31eMAPAR

L Muller CHU Nîmes

Echographie en urgence : *gadget ou véritable outil ?*

Echographie en réanimation

- Certification
- Impact sur les soins
- Avantages et limites
- Développements technologiques

Echographie en réanimation

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Echographie en réanimation : certification (1)

- DIU techniques ultrasoniques en anesthésie réanimation SFAR (DIU TUSAR)
  - Cœur
  - Poumon
  - FAST
  - Echo Doppler transcrânien
  - ALR
- DIU échographie et techniques ultrasonores (un module urgence) :
- DIU échocardiographie en réanimation SFC/SRLF

Echographie en réanimation : certification (2)

Le champ d'action des compétences ultrasonographiques en réanimation est basé sur des recommandations :

- Recommandations issues des sociétés savantes : SFAR/SRLF/ACCP
- Recommandations issues de groupes d'experts : WINFOCUS

Echographie en réanimation : certification (3)

Exemple de l'échocardiographie :

- Formation sur 6 mois à un an
- 100 à 150 ETT
- 30 à 50 ETO

Echocardiographie en réanimation : proposition d'un score de compétence

Validation of a skills assessment scoring system for transesophageal echocardiographic monitoring of hemodynamics

Table 1 Four-part skills assessment scoring system

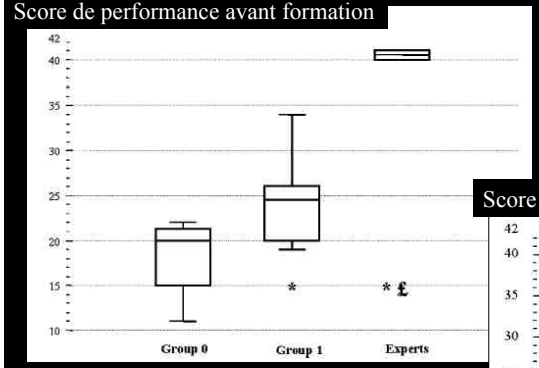
Qualitative data collection				Score
Introduction of probe	No	Problematic	Yes	/2
TE Long-axis view at 0°	Not recorded	Not optimal	Optimal	/2
TE Long-axis view at 120°	Not recorded	Not optimal	Optimal	/2
TG Short-axis view at 0°	Not recorded	Not optimal	Optimal	/2
TG Short-axis view at 120°	Not recorded	Not optimal	Optimal	/2
TE View of base of heart at 0°	Not recorded	Not optimal	Optimal	/2
TE View of base of heart at 90°	Not recorded	Not optimal	Optimal	/2
			Total	/14
Semiquantitative data collection				
Mitral regurgitation	None	Moderate	Marked to massive	/2
Aortic regurgitation	None	Moderate	Marked to massive	/2
Dilatation of right ventricle	None	Moderate	Marked	/2
Pericardial effusion	None	Noncompressive	Compressive	/2
Variations in diameter of superior vena cava	None	Minimal	Large	/2
			Total	/10
Quantitative data collection				
	Intensivist		Expert	
E/A ratio				/2
LV FAC (%)				/2
Aortic VTI (cm)				/2
Pulmonary VTI (cm)				/2
			Total	/8
Summary and treatment				
LV contractility	Normal	Moderately decreased	Greatly decreased	/2
Hypovolemia	No		Yes	/2
RV failure	No		Yes	/2
Treatment proposed	Wrong or incomplete		Right	/2
			Total	/8
TEE performed in less than 10 min (yes or no)				/2
Final score				/42

TE, transesophageal; *TG*, transgastric; *FAC*, fractional area change; *LV*, leftventricle; *RV*, right ventricle; *VTI*, velocity–time integral

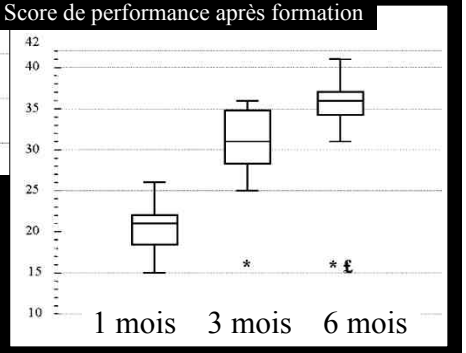
Charron et al Intensive Care Med 2007

Echocardiographie en réanimation : durée d'acquisition des compétences

Score de performance avant formation



Score de performance après formation



Groupe 0 = aucune expérience

Groupe 1 = 1 an de pratique

Charron et al Intensive Care Med 2007

Echocardiographie en réanimation : durée d'acquisition des compétences

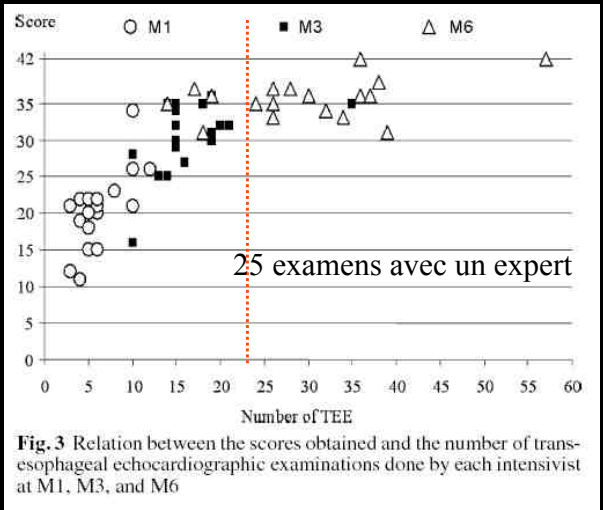


Fig. 3 Relation between the scores obtained and the number of transesophageal echocardiographic examinations done by each intensivist at M1, M3, and M6

