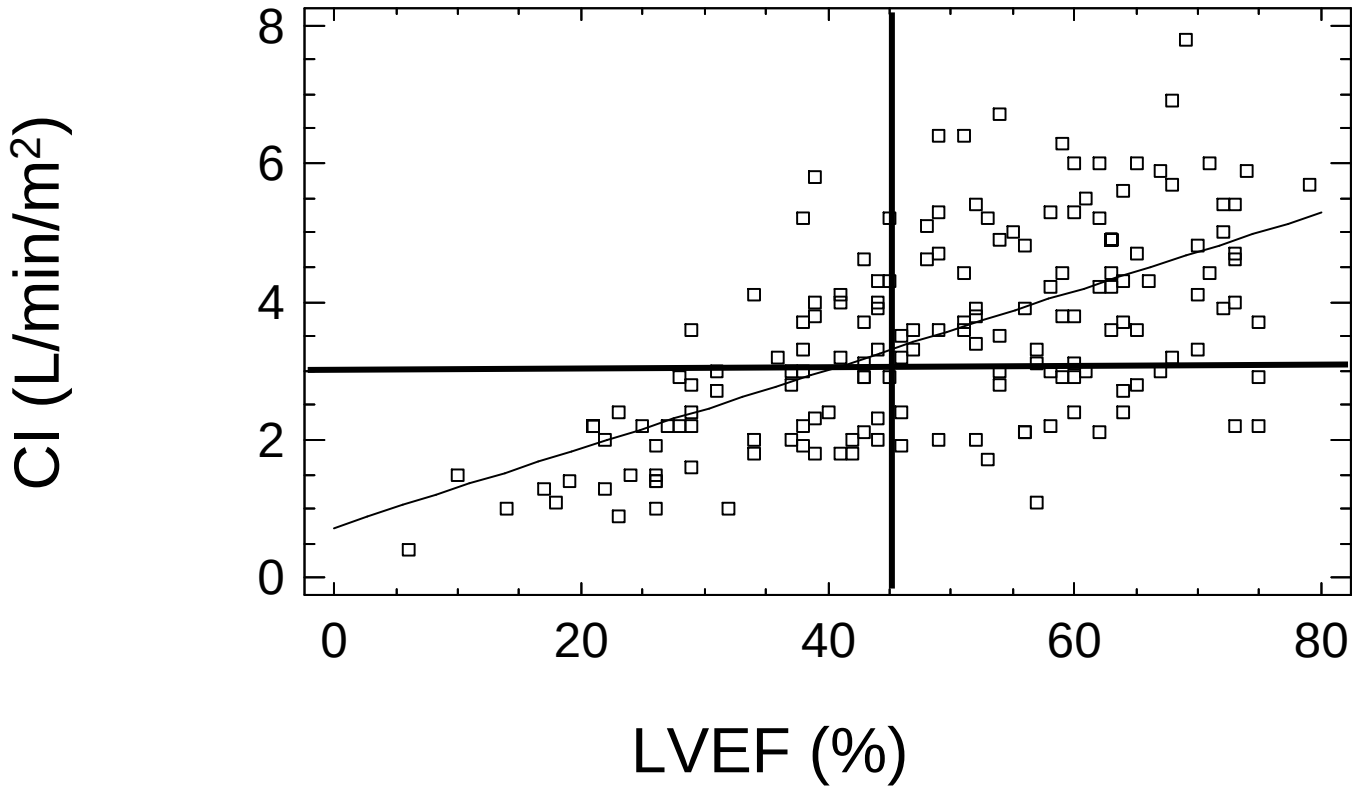
Clinical Commentary

Hemodynamic Instability in Sepsis

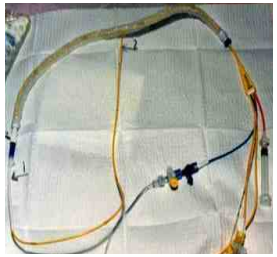
Bedside Assessment by Doppler Echocardiography

Antoine Vieillard-Baron, Sebastien Prin, Karim Chergui, Olivier Dubourg, and François Jardin

Medical Intensive Care Unit and the Department of Cardiology, University Hospital Ambroise Paré, Assistance Publique Hôpitaux de Paris, Boulogne Cedex, France

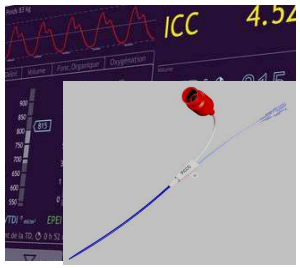


INVASIF — **“MINIMALLY” INVASIF** — **NON INVASIF**



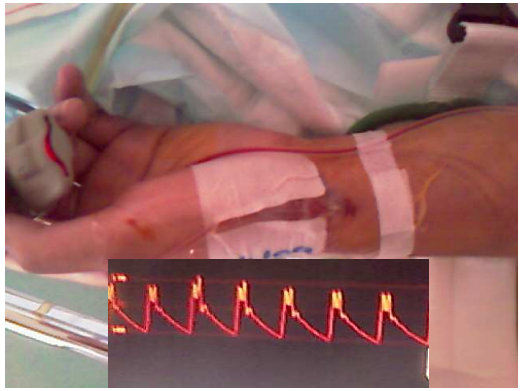
CAP

-Débit cardiaque
-Résistances vasculaires
-Pressions
-SvO2



THERMODILUTION TRANSPULMONAIRE

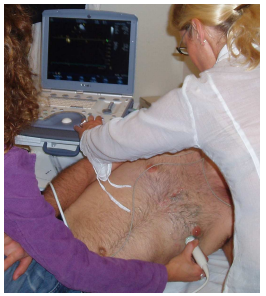
-Débit cardiaque
-Variations pression pulsée
-Fonction cardiaque?
-Précharge?
-Eau pulmonaire



CATHETER ARTERIEL

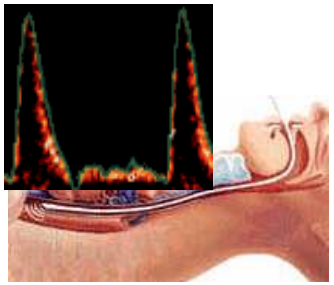
-Débit cardiaque
-Variations pression pulsée
-Tonus artériel

