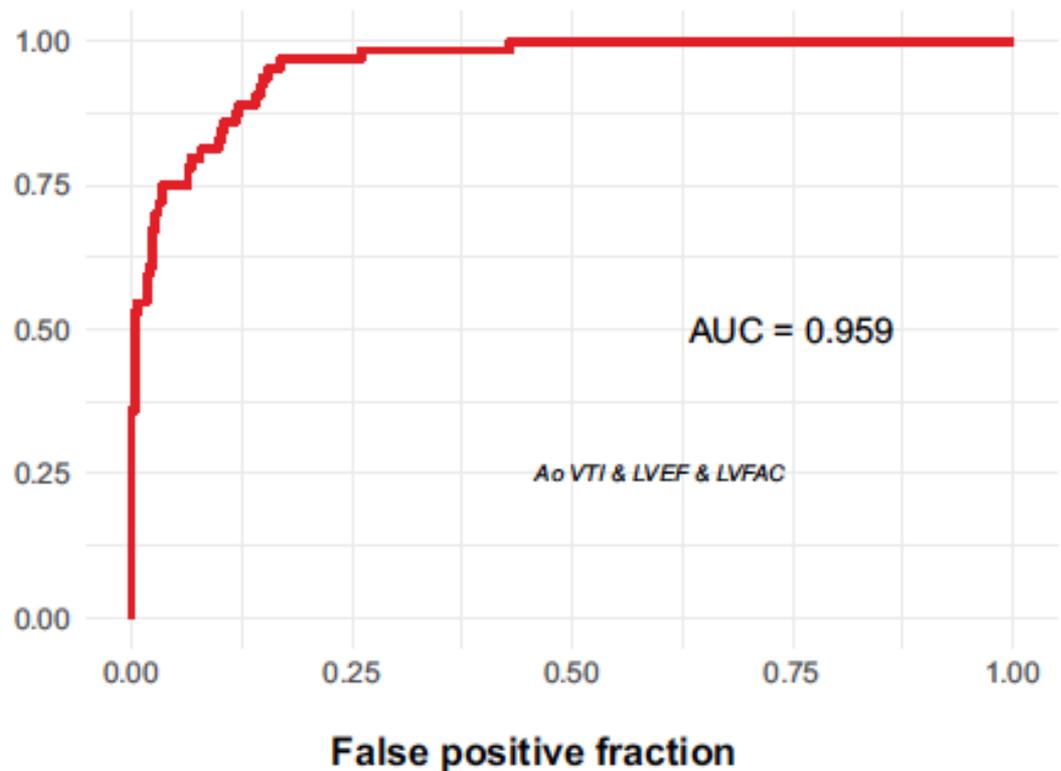
Hypovolemic

n	18/70
Sensitivity	25.7 [15.5;36]
Specificity	99.3 [98.4;100.3]
Pos. pred. value	90 [76.9;103.1]
Neg. pred. value	84.7 [80.9;88.5]

Identification de 5 phénotypes de choc :

Profil insuffisance cardiaque G

True positive fraction



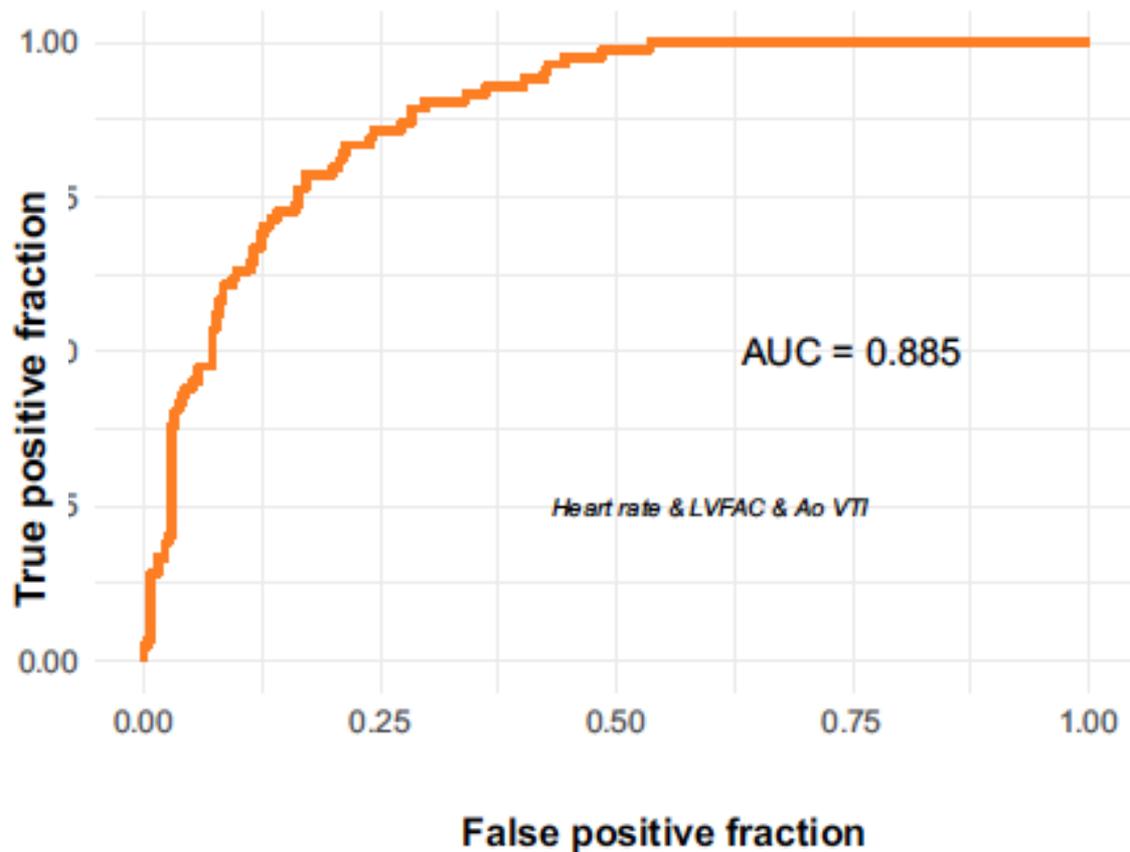
LVEF <40% & Ao VTI <14cm & LVFAC <33%

LV failure

n	35/64
Sensibility	54.7 [42.5;66.9]
Specificity	97.6 [95.9;99.4]
Pos. pred. value	83.3 [72.1;94.6]
Neg. pred. value	90.9 [87.7;94]

Identification de 5 phénotypes de choc :

Profil vasoplégie



Ao VTI >20cm & Heart rate <106bpm & LVFAC >58%

Hyperkinesia

n	15/84
Sensibility	17.9 [9.7;26]
Specificity	98.2 [96.6;99.8]
Pos. pred. value	75 [56;94]
Neg. pred. value	79.7 [75.4;84]

Hémodynamique et échographie : coupler ITV et flux mitral

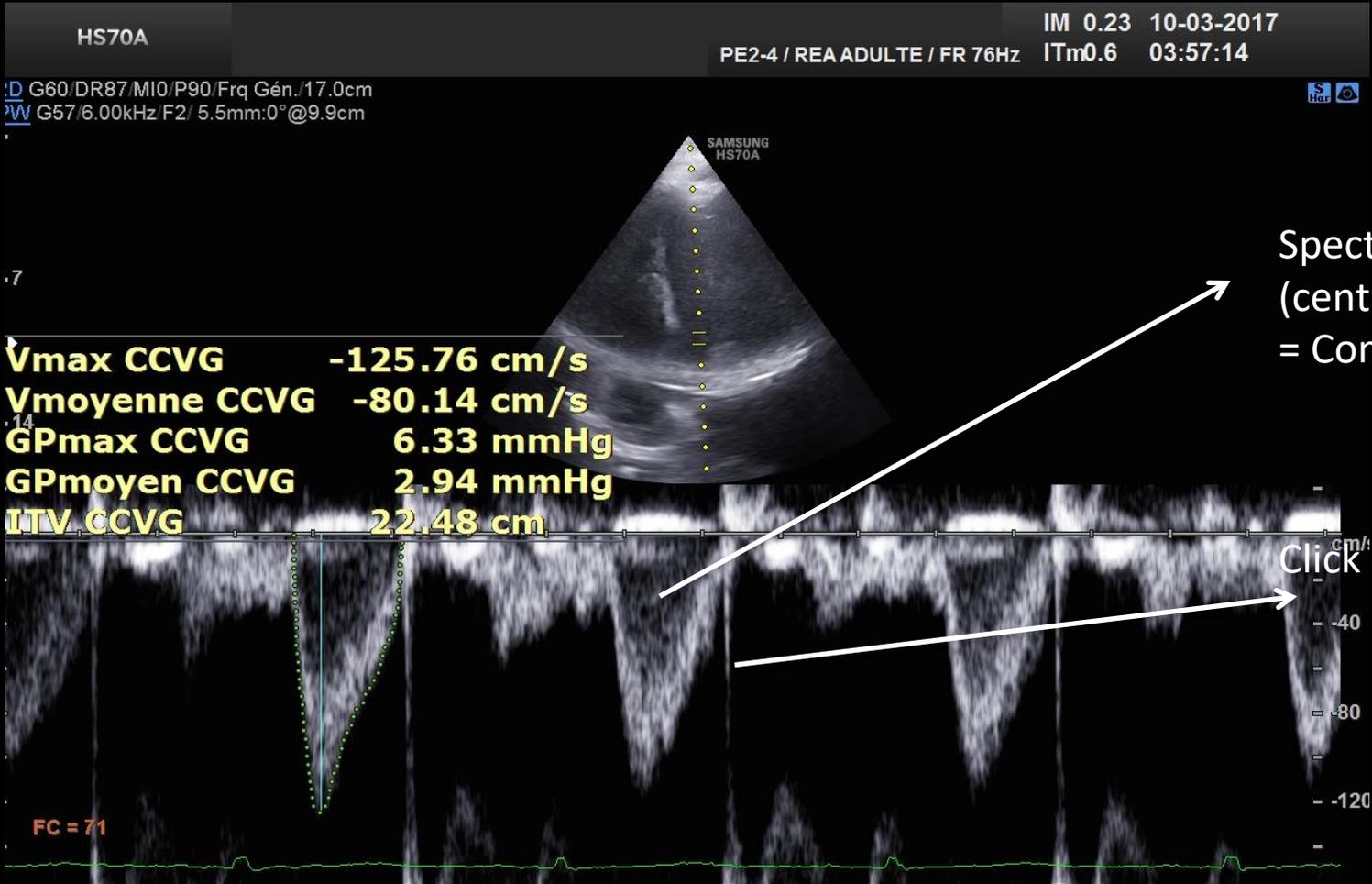
Les 3 profils fondamentaux au cours du choc

	FEVG	Profil mitral	ITV
Hypovolémie	> 55 %	$E < 0,7$ $E/A < 1$	< 14
Insuffisance cardiaque	< 40 %	$E > 1$ $E/A > 2$ $E/E' > 15$	< 14
Vasoplégie	> 55 %	$E \text{ } 0,7 - 1 \text{ m/s}$	> 14-20

Le futur de l'échocardiographie en 2019 :

2. *Outils de quantification automatique : FEVG, ITV sous
aortiquE*

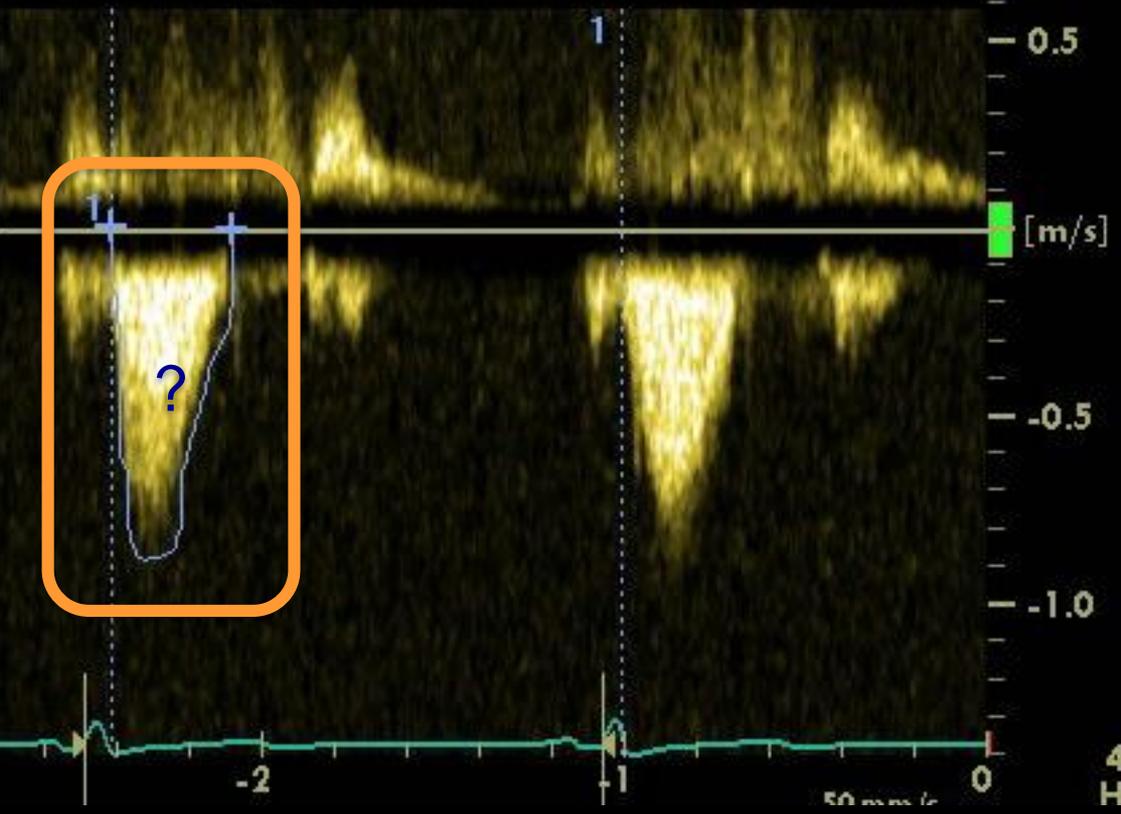
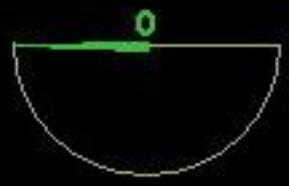
Volume d'éjection systolique en écho : Critères de qualité d'une bonne ITV