Charron et al Intensive Care Med 2007

Compétences échographiques en réanimation

CHEST Consensus Statement

American College of Chest Physicians/ La Société de Réanimation de Langue Française Statement on Competence in Critical Care Ultrasonography*

Paul H. Mayo, MD; Yannick Beaulieu, MD; Peter Doelken, MD; David Feller-Kopman, MD; Christopher Harrod, MS; Adolfo Kaplan, MD; John Oropello, MD; Antoine Vieillard-Baron, MD; Olivier Axler, MD; Daniel Lichtenstein, MD; Eric Maury, MD; Michel Slama, MD; and Philippe Vignon, MD

Mayo et al Chest 2009

Compétences échographiques en réanimation : échocardiographie

Table 7—*Competence in Basic CCE: Required Cognitive Skills in Recognition of Clinical Syndromes*

Clinical Syndromes	Echocardiographic Findings
Severe hypovolemia	Small, hyperdynamic ventricles Small IVC with wide respiratory variations
LV failure	Global LV systolic dysfunction Heterogeneous contractility pattern suggestive of myocardial ischemia LV cavity dilatation suggestive of chronic cardiac disease
RV failure	Acute cor pulmonale: RV dilatation and paradoxical septal motion* Isolated RV dilatation suggestive of RV infarct Associated findings: dilated, noncollapsible IVC
Tamponade	Pericardial effusion (regardless of size)† Right atrial/RV diastolic collapse Associated findings: dilated, noncollapsible IVC
Acute massive left-sided valvular regurgitation	Normal LV cavity size (acute valvulopathy) Normal/hyperdynamic LV systolic function (LV volume overload) Massive color Doppler regurgitant flow‡
Circulatory arrest	
During resuscitation	Tamponade or acute cor pulmonale (from massive pulmonary embolism) LV systolic function (cardiac standstill vs severely depressed vs hyperdynamic) Global LV systolic dysfunction
After successful resuscitation	Heterogeneous contractility pattern suggestive of myocardial ischemia

Table 6—*Competence in Basic Critical Care Echocardiography: Required Cognitive Skills in Image Interpretation*

Echocardiographic patterns
Global LV size and systolic function
Homogeneous/heterogeneous LV contraction pattern
Global RV size and systolic function
Assessment for pericardial fluid/tamponade
IVC size and respiratory variation
Basic color Doppler assessment for severe valvular regurgitation

Mayo et al Chest 2009

Compétences échographiques en réanimation : Doppler cardiaque

Table 13—*Competence in Advanced CCE: Parameters of LV Filling Pressure*

Parameters	Technical Considerations and Interpretation
E/A ratio, DTE[25]	Pulsed wave Doppler recorded at the tip of the mitral valve A restrictive pattern (E/A ratio ≥ 2, DTE < 120 ms) is highly suggestive of a PAOP > 18 mm Hg
Systolic fraction of the pulmonary vein flow[26–28]	Pulsed wave Doppler recorded in upper left pulmonary vein A low systolic fraction (≤ 40%) suggests a PAOP > 18 mm Hg
E/E′[29]	Pulsed wave Doppler recorded at the tip of the mitral valve (E) Tissue Doppler recorded at the mitral annulus (E′) PAOP and E/E′ are closely related

Mayo et al Chest 2009

Compétences échographiques en réanimation : « poumon»

Plèvre

Table 1—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Pleural Ultrasonography*

Identification of a relatively hypoechoic or echo-free space surrounded by typical anatomic boundaries: diaphragm, chest wall, ribs, visceral pleura, normal/consolidated/atelectatic lung
Identification of liver and ascites, spleen, kidney, heart, pericardium and pericardial effusion, spinal column, aorta, inferior vena cava
Identification of characteristic dynamic findings of pleural fluid, such as diaphragmatic motion, floating lung, dynamic fluid motion, respirophasic shape change
Characterization of fluid: anechoic; echogenicity (using liver/spleen as reference); homogeneous or heterogeneous; presence of strands/debris/septations
Identification of miscellaneous findings, such as pleural-based masses or thickening
Performance of semiquantitative assessment of fluid volume
Recognition of specific limitations of ultrasonography to identify pleural fluid, such as inadequate image quality due to technical limitations, subcutaneous emphysema, hemothorax, echo-dense purulent fluid, mimics of effusion such as mesothelioma or pleural fibrosis

Parenchyme

Table 2—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Lung Ultrasonography*