ETO



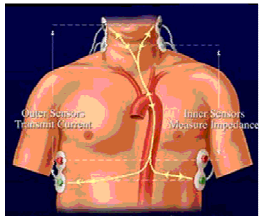
ETT

-Débit cardiaque
-Fonctions VG, VD
-Pressions
-Besoins en remplissage
-Péricarde



DOPPLER OESOPHAGIEN

-Débit cardiaque



BIO-IMPEDANCE

-Débit cardiaque

1993-2000

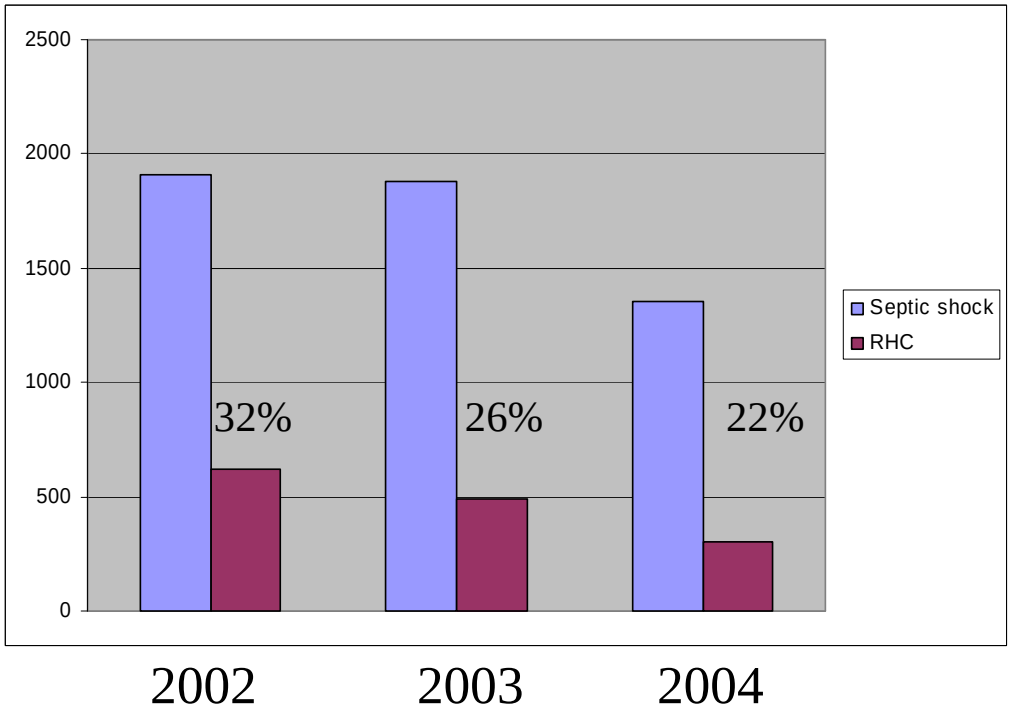
Variables	Septic Shock (*n* = 2,350)	Control Patients (*n* = 2,350)	p Value*
Baseline descriptors			
Age, yr	64.6 ± 13.3	64.9 ± 13.4	$< 10^{-2}$
Sex, female	30.1	30.1	
Type of admission, direct	39.3	39.3	
Admission category, medical	89.9	89.9	
SAPS II	54.1 ± 20.0	54.1 ± 20.1	NS
McCabe > 0	45.3	46.4	NS
Comorbidity			
Immunodeficiency	20.4	13.3	$< 10^{-4}$
Diabetes mellitus	2.6	3.2	NS
Chronic renal failure	3.4	5.1	$< 10^{-2}$
Hematologic malignancy	8.0	4.7	$< 10^{-4}$
Cancer	6.9	5.3	< 0.05
HIV-related disease	3.5	1.3	$< 10^{-4}$
Chronic pulmonary disease	12.3	8.2	$< 10^{-4}$
ALI–ARDS	22.3	7.6	$< 10^{-4}$
Interventions			
Mechanical ventilation	79.1	69.1	$< 10^{-4}$
Time on ventilator, d†	15.0 ± 20.2	8.6 ± 13.4	$< 10^{-4}$
Vasopressors‡	84.8	75.9	$< 10^{-4}$
Right-heart catheterization	36.7	25.7	$< 10^{-4}$
Renal support	25.1	16.4	$< 10^{-4}$
Mean daily omega score	18.4 ± 9.4	18.2 ± 11.3	NS
Outcomes			
ICU length of stay, d†;			
mean ± SD median (quartile)	16.8 ± 21		
	6 10 (4–		
ICU mortality rate	57.1		