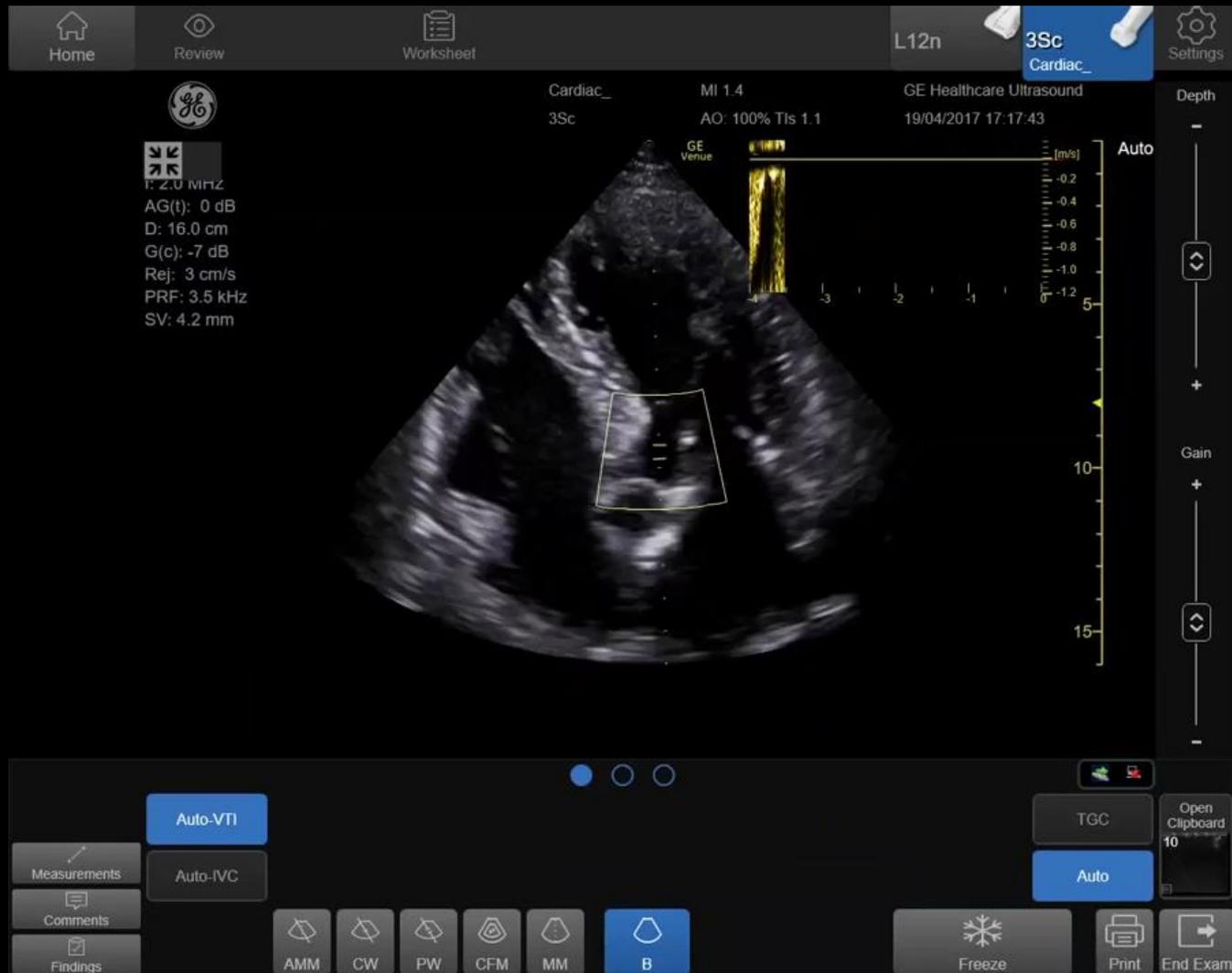
Spectre « creux »
(centre noir)
= Composante laminaire

Click de fermeture

1	VA Vmax	0.88 m/s
	VA Vmoy	0.61 m/s
	VA GDmax	3.11 mmHg
	VA GDmoy	1.73 mmHg
	VA Env.Ti	333 ms
	VA ITV	20.28 cm
	FC	42.71 BPM
	VA Vol. Eject	78.95 ml
	VA Débit Card.	3.37 l/min



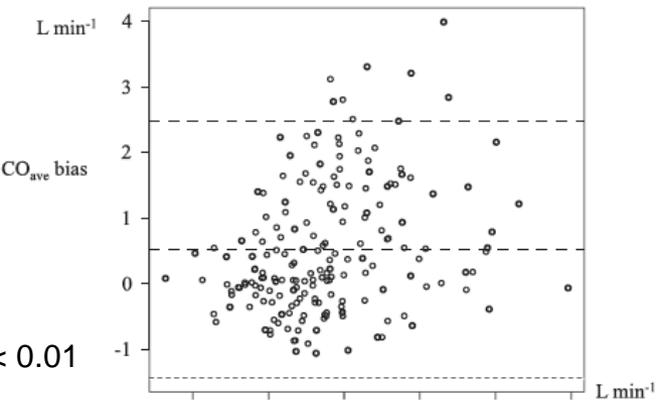
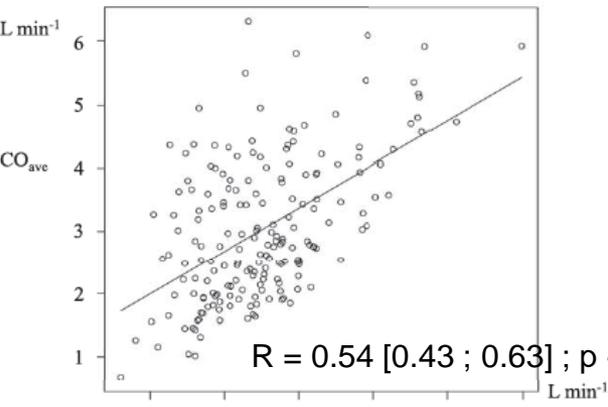
L'avenir : automatisation de la validité des ITV : code couleur de validité



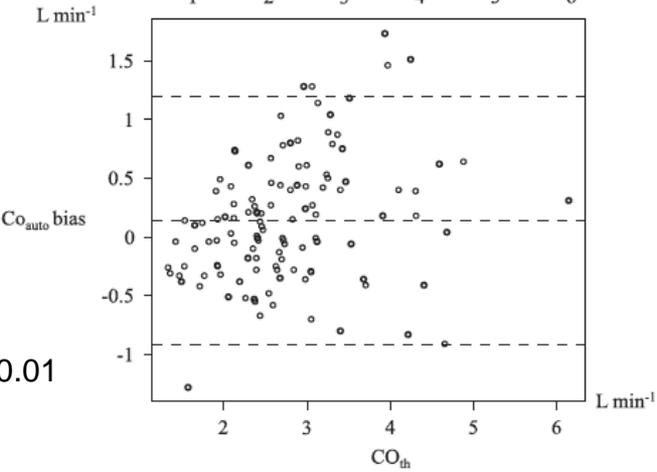
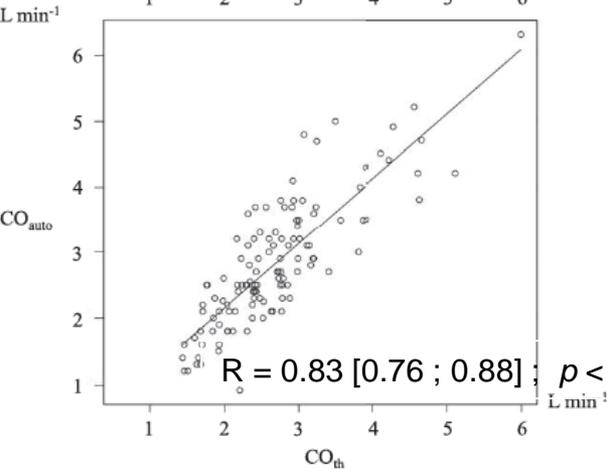
Mesure automatisée de l'ITV : meilleure que la méthode manuelle ?

A New Echocardiographic Tool for Cardiac Output Evaluation: An Experimental Study

Bobbia, Xavier; Muller, Laurent; Claret, Pierre-Géraud; Vigouroux, Laure; Perez-Martin, Antonia; de La Coussaye Jean Emmanuell; Lefrant, Jean Yves; Louart, Guillaume; Roger, Claire; Markarian, Thibaut.



Mesure manuelle
moyennée sur 3 cycles



Mesure automatique
de l'ITV sur 4 secondes
= 7-8 cycles en moyenne !

Mesure automatisée de l'ITV : *meilleure que la méthode manuelle ?*

a global success rate of 60%. The success rate drops to around 30% in critical conditions (Fig. 2). Because in highly critical

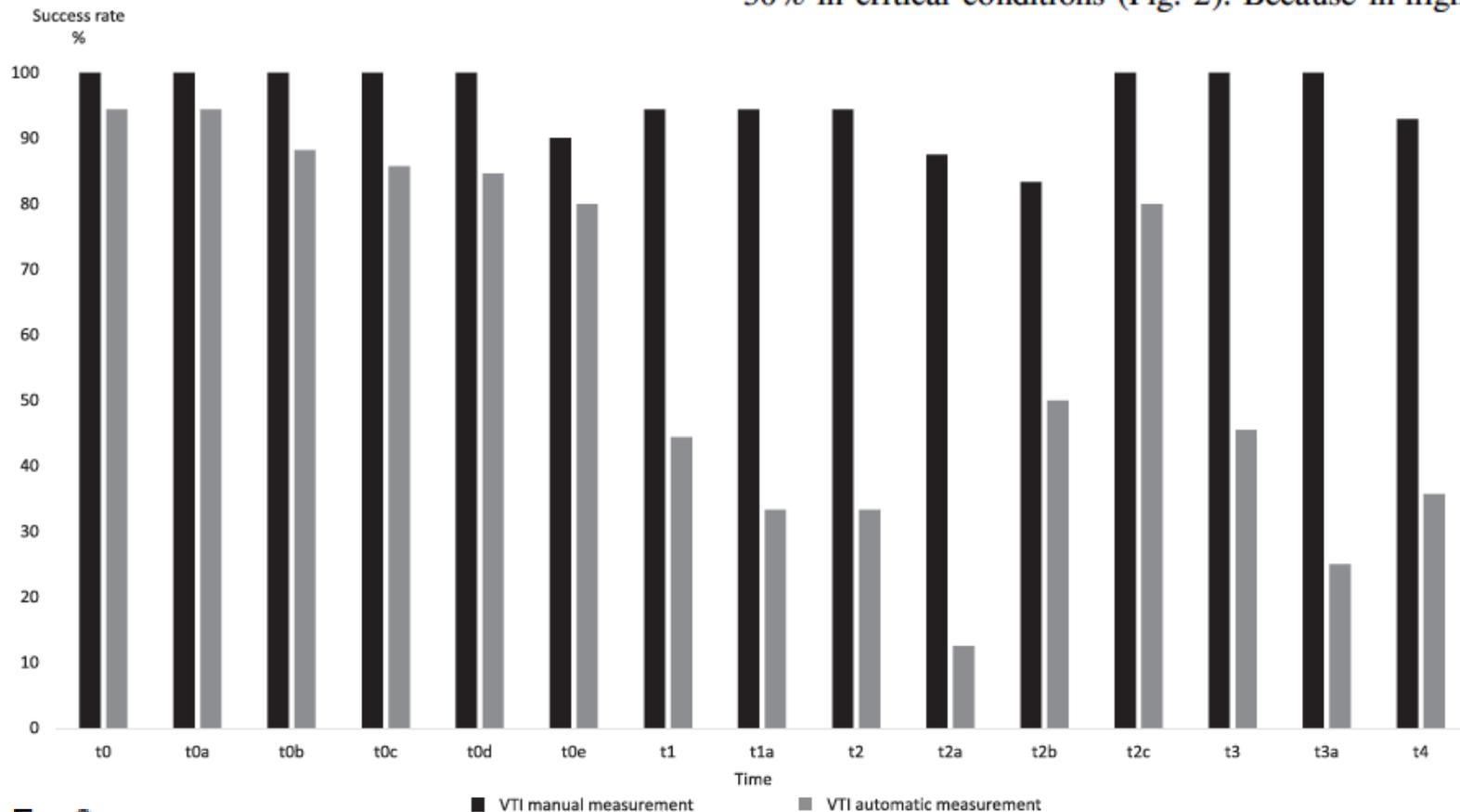


Fig. 2.

L'avenir : automatisation de la variation d'ITV ?