Knowledge of the basic semiology of lung ultrasound: A-lines, B-lines, sliding lung, lung point
Identification and characterization of consolidated lung: identification of tissue density lung, with or without air bronchograms
Identification and characterization of air artifacts suggestive of the normal aeration pattern: A-lines with sliding lung
Identification and characterization of air artifacts suggestive of alveolar interstitial pattern: number and location of B lines
Knowledge of the limitations of not visualizing lung sliding/B lines
Identification and characterization of air artifacts to rule out pneumothorax: presence of sliding lung, presence of B-lines
Identification and characterization of findings that rule in pneumothorax: presence of lung point (both by 2D imaging and M-mode)

Mayo et al Chest 2009

Compétences échographiques en réanimation : abdomen

Table 3—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Abdominal Ultrasonography*

Assessment for intraperitoneal fluid
Identification of a relatively echo-free space surrounded by typical anatomic boundaries: abdominal wall, diaphragm, liver, gallbladder, spleen, kidney, bladder, bowel, uterus, spinal column, aorta, IVC
Identification of abdominal wall, diaphragm, liver, gallbladder, spleen, kidney, bladder, bowel, uterus, spinal column, aorta, IVC
Identification of characteristic dynamic findings of intraperitoneal fluid, such as diaphragmatic motion, floating bowel, bowel peristalsis, dynamic fluid motion, and respirophasic shape change, compressibility
Characterization of fluid: anechoic; echogenicity (using liver/spleen as reference); homogeneous or heterogeneous; presence of strands/debris/septations
Qualitative assessment of intraperitoneal fluid volume
Recognition of specific limitations of ultrasonography to identify intraperitoneal fluid such as inadequate image quality due to technical limitations, hemoperitoneum, echo-dense purulent fluid
Assessment of the urinary tract
Bladder: identification of bladder, identification of urinary catheter, identification of abnormal bladder contents
Differentiation of distended bladder from ascites
Qualitative assessment of intravesicular volume, identification of overdistention
Kidneys: identification of both kidneys, identification of presence or absence of hydronephrosis, measurement of kidney in longitudinal axis
Assessment of the aorta
Identification of abdominal aorta
Identification of abdominal aortic aneurysm

Epanchement liquidien

Quantification épanchement

Dilatation rénale

Globe vésical

Anévrisme aorte abdominale

Mayo et al Chest 2009

Compétences échographiques en réanimation : thrombose veineuse

Table 5—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Vascular Ultrasonography for Diagnosis of Venous Thrombosis*

Identification of relevant veins and their associated artery: internal jugular, subclavian, axillary, brachial, basilic, common femoral, proximal saphenous, superficial femoral, popliteal with differentiation from adjacent artery
Identification of venous thrombosis: visualization of endoluminal thrombus, performance of compression study with identification of noncompressible vein consistent with thrombosis
Knowledge not to perform compression maneuver if there is a visible thrombus
Identification of adjacent structures such as lymph node, mass, hematoma, ruptured Baker cyst

Mayo et al Chest 2009

Compétences échographiques en réanimation : pose des cathéters

Table 4—*Technical (Image Acquisition) and Cognitive (Image Interpretation) Elements Required for Competence in Vascular Ultrasonography for Guidance of Vascular Access*

Identification of relevant veins and arteries: internal jugular/carotid, subclavian vein/artery, axillary vein/artery, brachial vein/artery, radial artery, femoral vein/artery vein, peripheral veins such as basilic, cephalic, external jugular
Differentiation of vein from artery based on anatomic position, compressibility, respirophasic changes
Identification of normal anatomic variability such as vascular hypoplasia, variability of carotid artery position relative to internal jugular
Identification of vascular thrombosis by direct visualization or by compression study (see "Vascular Ultrasonography for Diagnosis of Venous Thrombosis" section in text)
Identification of adjacent nonvenous structures such as sternocleidomastoid muscle, mass, lymph node
Knowledge of the effects of patient positioning on anatomic topography: head/lower extremity rotation effects on overlap of the artery by the vein, effects of Trendelenburg position on vascular distention

Mayo et al Chest 2009

Compétences échographiques en réanimation : le cerveau aussi !

Doppler de l'artère cérébrale moyenne

	Formule	Normale adulte < 60 ans	Normale adulte > 60 ans
Paramètres mesurés			
Vitesse systolique (Vs) (cm/s)	-	75 – 105, max 200	60 – 100
Vitesse diastolique (Vd) (cm/s)	-	35 – 55	35 – 55
Paramètres calculés			
Vitesse moyenne (Vm)	(Vs + (Vd x 2)) / 3	45 – 70	35 – 55
Index de pulsatilté (IP)	(Vs – Vd) / Vm	0,8 – 1,4	0,8 – 1,2
Index de Lindegaard (IL)	Vitesse ACM/ACI	< 3	< 3

Muller et al SFAR 2008

Compétences échographiques en réanimation : le cerveau aussi !

Doppler de l'artère cérébrale moyenne

Doppler transcrânien : valeurs d'alarme

Vd < 20 – 25 cm/s

Vm < 30 – 35 cm/s

IP > 1,2 – 1,4

2 des 3 critères présents : Hypoperfusion cérébrale grave appelant une manœuvre thérapeutique en urgence.