CUB-réa Network AJRCCM 2003

College des Utilisateurs des Bases des données en Réanimation

36 ICU

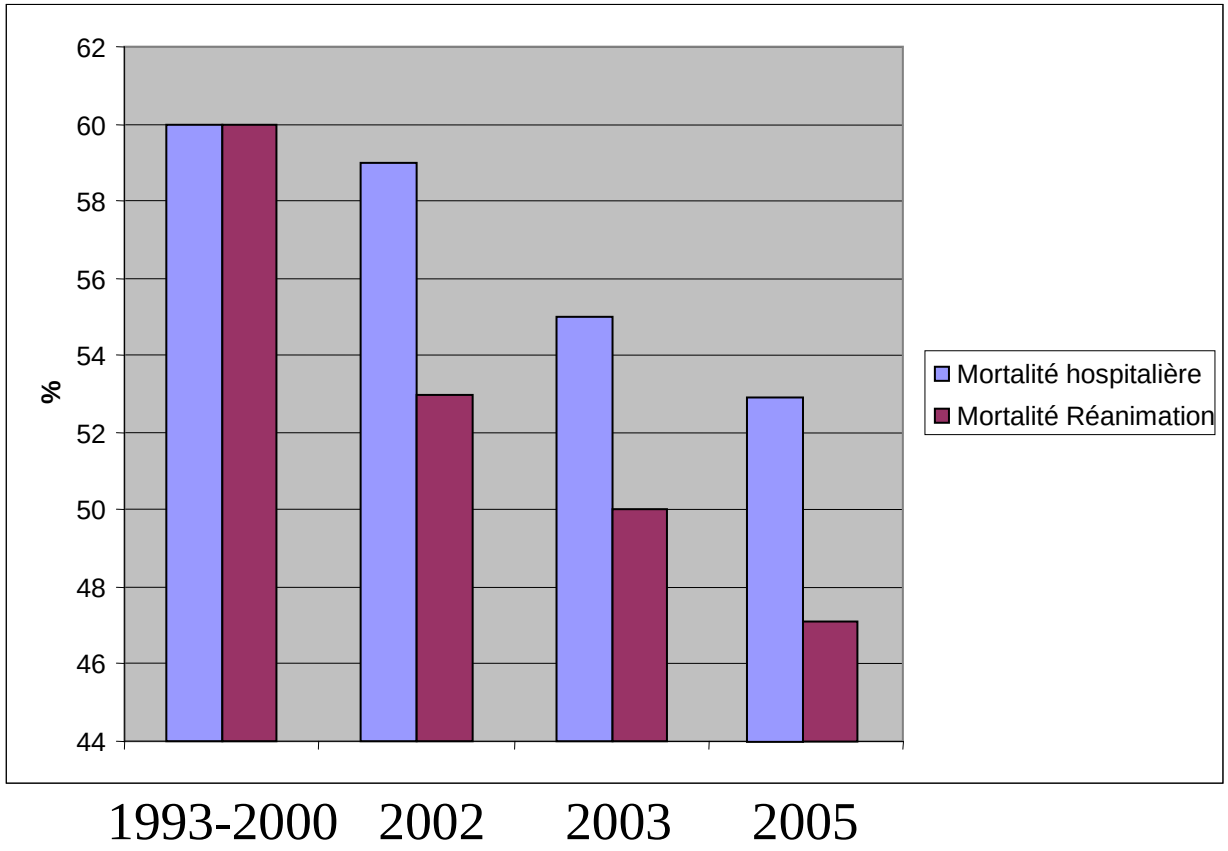
C.U.B Réa



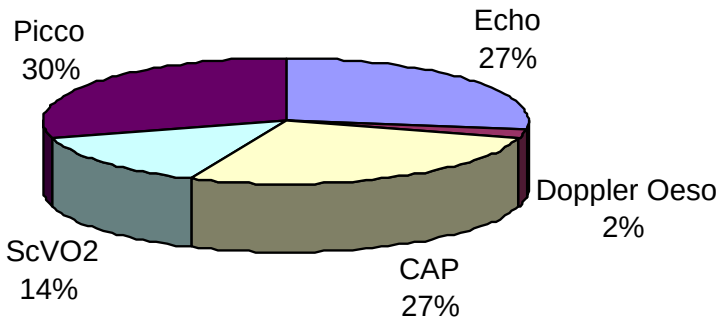
Collège des Utilisateurs des Bases des données en Réanimation

C.U.B Réa

36 ICU



- 44 services de réanimation
- France, Belgium, Switzerland



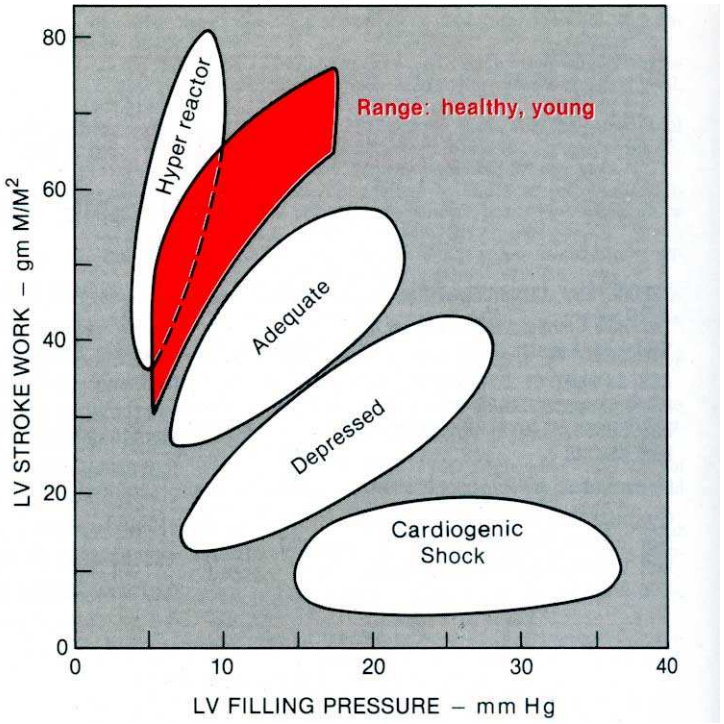
Sepsis in European intensive care units: Results of the SOAP study*

Vincent CCM 2006

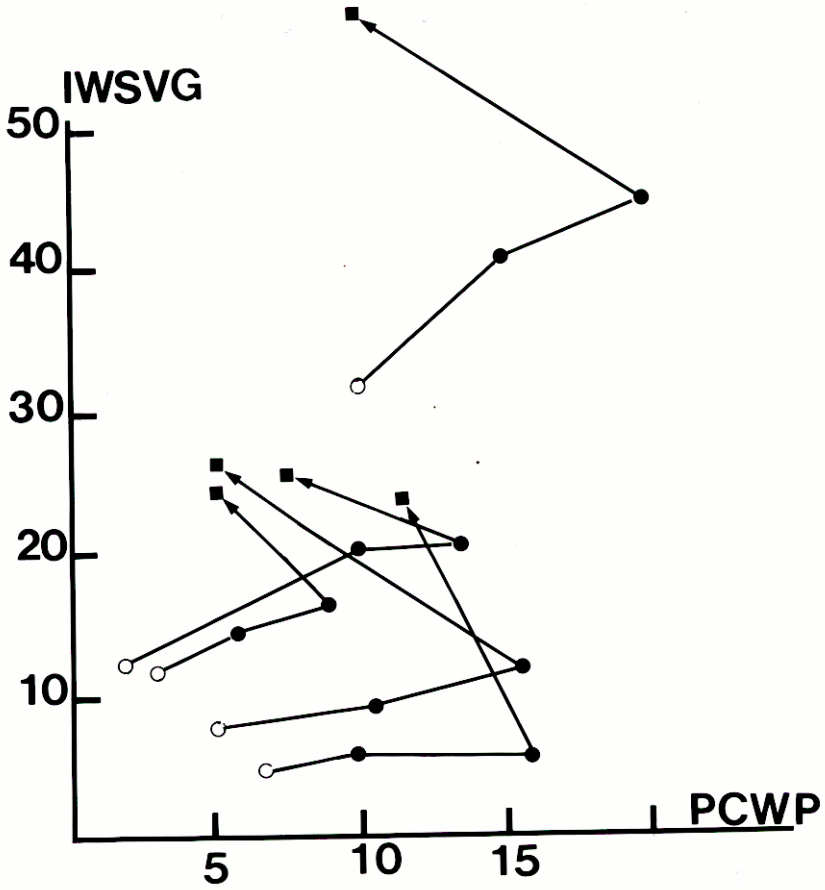
1-15 Mai 2002
1177 patients avec un sepsis

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



In Braunwald



21 patients in septic shock with bilateral chest infiltrates

	Day 1	
	Group 1	Group 2
RAP (mm Hg)	11 ± 3	9 ± 4
MPAP (mm Hg)	24 ± 6	25 ± 5
WP (mm Hg)	11 ± 4	11 ± 5

Jardin CCM 1990

DIAGNOSTIC ECHO

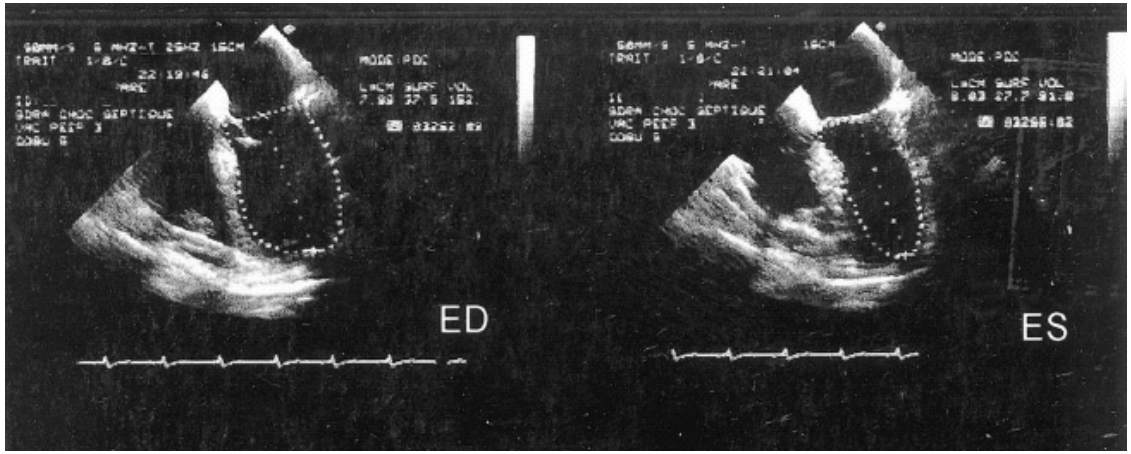
- 1- Hypocontractilité du VG
  - Diffuse
  - Parfois à prédominance segmentaire