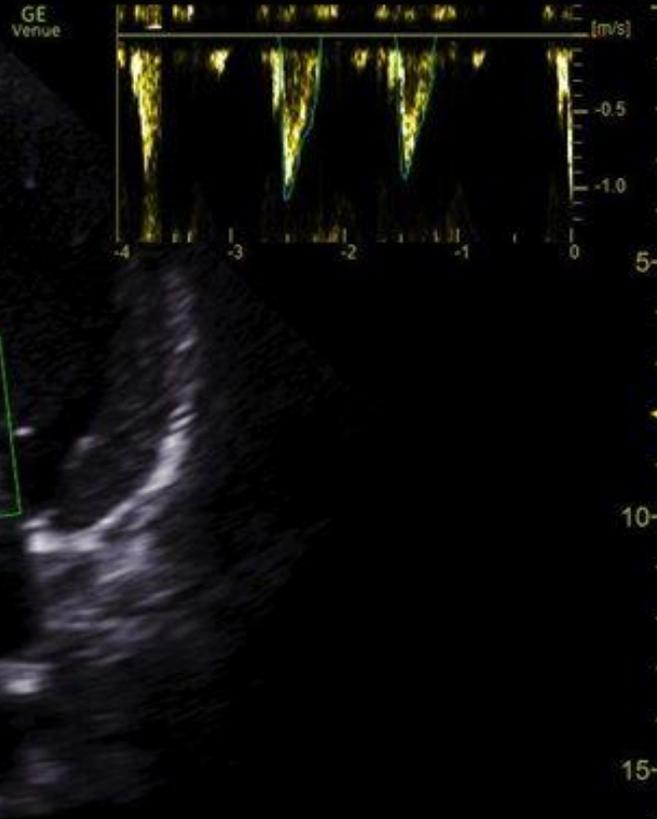
GE

LVOT VTI	23.3 cm
HR	50 BPM
CO*	5.7 l/min
LVOT Vmax	1.01 m/s

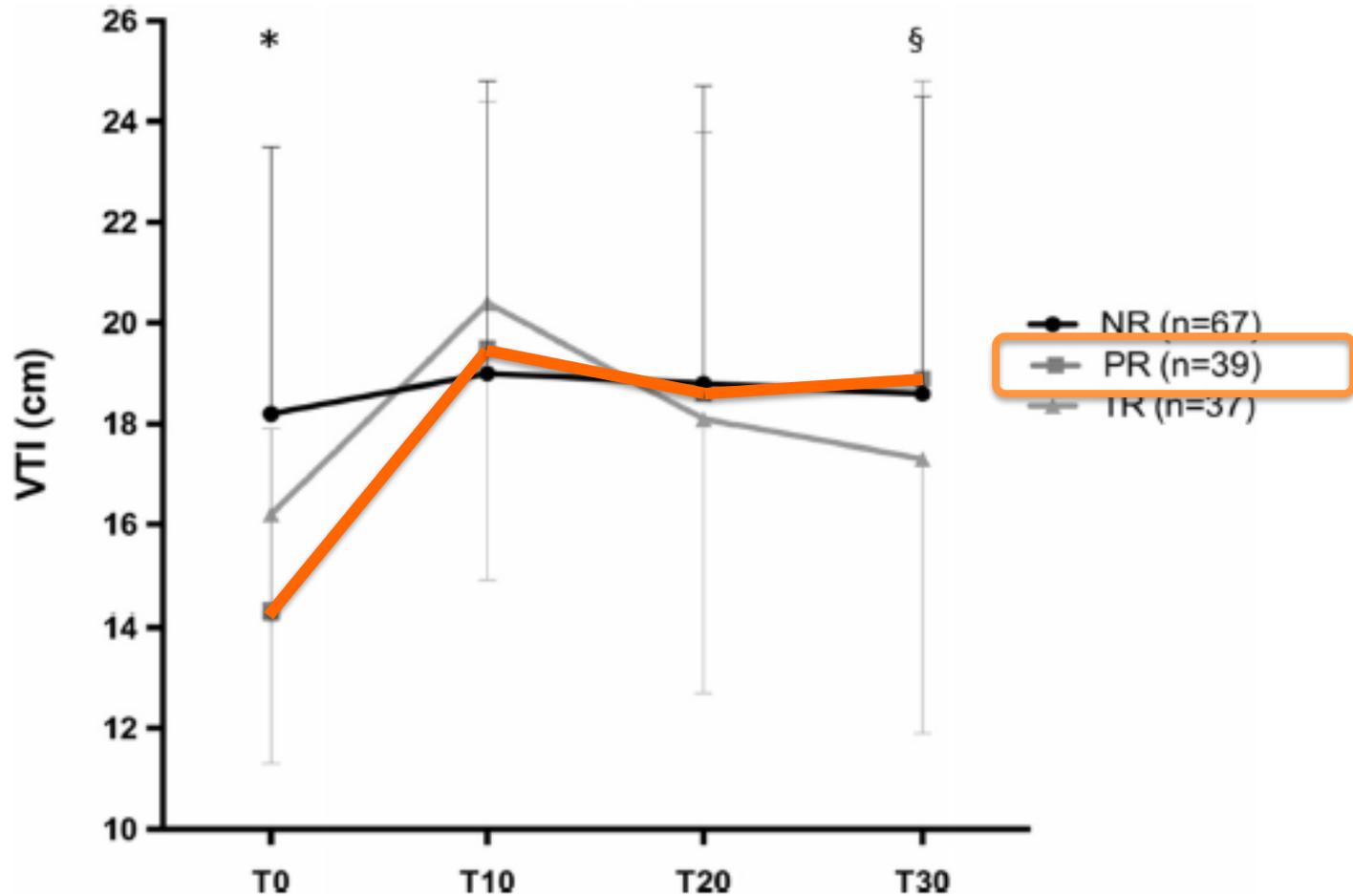
Shock / Heart
3Sc

MI 1.4
AO: 100% TIs 1.0

GE Healthcare Ultrasound
13/04/2017 13:25:47



Identification de 3 profils de réponse au remplissage:
Répondeurs persistants (PR), transitoires (TR) ou non répondeurs (NR)

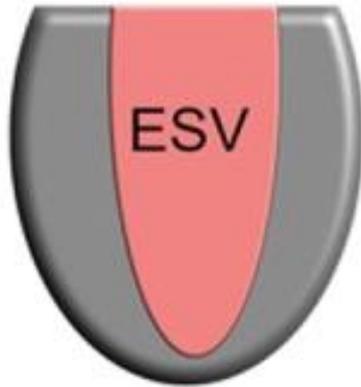


Automatisation de la fonction contractile :
De la contraction à la déformation = echo de strain

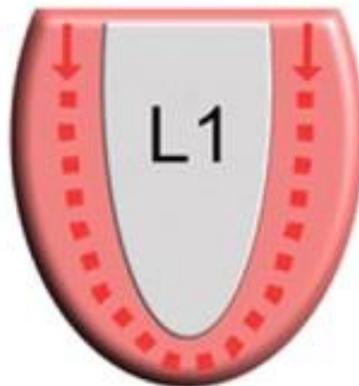
End-Diastole



End-Systole



$$\text{LVEF} = \frac{\text{EDV} - \text{ESV}}{\text{EDV}} \times 100$$

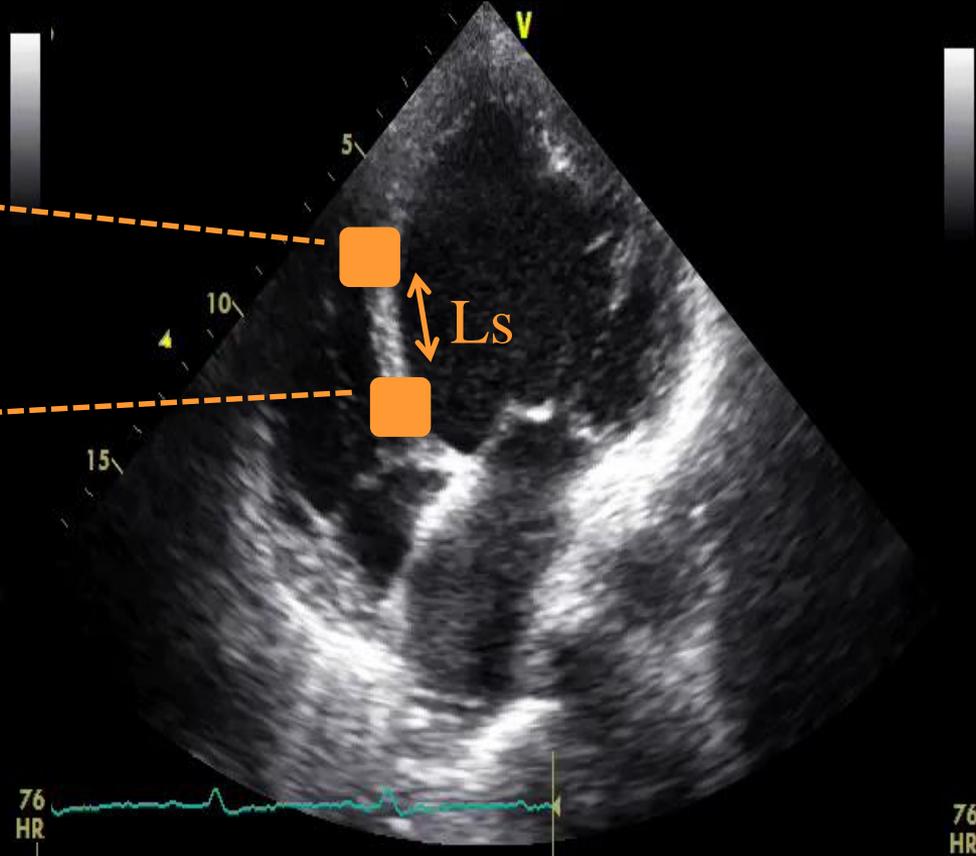
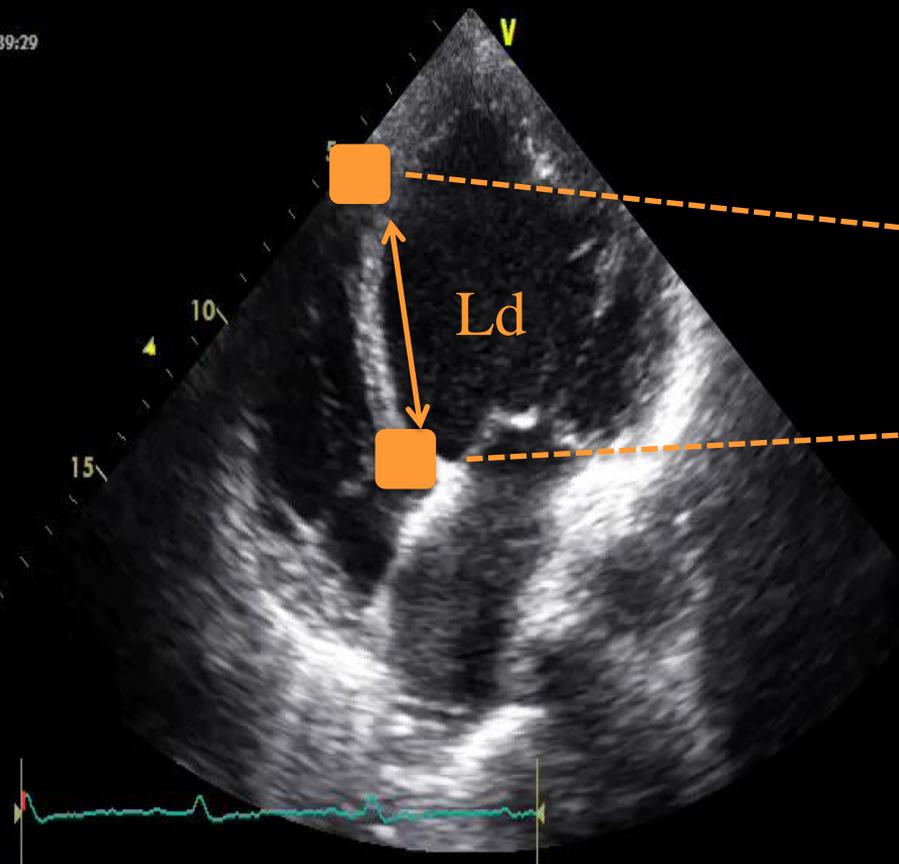


$$\text{GLS} = \frac{\text{L1} - \text{L0}}{\text{L0}} \times 100$$

Diastole

Systole

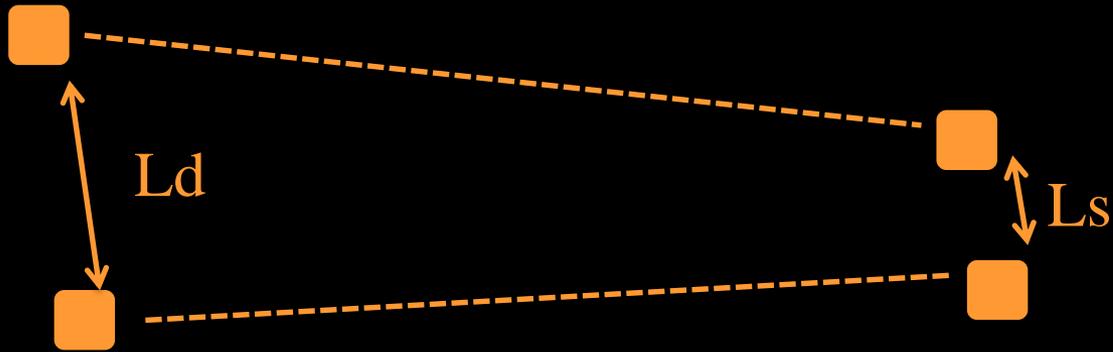
13:39:29
5



76
HR

Diastole

Systole



$$\text{Strain systolique} = (L_s - L_d) / L_d \times 100\%$$

How to record longitudinal strain ?