Doppler transcrânien : profils classiques

Vs basse, Vd basse, IP normal	**Hypoperfusion d'origine systémique**
Vs basse, Vd basse, IP élevé	**Hypoperfusion d'origine cérébrale**
Vs élevée, IP normal, IL < 3	**Hyperhémie**
Vs élevée, IP normal, IL > 3	**Vasospasme**

Muller et al SFAR 2008

Echographie en réanimation

- Certification
- Impact sur les soins
- Avantages et limites
- Développements technologiques

Echographies par des médecins non spécialistes : les leçons de la « FAST echo »

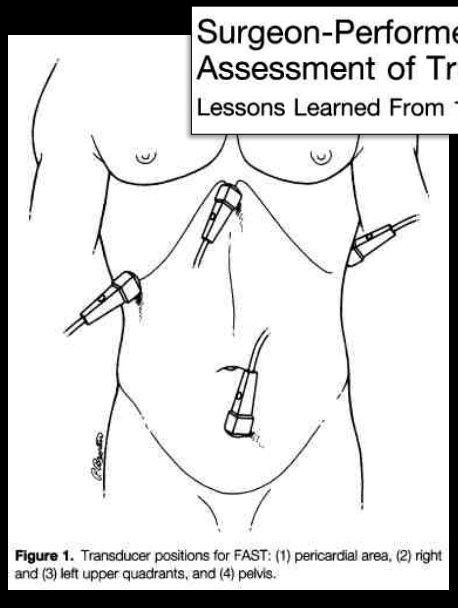
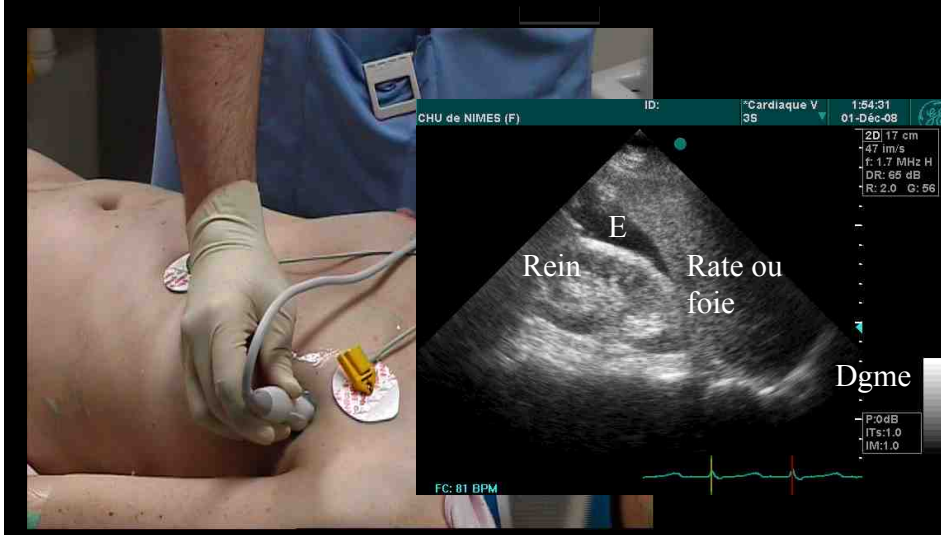


Figure 1. Transducer positions for FAST: (1) pericardial area, (2) right and (3) left upper quadrants, and (4) pelvis.

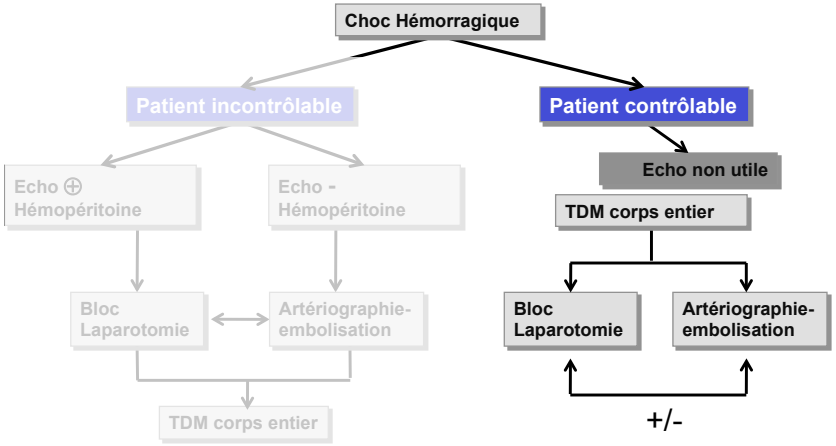
Focus
Assessment
for the
Sonographic
Examination
of the
Trauma patient

Rozycki et al Ann Surg 1998

Echo FAST : hémopéritoine chez le patient instable +++



Proposition d'algorithme de prise en charge des polytraumatisés avec trauma abdomino-pelvien : ne s'oppose pas au scanner !