- 2- Absence de dilatation significative du VG
  - VTD (grand axe): 70 ml/m^2
  - STD (petit axe): 13 cm^2/m^2

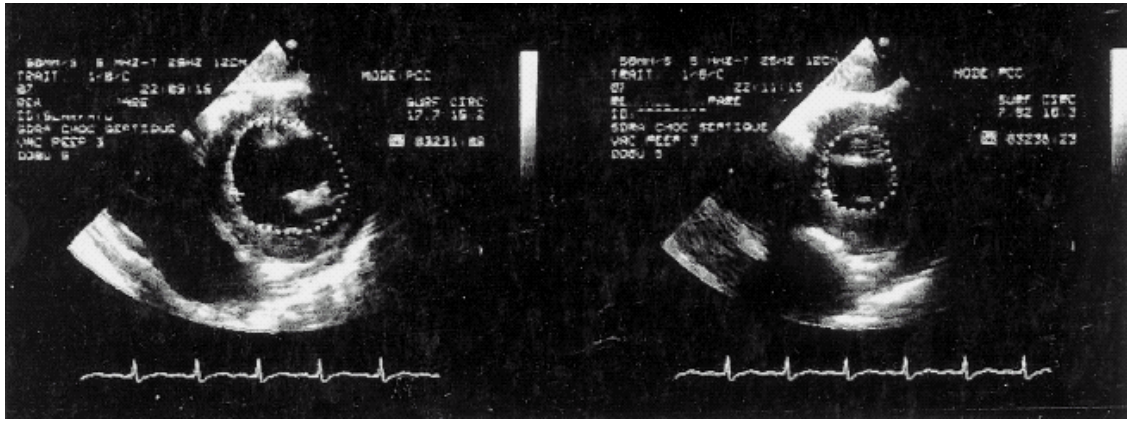
- 3- Pas d'argument pour des pressions de remplissage élevées (Doppler pulsé mitral)