Step 1 : tracking validation by machine and then by operator

2015/04/22-14:19:24

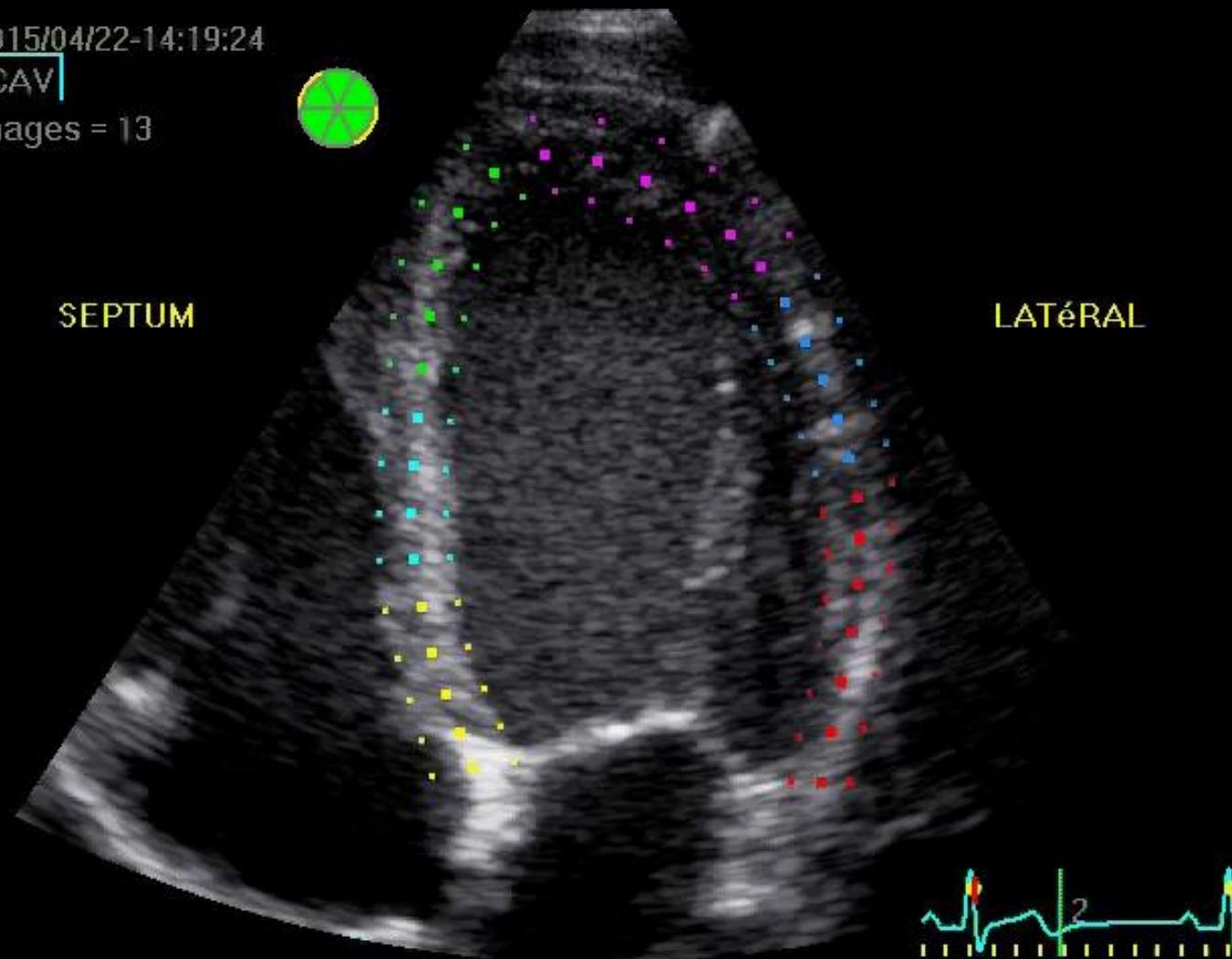
4CAV

Images = 13



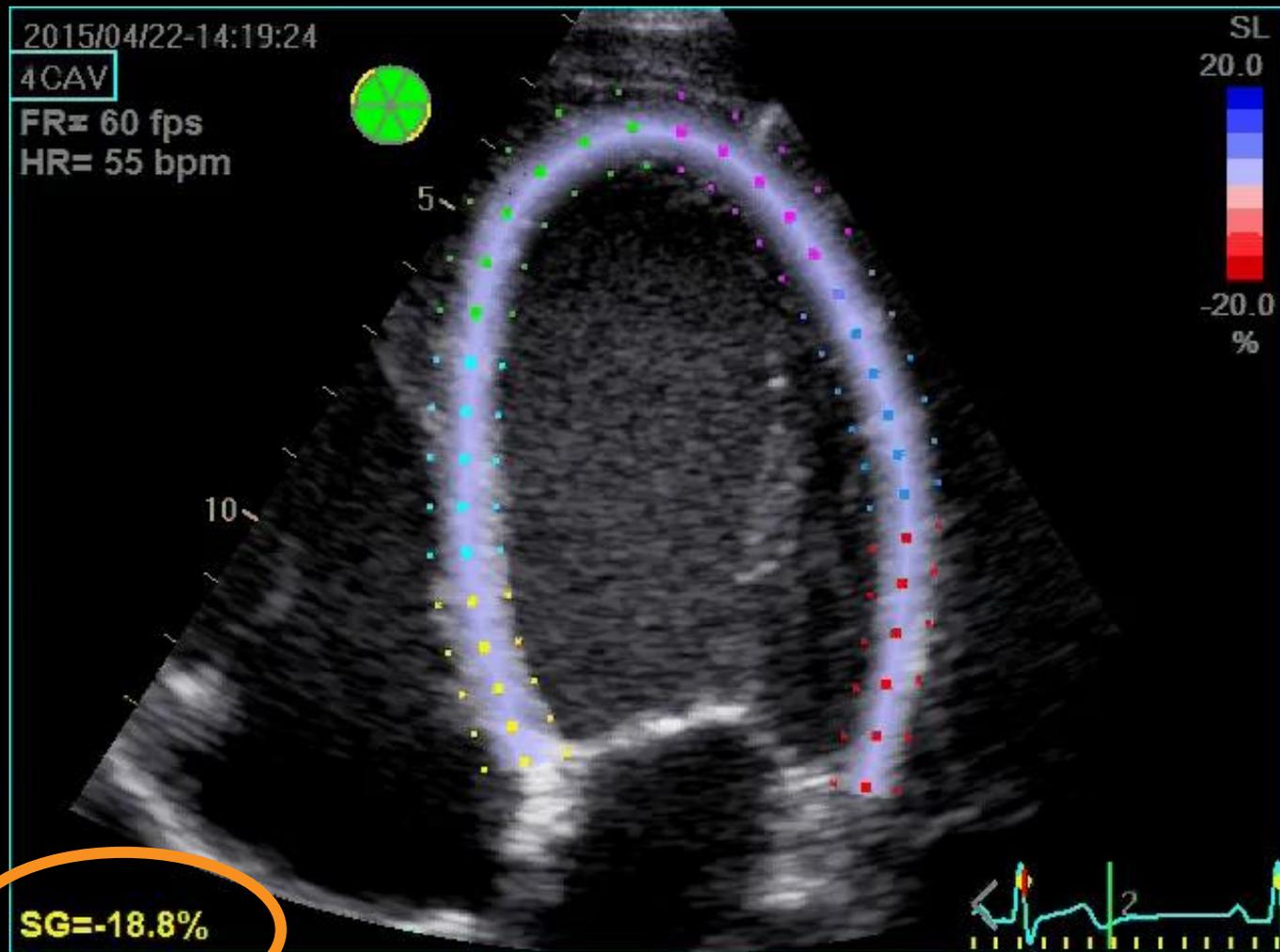
SEPTUM

LATÉRAL

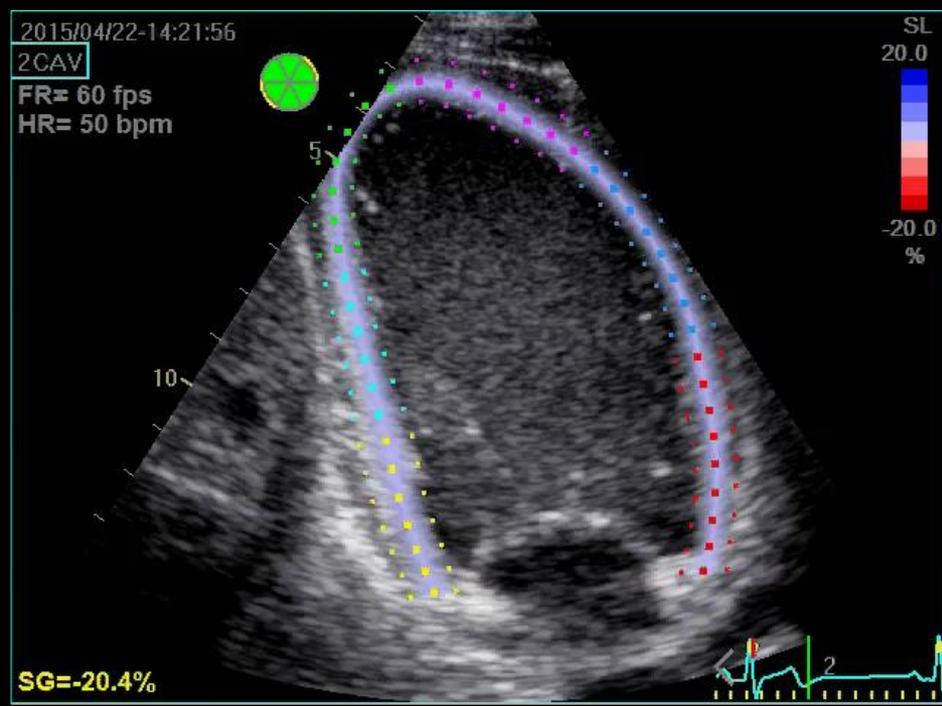
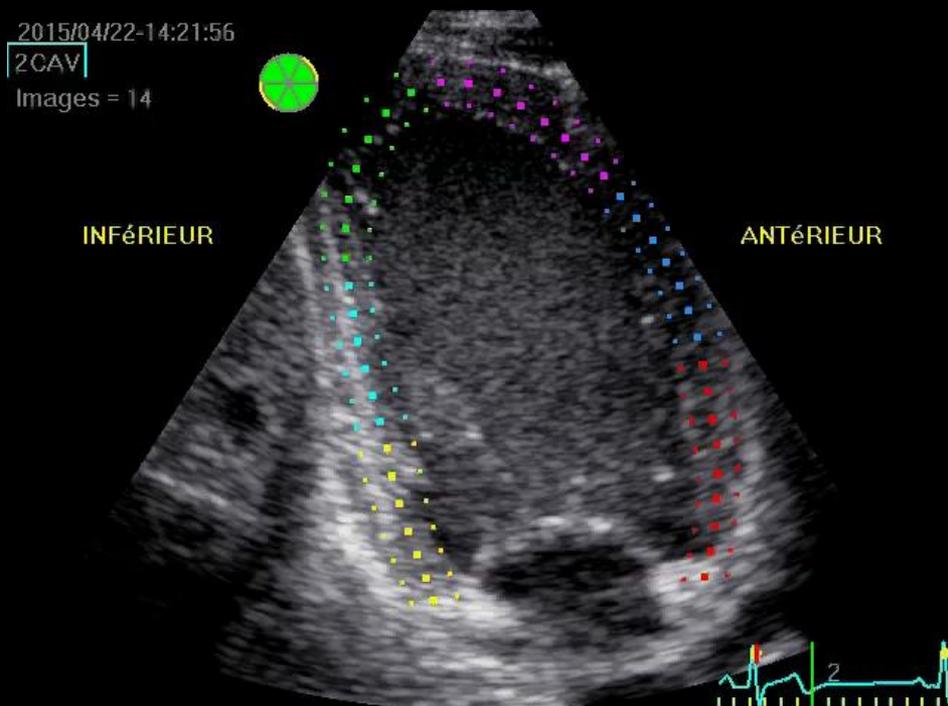


How to record longitudinal strain ?

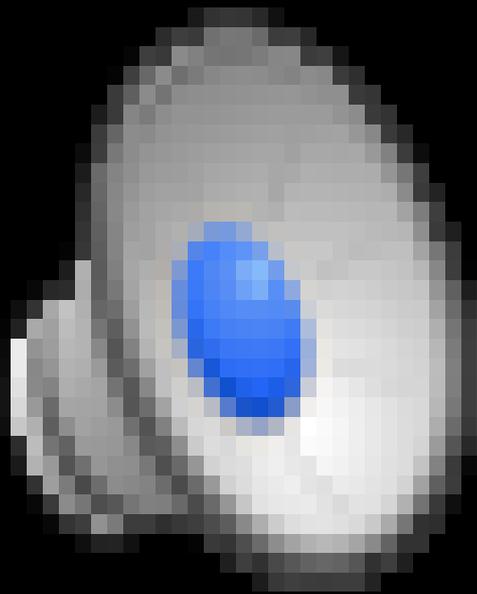
Step 2 : global and regional strain



Mesure du strain : Faire en 4, 2 et 3 cavités

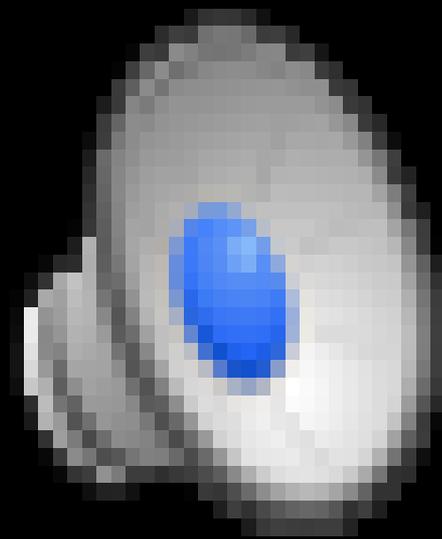


Speckle tracking, strain et FEVG automatique
Automatisation pour toute la fonction systolique



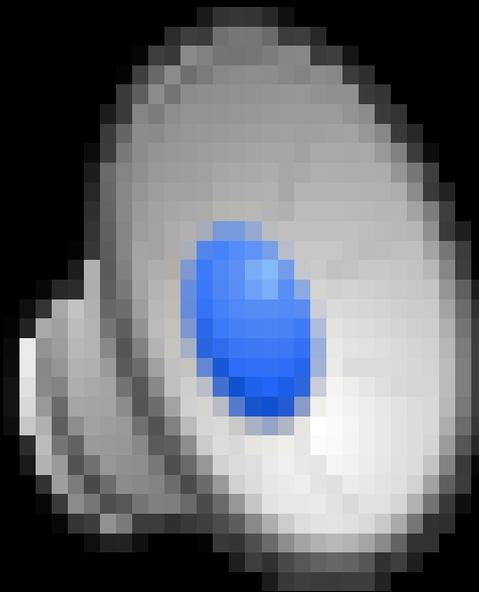
Speckle tracking, strain et FEVG automatique