22

Adapté de Geeraerts T et al. (Crit Care 2007,11:204) par J. Duranteau 2010

cas n° 1

Limites de la FAST écho : sous estime les lésions fines chez les patients stables

Not So Fast (n = 372).

M. Todd Miller, MD, Michael D. Pasquale, MD, FACS, William J. Bromberg, MD, Thomas E. Wasser, PhD, and John Cox, MD

Table 5 Patients with CT Scan–Documented Intra-abdominal Injury and a True-Negative FAST Examination

Patient	Intra-abdominal Injuries Identified by CT Scan
1	Grade 1 liver laceration
2	Grade 1 splenic contusion
3	Grade 1 liver laceration
4	Grade 3 splenic laceration
5	Grade 1 liver laceration
6	Grade 1 splenic laceration
7	Grade 2 splenic laceration
8	Grade 1 liver contusion
9	Grade 1 splenic laceration, aortic wall hematoma
10	Grade 1 liver hematoma, grade 1 kidney contusion
11	Grade 1 liver hematoma
12	Grade 1 liver hematoma
13	Grade 2 liver laceration
14	Grade 1 splenic hematoma
15	Grade 2 liver hematoma, grade 1 kidney contusion
16	Grade 1 splenic hematoma
17	Grade 1 liver laceration
18	Grade 2 liver laceration, right adrenal hemorrhage
19	Grade 2 liver laceration

Table 6 Patients with CT Scan–Documented Retroperitoneal Injury with a True-Negative FAST Examination

Patient	Retroperitoneal Injuries Identified by CT Scan
1	Aortic wall hematoma
2	Right adrenal hemorrhage, pancreatic head hemorrhage
3	Duodenal hematoma
4	Duodenal hematoma
5	Right adrenal hemorrhage with pericaval fluid
6	Grade 1 kidney contusion
7	Grade 1 renal laceration with hematoma
8	Pancreatic contusion
9	Perinephric hematoma
10	Grade 1 kidney contusion
11	Right renal cyst rupture

Conclusion: Use of FAST examination as a screening tool for BAI in the hemodynamically stable trauma patient results in underdiagnosis of intra-abdominal injury. This may have an impact on treatment and outcome in trauma patients. Hemodynamically stable patients with suspected BAI should undergo routine CT scanning.

Miller et al J Trauma 2003

FAST echo et diagnostic des lésions fines : inutile !!!

Surgeon-Performed Bedside Organ Assessment With Sonography After Trauma (BOAST): A Pilot Study From the WTA Multicenter Group

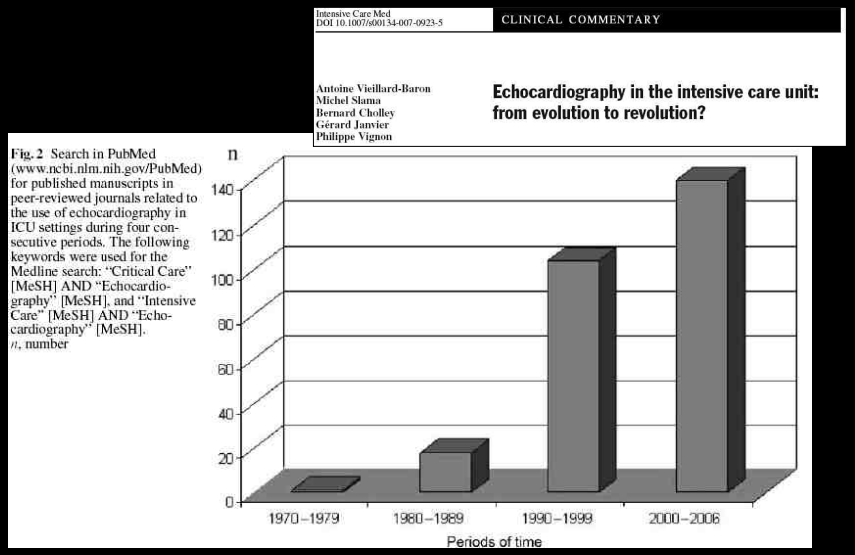
Table 3 Number of Organ Injuries on BOAST/Number of Organ Injuries on Initial CT Scan CT Organ Grade

Organ	I	II	III	IV	V
Liver	0/20 = 0%	8/26 = 31%	8/15 = 53.3%	6/10 = 60%	1/1 = 100%
Spleen	0/8 = 0%	4/12 = 33.3%	11/20 = 55%	1/4 = 25%	None
Kidney	0/6 = 0%	1/4 = 25%	3/5 = 60%	3/4 = 75%	None
135 Organs	0/34 = 0%	13/42 = 31%	22/40 = 55%	10/18 = 55.5%	1/1 = 100%

- Plus les lésions sont fines, plus le risque d'erreur est grand
- Seules 34 % des lésions d'organes pleins sont vues en échographie (vs Scanner)