Hypocontractilité

FE = VTD - VTS / VTD

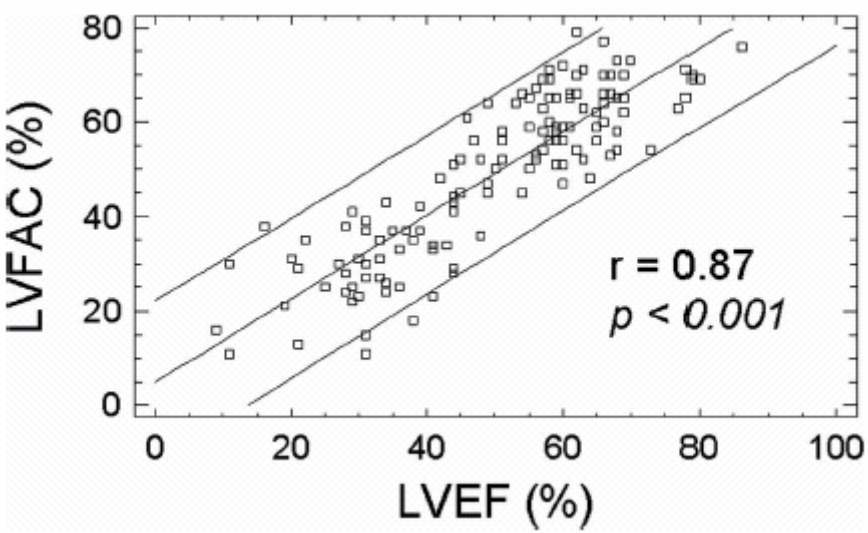


FRS = STD - STS / STD



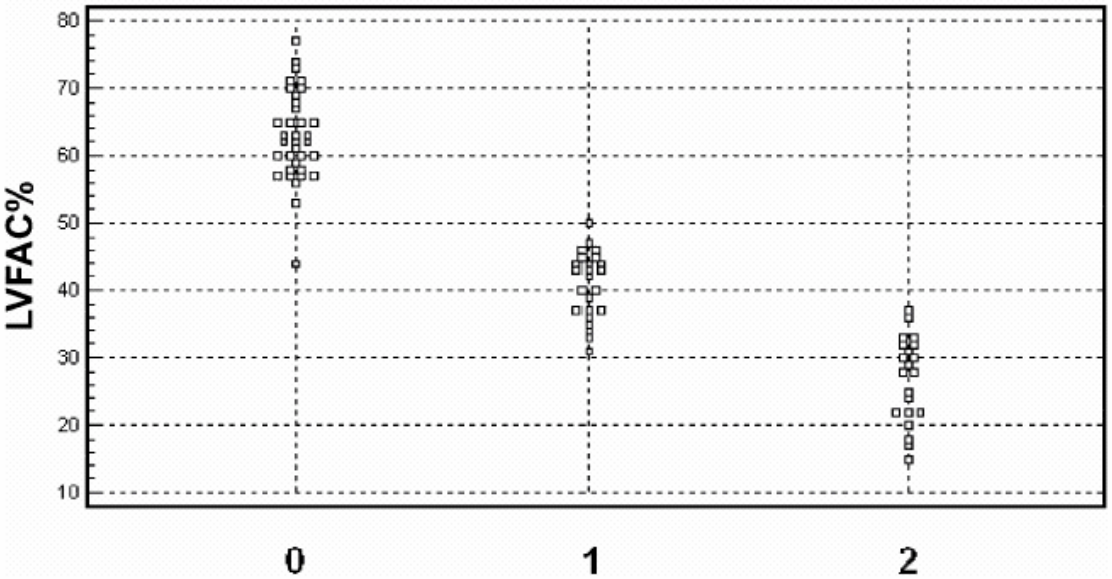
- La FRS sera préférée

Crit Care Med 2008

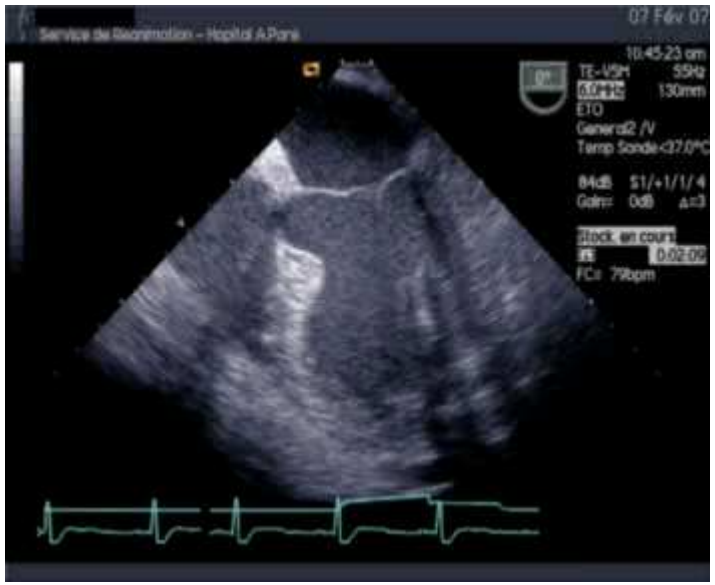


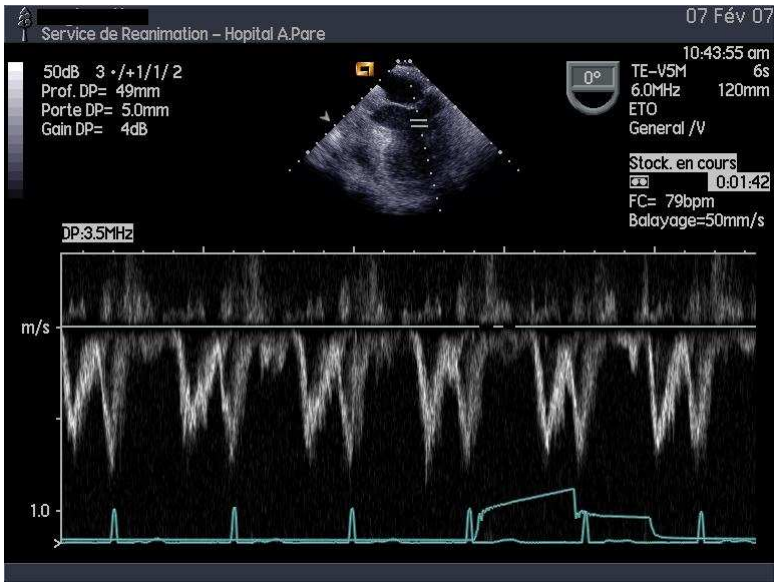
- Une mesure n’est pas toujours nécessaire

ICM 2006



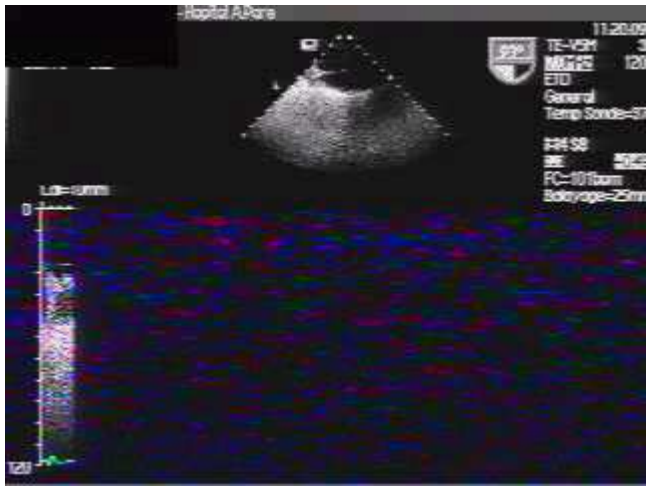
Pas d’arguments pour des pressions de remplissage élevées



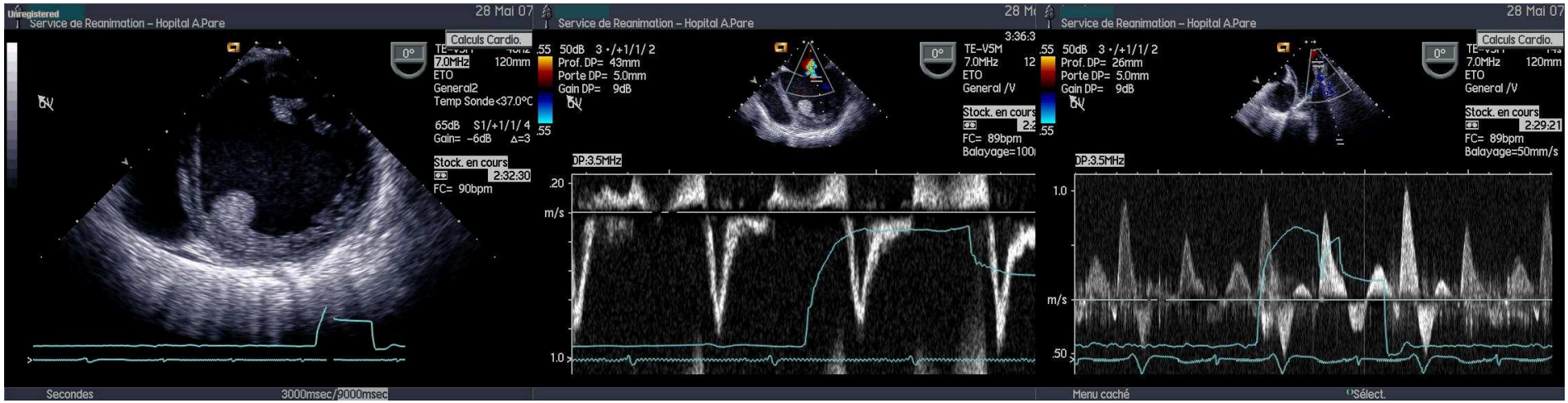


Baseline
CI 1.4 L/min/m^2

Volume expansion
CI 2.6 L/min/m^2



A l’inverse….



Choc cardiogénique

Baseline **NE infusion** **Dobu and NE infusion**

- Le traitement comporte en première attention de la dobutamine
- Dose entre 5-7,5 µg/kg/min
- En cas d'échec, adrénaline

Table 3. Hemodynamic changes observed after 24 hrs of continuous infusion of an inotropic agent

	Before Dobutamine (n = 30)	After 24 hrs Dobutamine (n = 30)	Before Epinephrine (n = 10)	After 24 hrs Epinephrine (n = 10)
SAP (mmHg)	96 ± 22	108 ± 15	93 ± 12	136 ± 27[a]
HR (beats/min)	107 ± 24	100 ± 22	107 ± 31	100 ± 23
CI (L/min/m^2)	2.3 ± 1	2.9 ± .9	2.2 ± 1	3.6 ± .8[a]
LVEF (%)	32 ± 9	49 ± 13[a]	32 ± 9	53 ± 10[a]
LVEDV (mL/m^2)	69 ± 23	72 ± 19	72 ± 17	74 ± 10
SAP/LVESV	2.5 ± 1.1	4.4 ± 2.5[a]	2.3 ± .9	4.4 ± 2.2[a]

Crit Care Med 2008

- La dysfonction systolique VG peut survenir à J1, J2, J3
- Intérêt de répéter l'examen pendant les 3 premiers jours