L'opérateur a son mot à dire



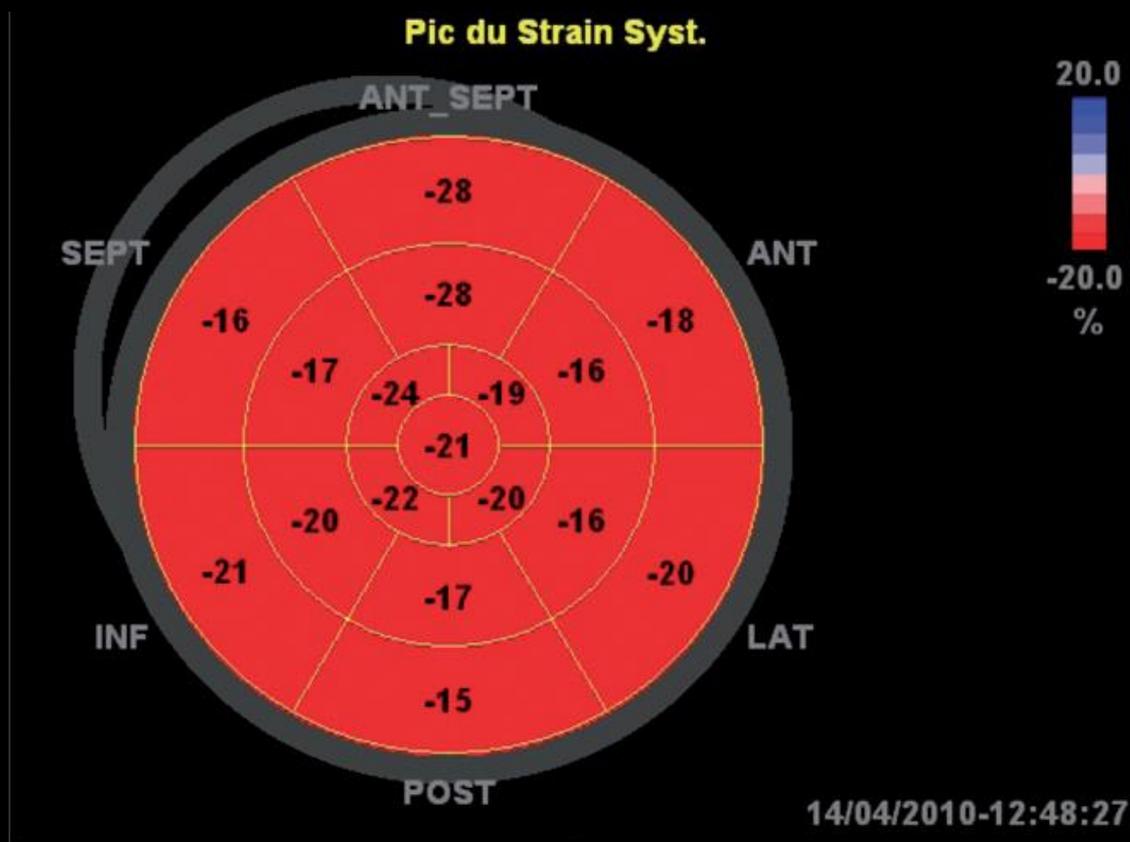
Speckle tracking et strain et FEVG automatique

L'opérateur a son mot à dire



Speckle tracking, strain en 2, 3 et 4 cavités

Cartographie ventriculaire gauche = « Bulleye »

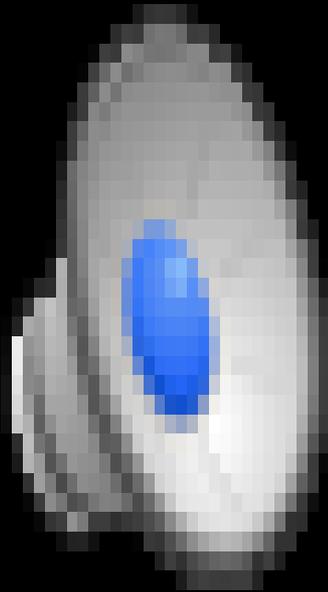


GLPS_LAX	-22.6 %
GLPS_A4C	-19.1 %
GLPS_A2C	-17.9 %
GLPS_Avg	-19.8 %

AVC_STORED	333 msec
HR_ApLAX	93.2 bpm

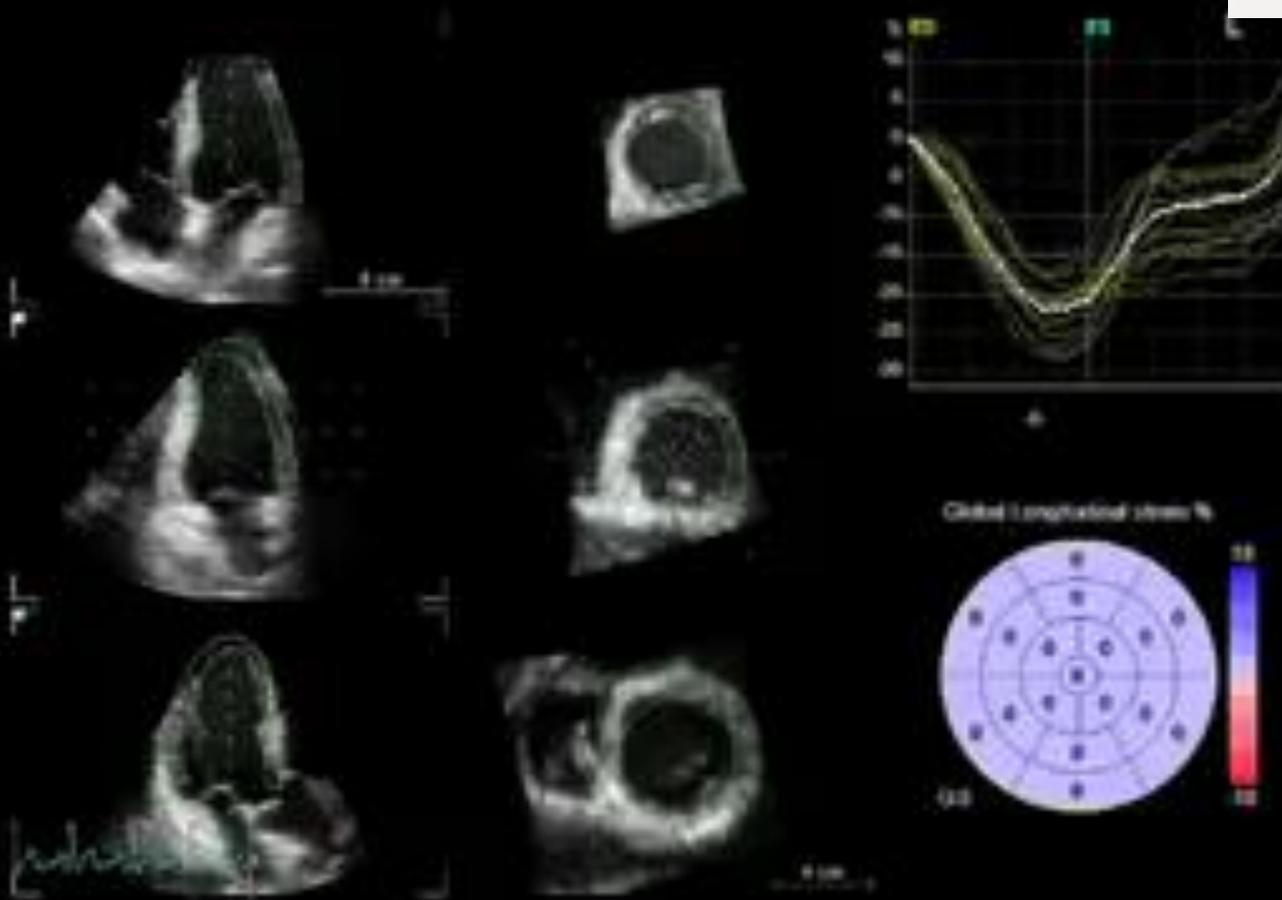
Nouveautés en échocardiographie

... acquisition tridimensionnelle de tout le coeur



Nouveautés en échocardiographie

... acquisition de tout le strain en une incidence



Strain longitudinal global :

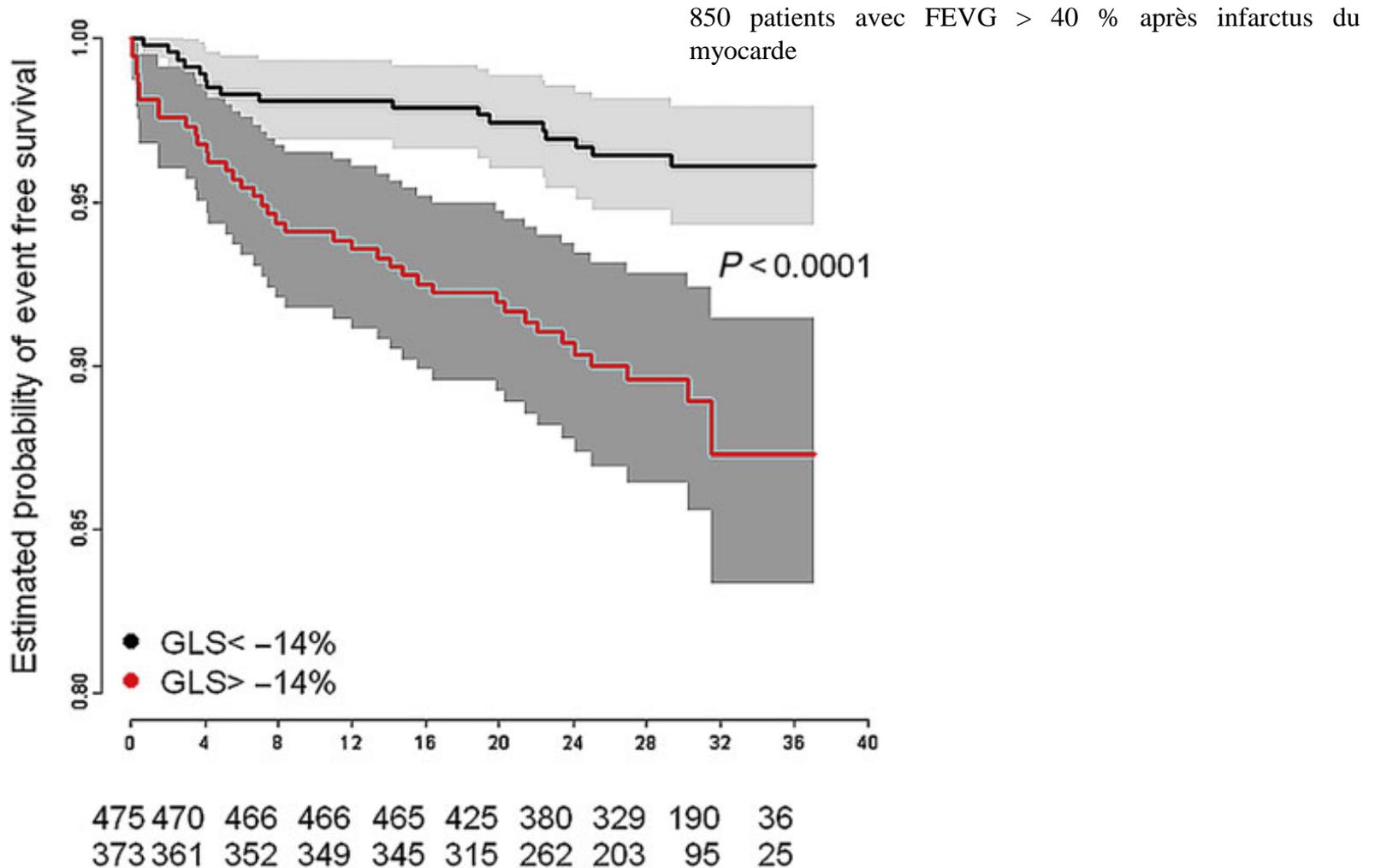
Une valeur de fonction systolique

Strain global normal = - 14 à -22 % %

En moyenne = - 18 %

Echocardiographie de déformation : FEVG ou Strain ?

... GLS > -14 % => surmortalité, même si FEVG Normale

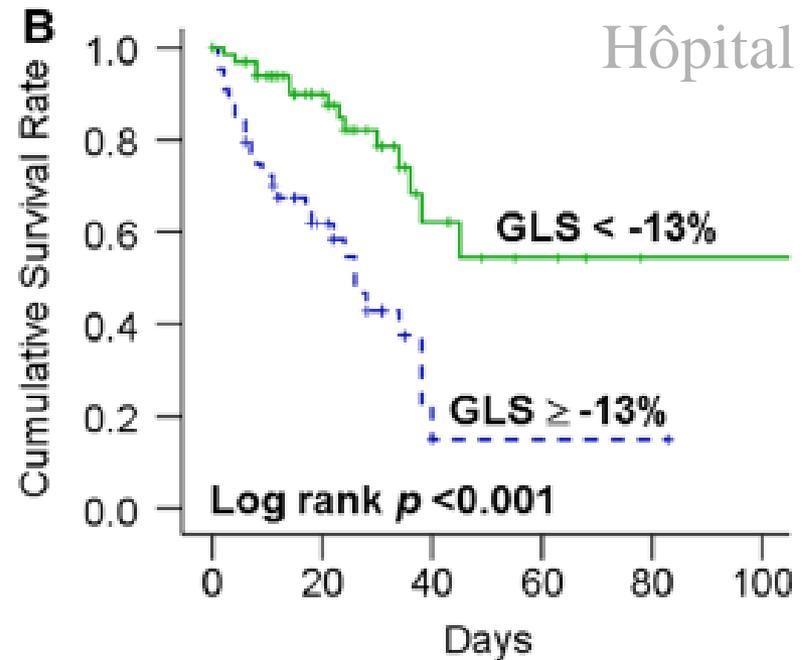
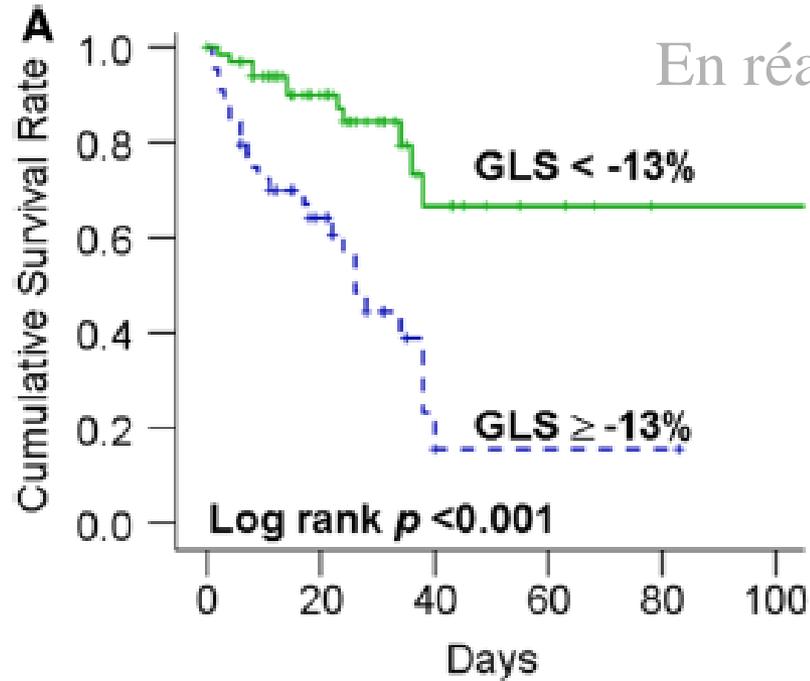


2D Strain en réanimation :