Rozycki et al J Trauma 2005

Echocardiographie en réanimation : beaucoup de données scientifiques



Intensive Care Med
DOI 10.1007/s00134-007-0923-5

CLINICAL COMMENTARY

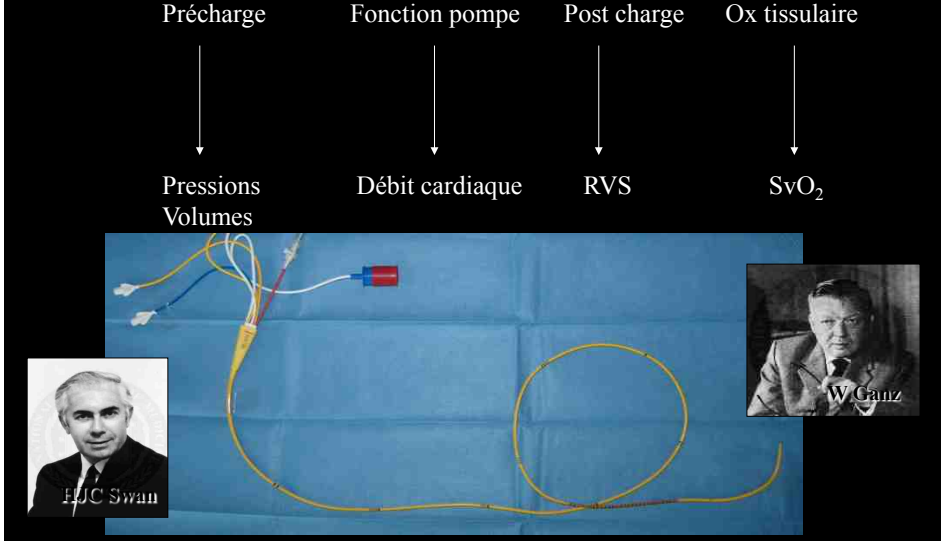
Antoine Vieillard-Baron
Michel Slama
Bernard Cholley
Gérard Janvier
Philippe Vignon

Echocardiography in the intensive care unit: from evolution to revolution?

Fig. 2 Search in PubMed (www.ncbi.nlm.nih.gov/PubMed) for published manuscripts in peer-reviewed journals related to the use of echocardiography in ICU settings during four consecutive periods. The following keywords were used for the Medline search: "Critical Care" [MeSH] AND "Echocardiography" [MeSH], and "Intensive Care" [MeSH] AND "Echocardiography" [MeSH]. *n*, number

Vieillard Baron et al Intensive Care Med 2007

Le moniteur hémodynamique idéal : *conception « classique »*



Cathéter artériel pulmonaire et pronostic : *impact ?*

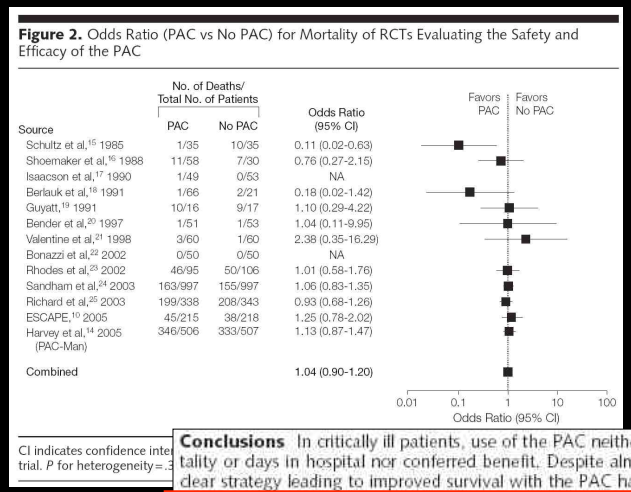


Figure 2. Odds Ratio (PAC vs No PAC) for Mortality of RCTs Evaluating the Safety and Efficacy of the PAC

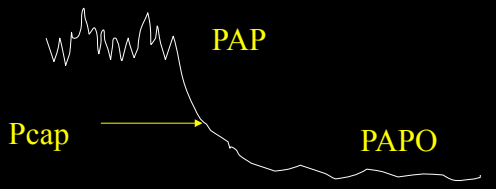
Source	No. of Deaths/ Total No. of Patients: PAC	No PAC	Odds Ratio (95% CI)
Schultz et al,[15] 1985	1/35	10/35	0.11 (0.02-0.63)
Shoemaker et al,[16] 1988	11/58	7/30	0.76 (0.27-2.15)
Isaacson et al,[17] 1990	1/49	0/53	NA
Berlauk et al,[18] 1991	1/66	2/21	0.18 (0.02-1.42)
Guyatt,[19] 1991	10/16	9/17	1.10 (0.29-4.22)
Bender et al,[20] 1997	1/51	1/53	1.04 (0.11-9.95)
Valentine et al,[21] 1998	3/60	1/60	2.38 (0.35-16.29)
Bonazzi et al,[22] 2002	0/50	0/50	NA
Rhodes et al,[23] 2002	46/95	50/106	1.01 (0.58-1.76)
Sandham et al,[24] 2003	163/997	155/997	1.06 (0.83-1.35)
Richard et al,[25] 2003	199/338	208/343	0.93 (0.68-1.26)
ESCAPE,[10] 2005	45/215	38/218	1.25 (0.78-2.02)
Harvey et al,[14] 2005 (PAC-Man)	346/506	333/507	1.13 (0.87-1.47)
Combined			1.04 (0.90-1.20)

CI indicates confidence inter
trial. *P* for heterogeneity=.3

Conclusions In critically ill patients, use of the PAC neither increased overall mortality or days in hospital nor conferred benefit. Despite almost 20 years of RCTs, a clear strategy leading to improved survival with the PAC has not been devised. The neutrality of the PAC for clinical outcomes may result from the absence of effective evidence-based treatments to use in combination with PAC information across the spectrum of critically ill patients.