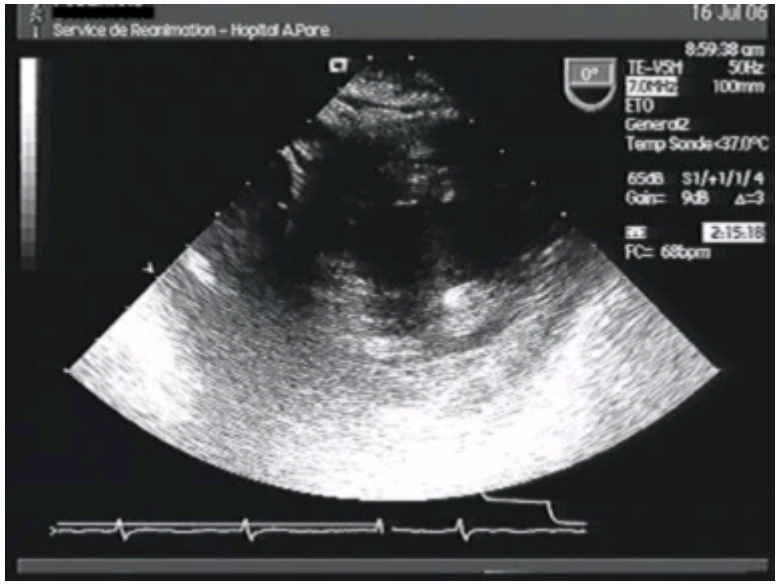
Table 2. Hemodynamic data obtained in nonhypokinetic, primary, and secondary hypokinetic patients and at the time of vasopressors weaining

	1 Non-hypo. (n = 27)	2 Primary Hypo. (n = 26)	3 Secondary Hypo. (n = 14)	4 Weaning (n = 44)
SAP (mm Hg)	93 ± 23	97 ± 22	110 ± 21	124 ± 21[b]
HR (beats/min)	106 ± 21	108 ± 26	112 ± 24	88 ± 19[b]
CI (l/min/m^2)	3.6 ± 1.5	2.6 ± 0.9[a]	2.1 ± 0.8[a]	3.3 ± 0.8
LVEF (%)	65 ± 9	31 ± 9[a]	31 ± 8[a]	57 ± 8[b]
LVEDV (ml/m^2)	68 ± 24	76 ± 24	61 ± 15	75 ± 19
SAP/LVESV	4.8 ± 2	2.1 ± 0.8[a]	2.9 ± 1.1[a]	4.4 ± 2[b]

Crit Care Med 2008

- Impact clinique si FEVG < 40-45%


Service de Reanimation – Hopital A.Pare
09 Jul 06
10:07:19 am
TE-V5M 43Hz
7.0MHz 150mm
ETO
General2
Temp Sonde<37.0°C
65dB S1/+1/1/4
Gain= -2dB Δ=3
Prof. DP= 22mm
FC=141bpm

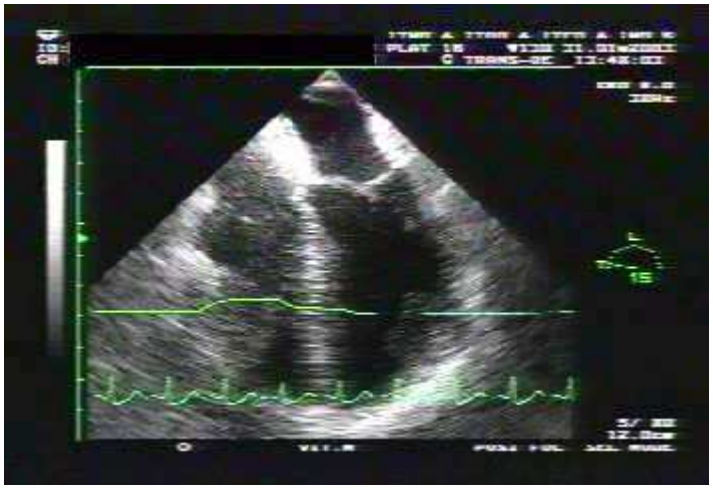

Service de Reanimation – Hopital A.Pare
16 Jul 06
8:59:38 am
TE-V5M 50Hz
7.0MHz 100mm
ETO
General2
Temp Sonde<37.0°C
65dB S1/+1/1/4
Gain= 9dB Δ=3
FC= 68bpm

Hyperkinetic state

40 pts in septic shock

15%

Anesthesiology 2001



Hypokinetic state (LVEF < 45%)

67 pts in septic shock 2004-2006

60% of the patients

- 26 (39%) at D1

- 14 (21%) after

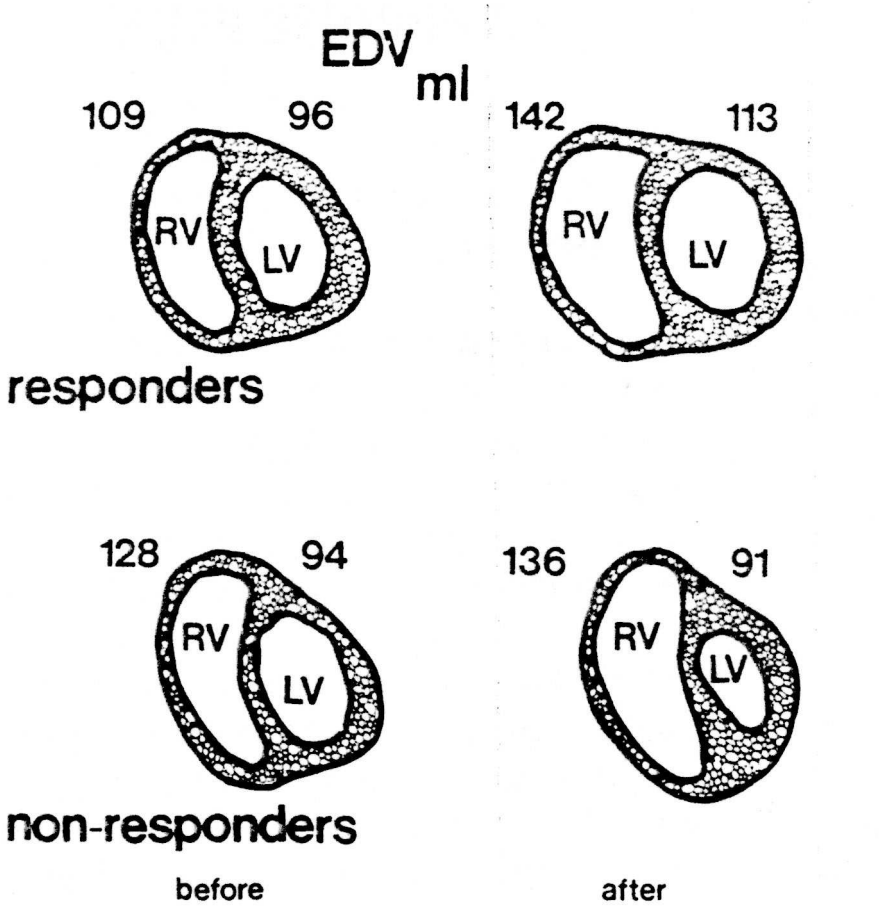


Fig. 4. Schematic representation (cross-section) of effect of volume loading (before and after) on end-diastolic volume *(EDV)* of right ventricle *(RV)* and left *(LV)* ventricle seen in responders and nonresponders.