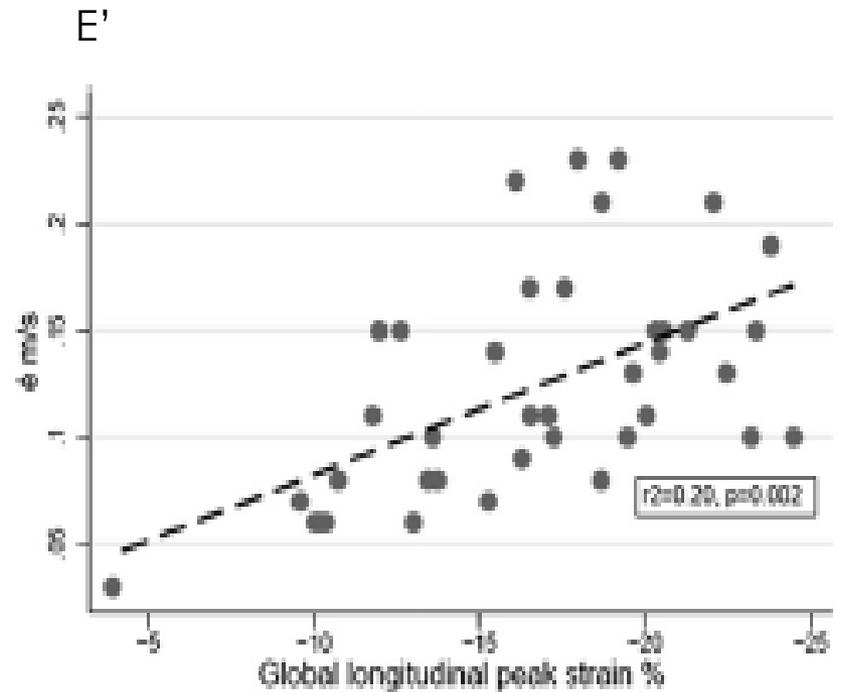
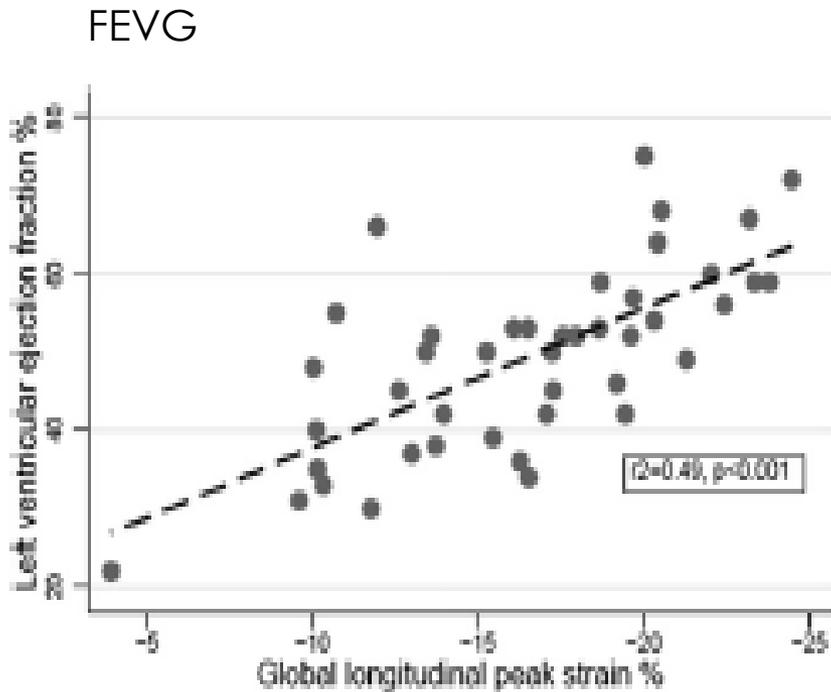
... Facteur pronostique au cours du sepsis (n = 111)

Wei-Ting Chang
Wen-Huang Lee
Wei-Ting Lee
Po-Sheng Chen
Yu-Ru Su
Ping-Yen Liu
Yen-Wen Liu
Wei-Chuan Tsai

Left ventricular global longitudinal strain is independently associated with mortality in septic shock patients



2D Strain chez le patient critique : ... Choc septique : fonction systolique... et diastolique



Use of speckle-tracking strain in preload-dependent patients, need for cautious interpretation!

C. Nafati^{1,4*†}, M. Gardette^{1†}, M. Leone^{2,3}, L. Reydellet¹, V. Blasco¹, A. Lannelongue¹, F. Sayagh¹, S. Wiramus¹, F. Antonini², J. Albanèse¹ and L. Zieleskiewicz²

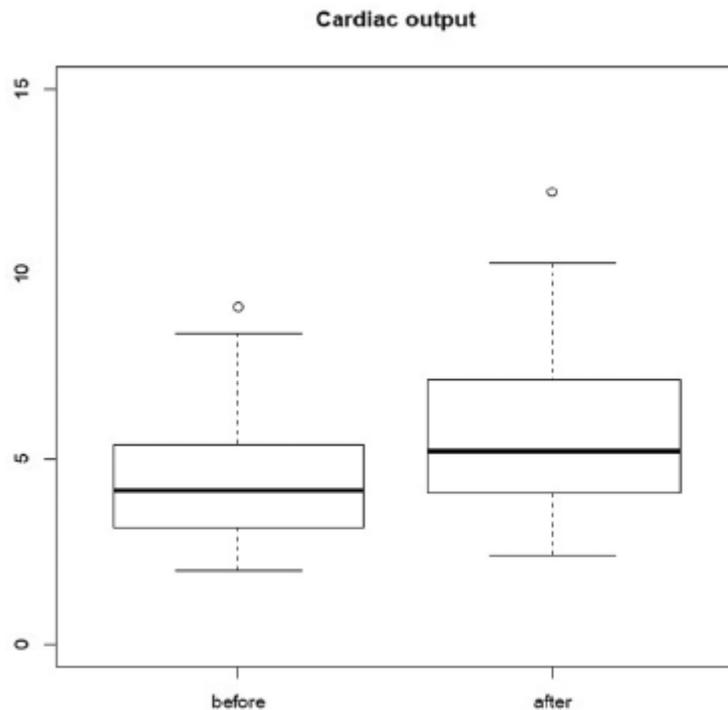


Fig. 2 Significant increase of cardiac index before and after fluid challenge 2.4 ± 0.9 – 3.1 ± 1.2 L/min/m² ($p < 0.01$)

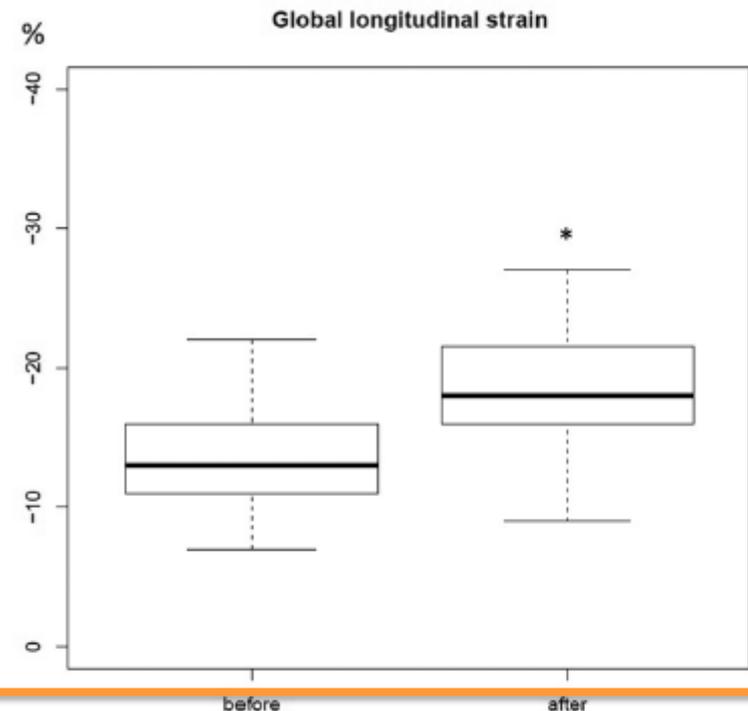
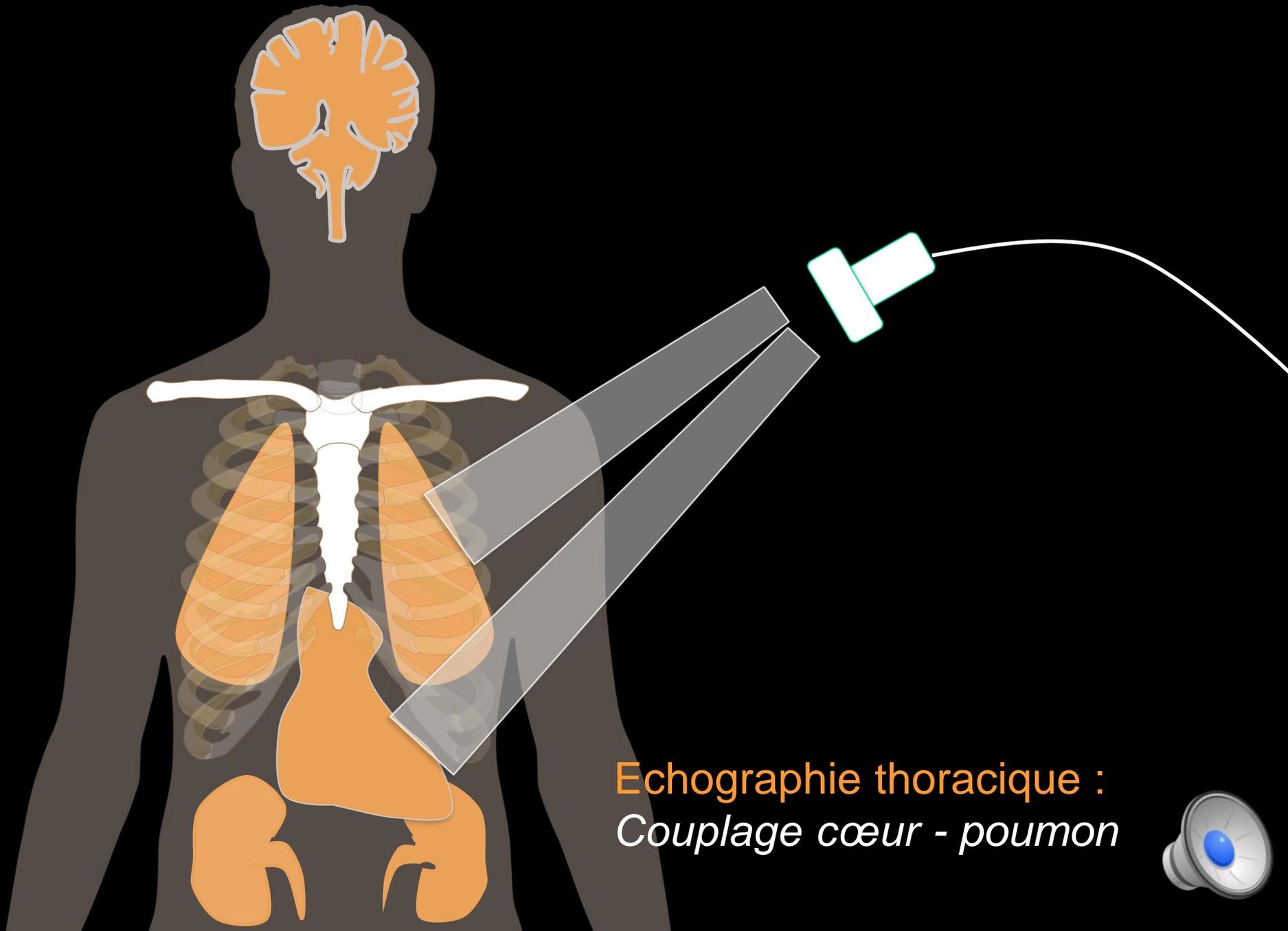


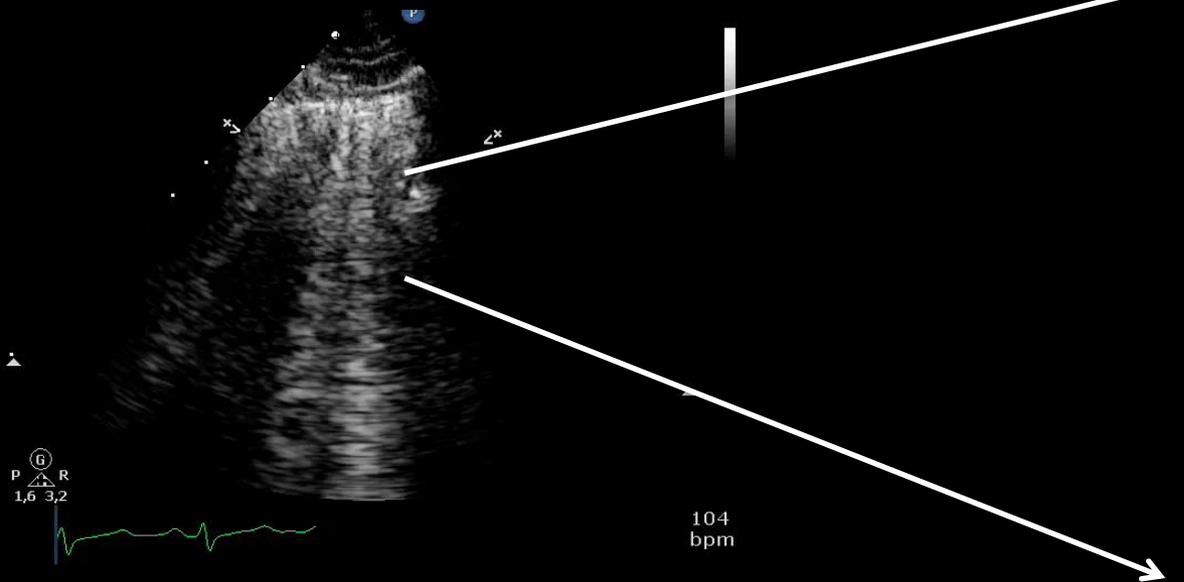
Fig. 3 Significant increase of absolute value in GLS: -13.3 ± 3.5 versus $-18.4 \pm 4.5\%$ ($p < 0.01$)