Shah et al JAMA 2005

Cathéter artériel pulmonaire : *pas si facile*



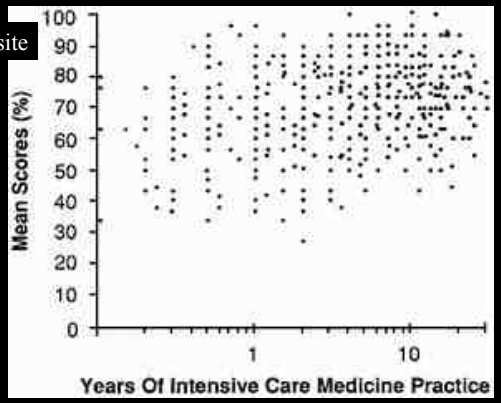
Conditions de validité de la PAPO :

- PAPO < PAPd
- ΔPAPO / Δ PAP < 1.5 = Zone III
- Courbe PAPO = oreillette
- Absence d'onde V de régurgitation
- Attention si forte PEP ou hyperinflation

Cathéter artériel pulmonaire : *20000 lieues sous les mers...*

Interprétation d'une courbe de PAPO par des réanimateurs et/ou cardiologues

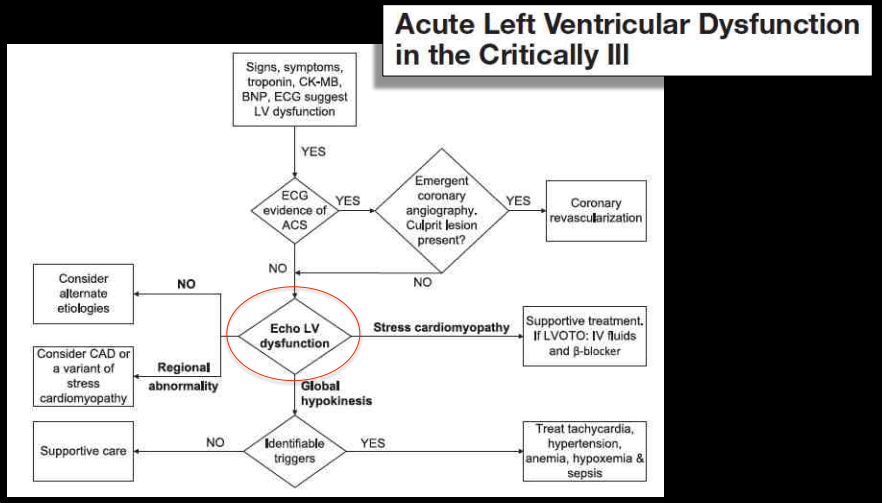
Score de réussite



The scores were significantly correlated with the number of years of intensive care practice ($p < .001$), but this association was weak (rho = 0.31) (Figure 1). The scores were also higher if the ICU was affiliated with a university hospital (75.0%) rather than not affiliated with a university hospital (67.8%, $p < .0001$).

Gnaegi A, Feihl F, Perret C Critical Care Medicine 1997;25:213-220

Echocardiographie en réanimation : au centre de l'évaluation cardiaque



Chockalingam et al Chest 2010

Prévalence des anomalies cardiaques à l'admission en réanimation

- 467 patients de réanimation médicale; ETT dans les 18 heures suivant l'admission
- 36 % des patients de réanimation ont une anomalie cardiaque
  - 22 % : 1 anomalie
  - 7,2 % : 2 anomalies
  - 6,8 % : 3 anomalies
- 77 % des patients ayant anomalie significative échographique n'ont pas été détectés cliniquement
- Pas de corrélation anomalie cardiaque / mortalité; mais durée de séjour en réanimation et totale augmentée chez ces patients

Range and Prevalence of Cardiac Abnormalities in Patients Hospitalized in a Medical ICU

Eduardo Bossone, Bruno DiGiovine, Sara Watts, Pamela A. Marcovitz, Louise Carey, Charles Watts and William F. Armstrong

Chest 2002;122;1370-1376
DOI 10.1378/chest.122.4.1370

Bossone et al *Chest*. 2002

Echographie cardiaque trans thoracique et diagnostic incompétence myocardique

Transthoracic Echocardiography To Identify or Exclude Cardiac Cause of Shock

- **100 patients en état de choc**
- **99 sont échogènes**
- **Sensibilité = 100 %**
- **Spécificité = 95 %**
- **VPP = 97 %**
- **VPN = 100 %**