Schneider Am Heart J 1988

F 19 years old, infection of the urinary tract

In emergency room

Fever

Tachycardia, SAP 65 mmHg

Normal lung at chest radiography

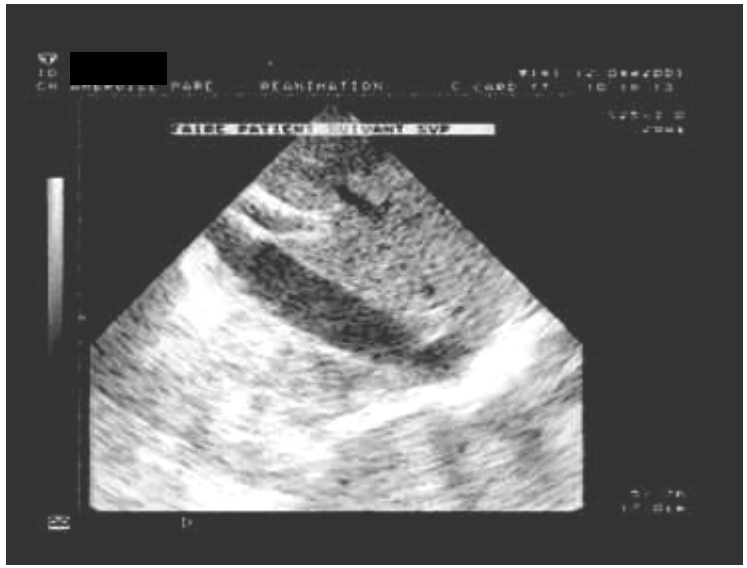
After 500 ml of blood volume expansion,

SAP 70 mmHg,

Abdominal pain

=> Blood volume expansion

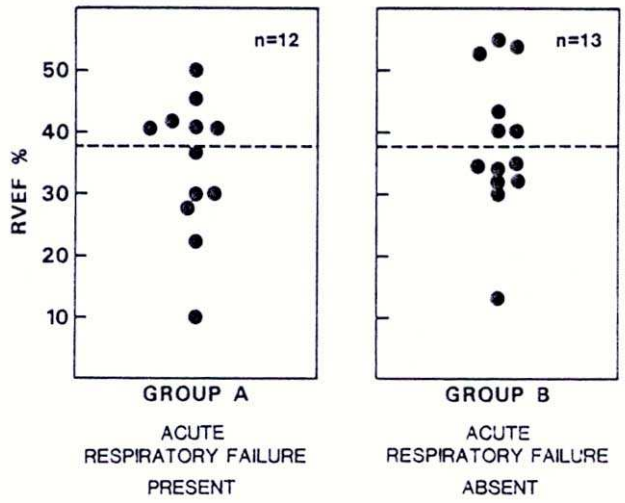
Hospitalized in ICU for circulatory failure and suspicion of peritonitis.



Right Ventricular Performance in Septic Shock: A Combined Radionuclide and Hemodynamic Study

ASHER KIMCHI, MD, A. GRAY ELLRODT, MD, FACC, DANIEL S. BERMAN, MD, FACC, MARY S. RIEDINGER, RN, CCRN, H. J. C. SWAN, MD, PHD, FACC, GLEN H. MURATA, MD

JACC 1984



52%

Sepsis-related cardiogenic shock

FRANÇOIS JARDIN, MD; DOMINIQUE BRUN-NEY, MD; BERTRAN AUVERT, MD, PHD; ALAIN BEAUCHET, MD; JEAN PIERRE BOURDARIAS, MD

CCM 1990

- 7/21 (30%) with a biventricular systolic dysfunction

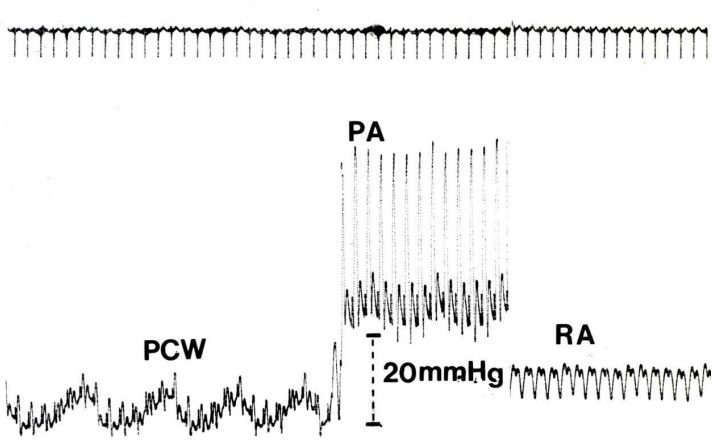
Early Preload Adaptation in Septic Shock?

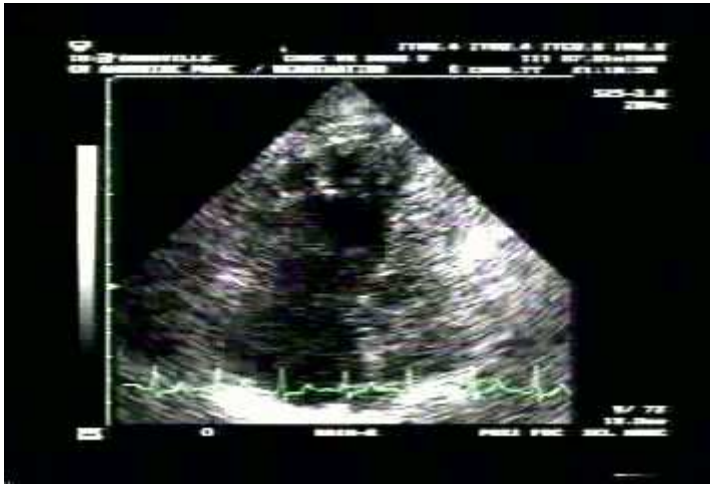
A Transesophageal Echocardiographic Study

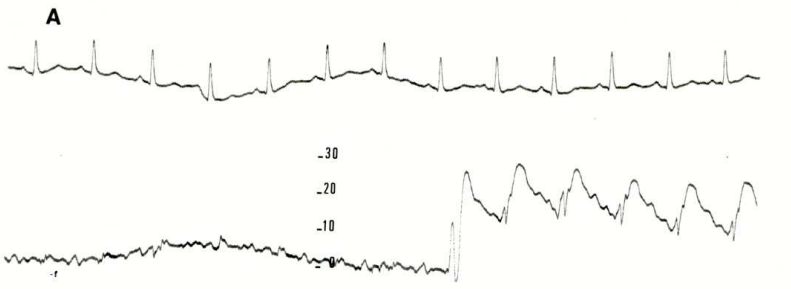
Antoine Vieillard-Baron, M.D., Jean-Marie Schmitt, M.D.,† Alain Beauchet, M.D.,‡ Roch Augarde, M.D.,† Sebastien Prin, M.D.,† Bernard Page, M.D.,§ François Jardin, M.D.‖*