Echographie thoracique :
Couplage cœur - poumon



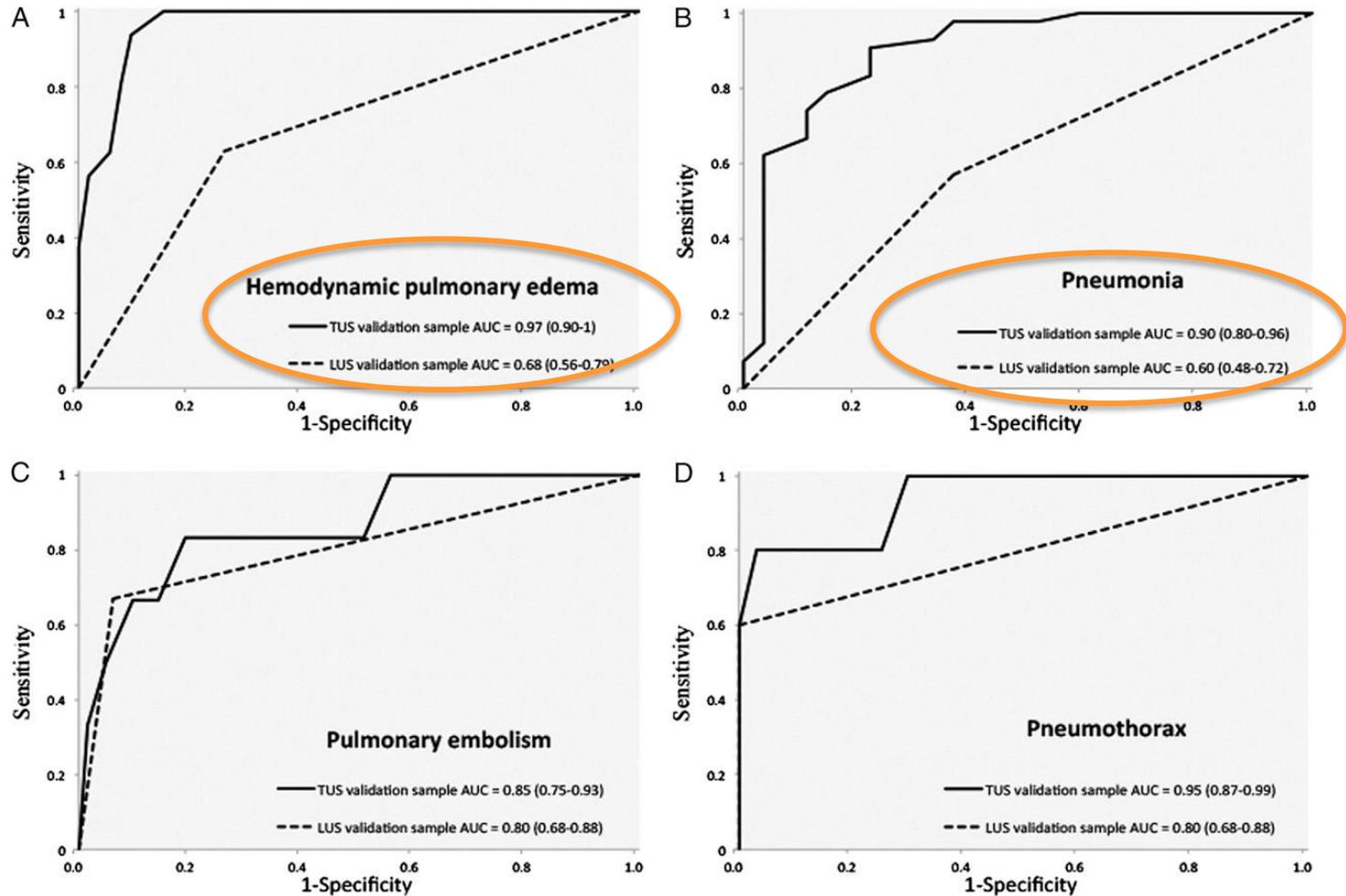
B lines = How to use it in clinical practice ?



Bilateral :
Pulmonary edema
(High LVEDP)
ARDS
(Low LVEDP)

Localized :
Pneumonia
Contusion (trauma)

Association échocardiographie et pleuro pulmonaire au cours des dyspnées: *Supérieur à l'écho pleuro pulm seule*



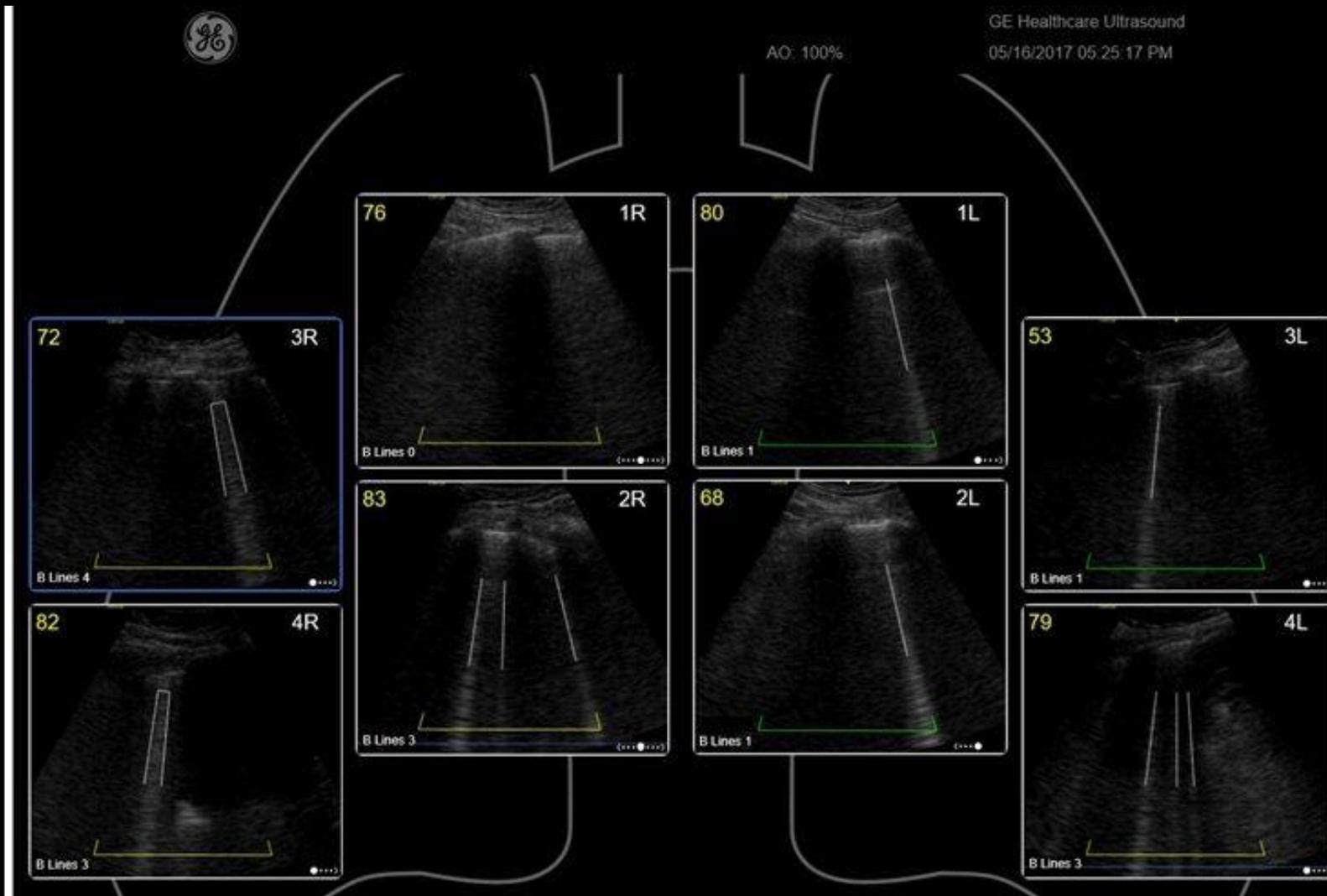
L'avenir : automatisation des lignes B :

1. Recrutement
2. Tolérance du remplissage

The screenshot displays the GE Healthcare Ultrasound interface for a lung assessment. The top navigation bar includes Home, Review, Worksheet, 3Sc Lung / Lung, C1-5, and Settings. The main display area shows a B-mode ultrasound image of the lung with a white line indicating a B-line. The text 'Lung / Lung' and '3Sc' is visible. The GE logo and 'GE Venue' are also present. The top right corner shows 'MI 1.1', 'AO: 100% TI 0.2', and 'GE Healthcare Ultrasound 14/04/2017 08:05:56'. The left sidebar shows 'Assessments' with 'Lung' selected, and a date '14/04/2017'. The central text area displays '1L : 1L', 'FPS: 21', 'f: 3.5 MHz', and 'B Lines ≤ 1'. The bottom control panel includes a Cine button, playback controls, Auto B-Lines, Reverse, Split, B, Store, Freeze, Print, and End Exam buttons. A Gain control is visible on the right side of the screen.

Automatisation des comptes rendu :