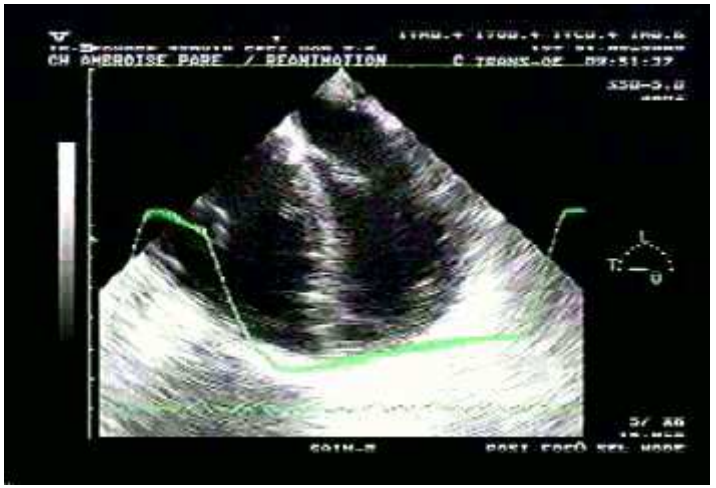
Anesthesiology 2001

- 13/40 (33%) with RV dilatation


PA
PCW
20mmHg
RA




A
30
20
10
0


CH AMBROISE PARE / REANIMATION
C TRANS-OE

- Patiente de 66 ans, admise en réanimation pour état de choc septique à point de départ urinaire

  - Sédation, intubation orotrachéale, VM
    - PP 18 cmH_2O, PEEP 5

  - Expansion volémique

  - Œdème pulmonaire

- A J2, l’évolution hémodynamique va être favorable sous 5 mg/heure de NA
  - PAS 110 mmHg
  - pH 7,39
  - BE -2 mEq/L

- A J3, on note une nouvelle dégradation hémodynamique

  - PAS 80 mmHg
  - Extrémités froides

mEq/L

CLINICAL SUSPICION (BP, lactates, BD, urinary output…)
SYSTEMATIC HEMODYNAMIC EVALUATION (D1, D2, D3 septic shock, ARDS)
HEMODYNAMIC CHANGES RELATED TO TREATMENT (impact of PEEP, prone position, NE, dobutamine..)

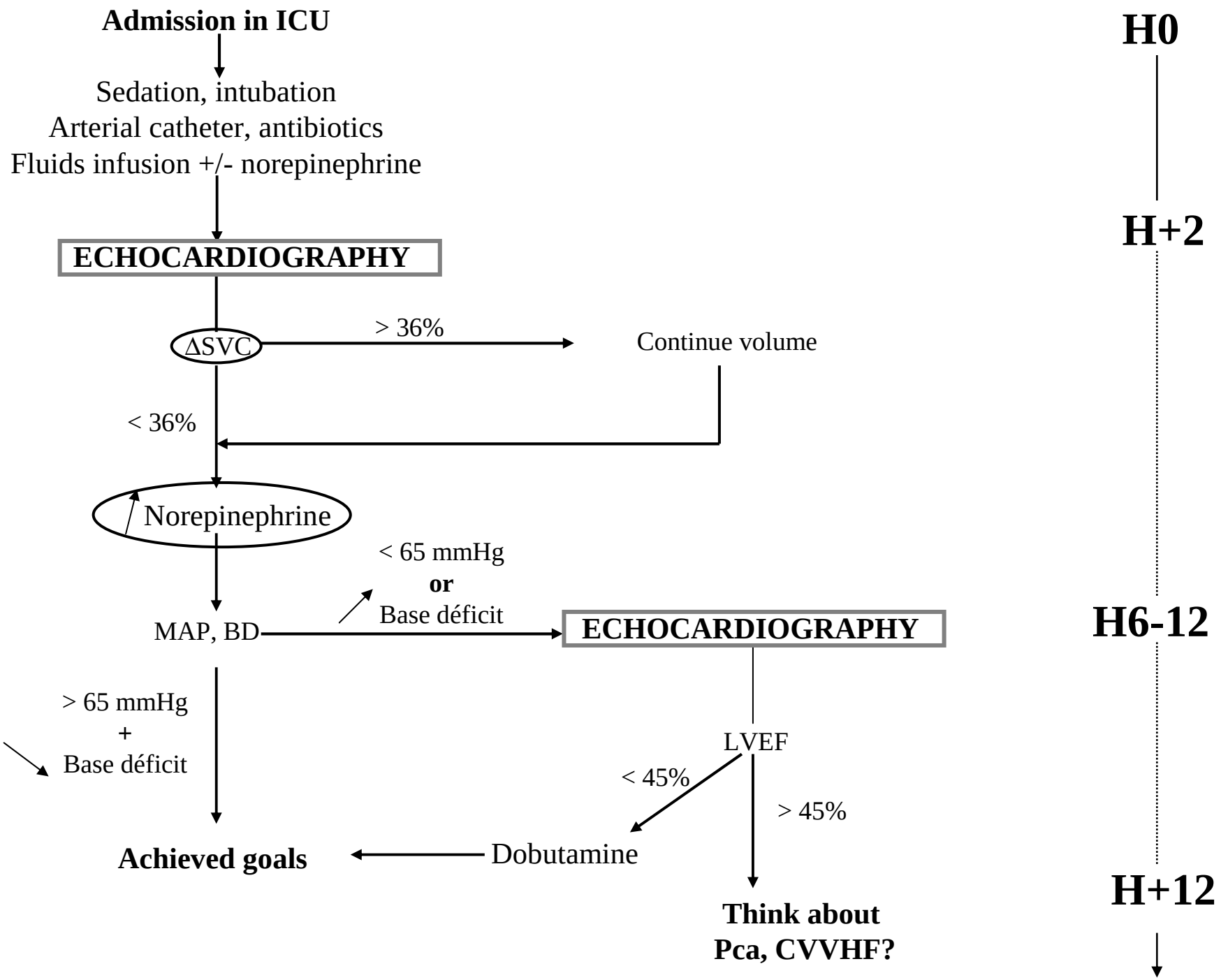
RIGHT EVALUATION

- To well-known the literature: parameters
- To know the pitfalls
- To be able to interpret the exam according to clinical situation

RIGHT DECISION AND RIGHT TREATMENT

ALGORITHM

RE-EVALUATION


Admission in ICU
Sedation, intubation
Arterial catheter, antibiotics
Fluids infusion +/- norepinephrine
ECHOCARDIOGRAPHY
ΔSVC
> 36%
Continue volume
< 36%
Norepinephrine
MAP, BD
< 65 mmHg
or
Base déficit
ECHOCARDIOGRAPHY
> 65 mmHg
+
Base déficit
LVEF
< 45%
> 45%
Dobutamine
Achieved goals
Think about
Pca, CVVHF?
H0
H+2
H6-12
H+12