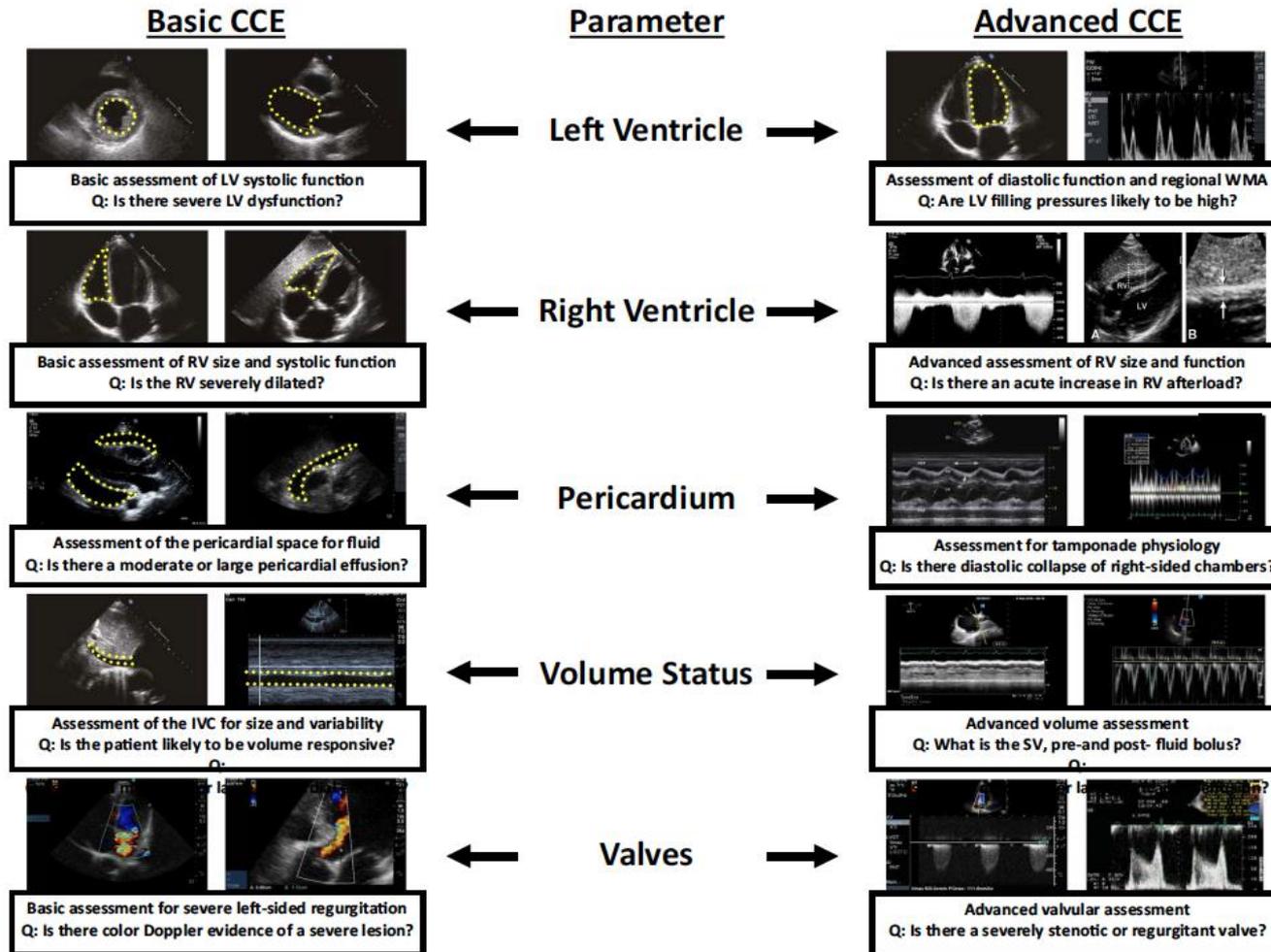
... Poumon



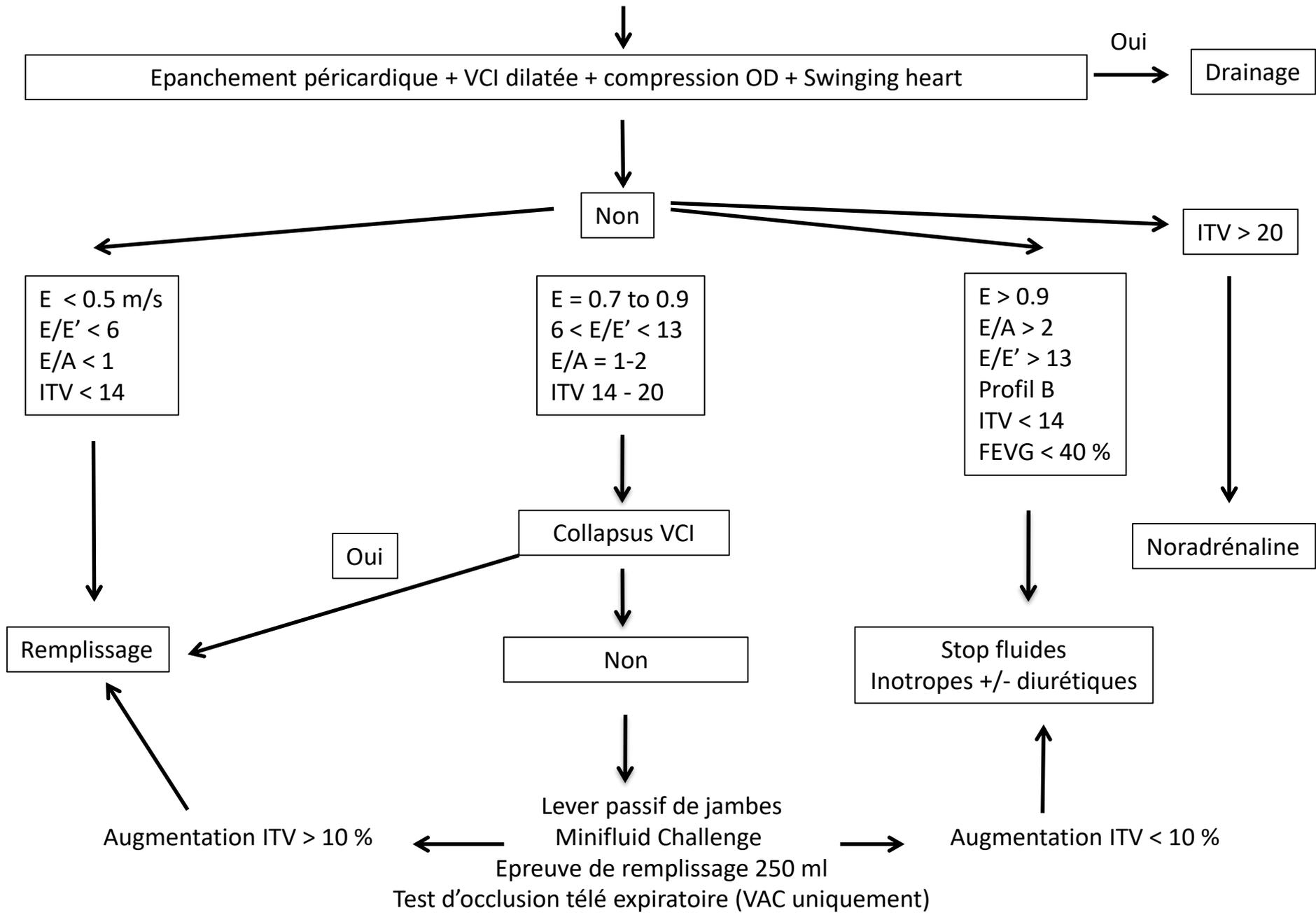
Le futur de l'échocardiographie en 2019 :

3. trouver le bon algorithme ?

Le futur de l'échocardiographie en 2019 : *trouver le bon algorithme ?*



Choc : gestion du remplissage vasculaire par échographie



Le futur de l'échocardiographie en 2019 :

4. Impact sur le pronostic ?

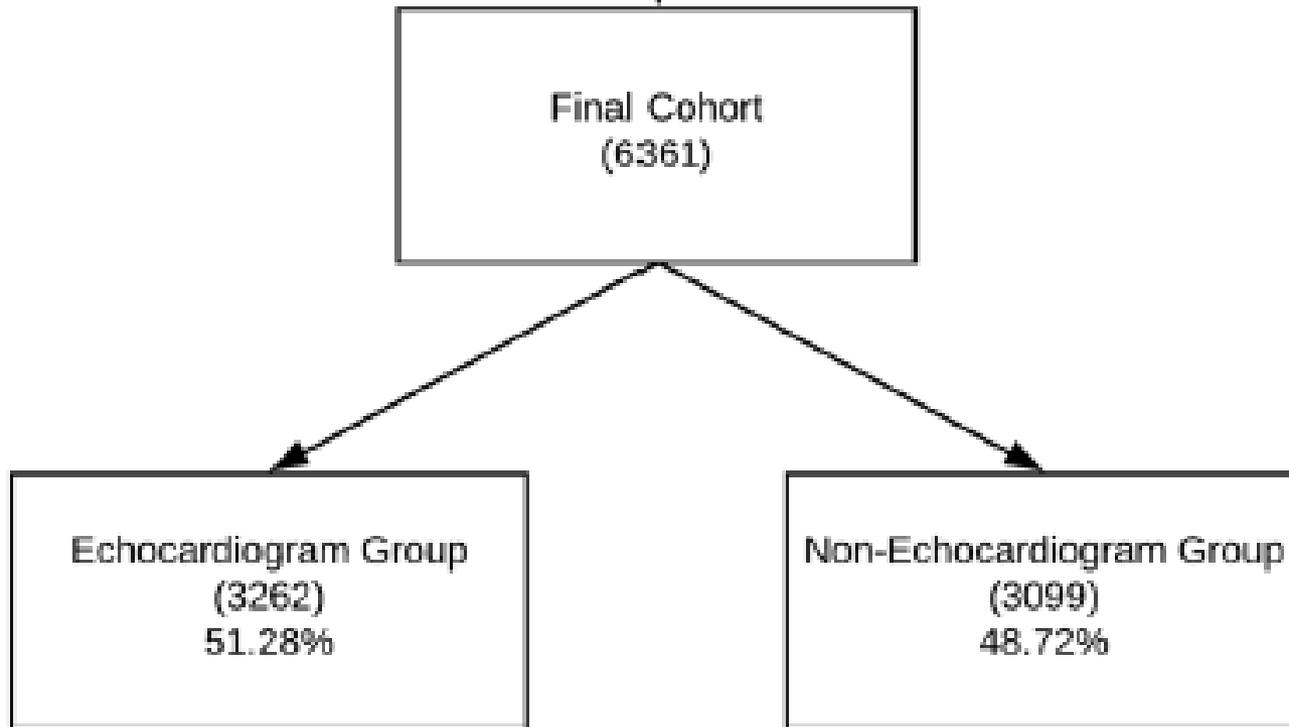
Thierry Boulain
Julie Boisrame-Helms
Stephan Ehrmann
Jean-Baptiste Lascarrou
Adrien Bouglé
Arnaud Chiche
Karim Lakhali
Stéphane Gaudry
Sébastien Perbet
Arnaud Desachy
Séverin Cabasson
Isabelle Geneau
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Noémie Clavieras
Pablo L. Massanet
Frédéric Bellec
Yoan Falquet
François Réminiac
Philippe Vignon
Pierre-François Dequin
Ferhat Meziani

Volume expansion in the first 4 days of shock: a prospective multicentre study in 19 French intensive care units

Signs or symptoms prompting the fluid bolus

Low blood pressure	2,020 (78.5 %)
Tachycardia	754 (29.4 %)
Low urine output	1,252 (48.7 %)
Skin mottling	640 (24.9 %)
Cyanosis of the extremities or capillary refill time >2 s	245 (9.5 %)
Impairment of consciousness supposed to be related to low cerebral blood supply	93 (3.6 %)
Arterial lactate >2 mmol/l	489 (19.1 %)
Low central venous pressure	62 (2.4 %)
Use of a predictive index indicating probable fluid responsiveness	248 (9.6 %)
Stroke volume increase assessed by Doppler echocardiography	50 (2.0 %)

Transthoracic echocardiography and mortality in sepsis: analysis of the MIMIC-III database



Transthoracic echocardiography and mortality in sepsis: analysis of the MIMIC-III database

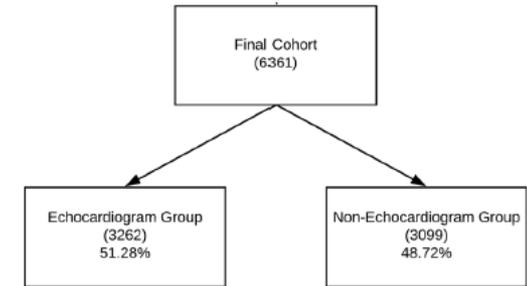


Table 2 Primary outcome analysis with five different models: (1) doubly robust model with unbalanced covariates (2) doubly robust model with all covariates, (3) propensity score IPW model, (4) propensity score matching model, (5) multivariate logistic regression model

Method	OR	CI		p value
		2.5%	97.5%	
Doubly robust with unbalanced covariates	0.78	0.68	0.90	<0.001
Doubly robust with all covariates	0.64	0.52	0.78	<0.001
Propensity score IPW	0.84	0.78	0.92	<0.001
Propensity score matching	0.78	0.66	0.92	<0.001
Multivariate	0.64	0.53	0.78	<0.001

Septic Shock

Advances in Diagnosis and Treatment

Christopher W. Seymour, MD, MSc; Matthew R. Rosengart, MD, MPH

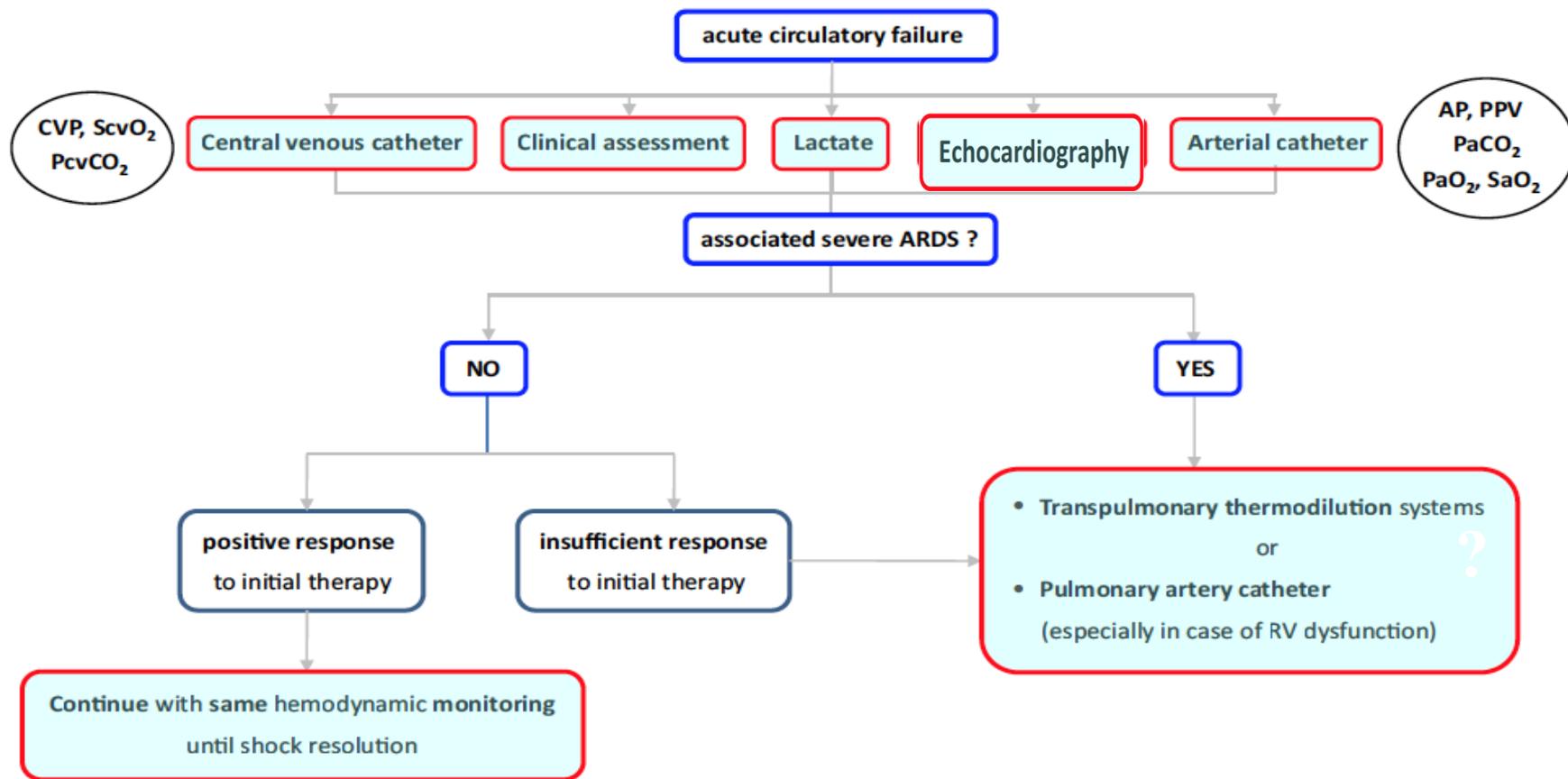
Table 1. Major Advances in the Diagnosis and Treatment of Traumatic and Septic Shock

Action	Caveat
Diagnostic	
Clinical diagnosis is the criterion standard: Typically, systolic blood pressure ≤ 90 mm Hg or mean arterial blood pressure ≤ 65 mm Hg or >40 -mm Hg decrease from baseline; Poor peripheral perfusion, low urinary output, altered mentation, elevated lactate	Normotensive shock with isolated hyperlactemia needs clarity; Lactate and systolic blood pressure thresholds are uncertain; Biologic phenotyping may be promising but not yet feasible in real time or tested in randomized clinical trials
Pulmonary artery catheterization and continuous monitoring of central venous oxygen saturation not recommended for routine diagnosis	May have a role in right ventricular dysfunction, complex cases with diagnostic uncertainty
Focused ultrasonography is suggested if there is concern for overlapping hemodynamic manifestations of shock	Practical, easy to use, and recommended by expert consensus ⁷
Arterial pulse contour analysis	Awaiting randomized clinical trials for patient outcomes; Requires controlled mechanical ventilation and sinus rhythm



Less invasive hemodynamic monitoring in critically ill patients

Jean-Louis Teboul^{1*}, Bernd Saugel², Maurizio Cecconi³, Daniel De Backer⁴, Christoph K. Hofer⁵, Xavier Monnet¹, Azriel Perel⁶, Michael R. Pinsky⁷, Daniel A. Reuter², Andrew Rhodes³, Pierre Squara⁸, Jean-Louis Vincent⁹ and Thomas W. Scheeren¹⁰



REVIEW

Clinical review: Update on hemodynamic monitoring - a consensus of 16

Jean-Louis Vincent^{1*}, Andrew Rhodes², Azriel Perel³, Greg S Martin⁴, Giorgio Della Rocca⁵, Benoit Vallet⁶, Michael R Pinsky⁷, Christoph K Hofer⁸, Jean-Louis Teboul⁹, Willem-Pieter de Boode¹⁰, Sabino Scolletta¹¹, Antoine Vieillard-Baron¹², Daniel De Backer¹, Keith R Walley¹³, Marco Maggiorini¹⁴ and Mervyn Singer¹⁵

Principle 1: no hemodynamic monitoring technique can improve outcome by itself

CAUTION

**THIS MACHINE
HAS NO BRAIN
USE YOUR OWN**

BY WHA CENTER IS. (202) 462-1111

I have a dream...