Table 1—*Causes of Cardiogenic Shock*

Causes	No.
Severe LV systolic dysfunction	21
Severe RV systolic dysfunction	9
Severe biventricular systolic dysfunction	8
Tamponade	10
Postinfarction mechanical complication	9
Free-wall rupture	1
Ventricular septal rupture	5
Papillary muscle rupture and severe mitral regurgitation	3
Severe LVOT obstruction	1
Total	63

Table 3—*Change in Management After TTE*

Change in Management	No. of Patients
Medical therapy	29
Surgery	12
Pericardiocentesis	4
Aortic balloon pump	3
Thrombolysis	2
Angioplasty	1

= 51 % de modifications thérapeutiques

Joseph et al *Chest*. 2004

Echographie cardiaque trans thoracique et réanimation « générale »

British Journal of Anaesthesia 102 (3): 340–4 (2009)
doi:10.1093/bja/aen378 Advance Access publication January 18, 2009

BJA

CRITICAL CARE

Impact of echocardiography on patient management in the intensive care unit: an audit of district general hospital practice

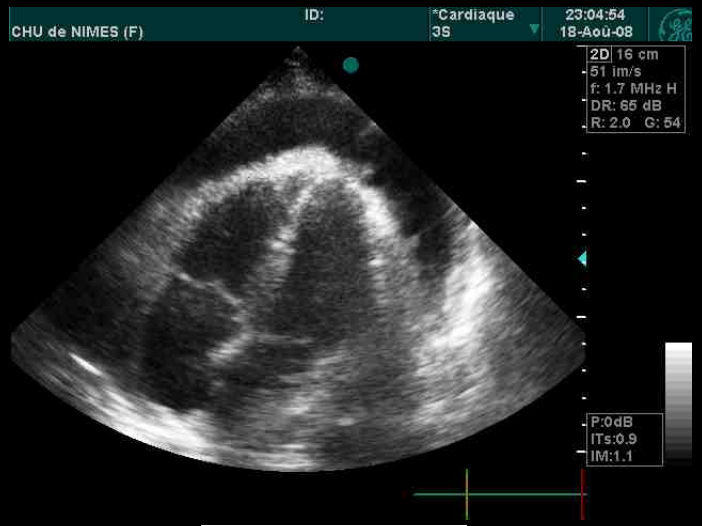
R. M. L'E. Orme*, M. P. Oram and C. E. McKinstry

Results. Two hundred and fifty-eight echocardiograms were performed in 217 patients, of which 224 (86.8%) were performed by intensive care consultants. One hundred and eighty-seven studies (72.4%) were TTEs and 71 (27.8%) were TOEs. TTE provided diagnostic images in 91.3% of spontaneously breathing and 84.2% of mechanically ventilated patients. Management was changed directly as a result of information provided in 51.2% of studies. Changes included fluid administration, inotrope or drug therapy, and treatment limitation.

Conclusions. Echocardiography may have a significant impact on the management of patients in the general ICU. We recommend that appropriate training in echocardiography should be incorporated into the intensive care curriculum in the UK.

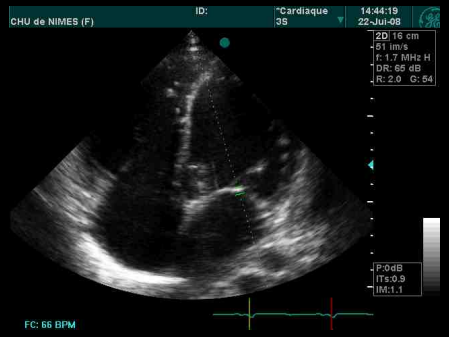
Orme et al Br J Anaesth 2009

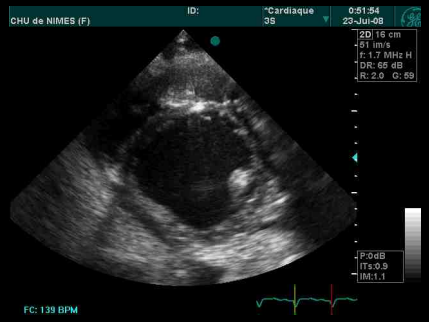
Une hépatite non cholestatique…



« Swinging Heart »

Fonction systolique VG : choc septique sur inhalation

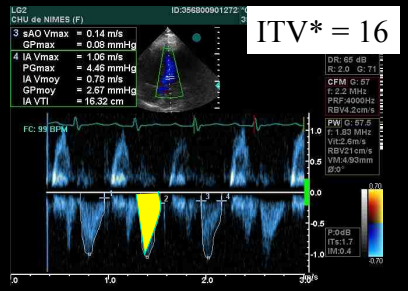




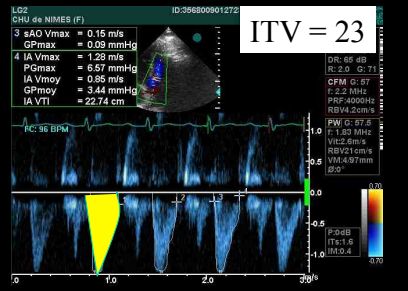
Patient de 34 ans, OH chronique +++, coma éthylique + choc

« mini fluid » challenge : test rapide de la réponse au remplissage

1 minute



ITV* = 16

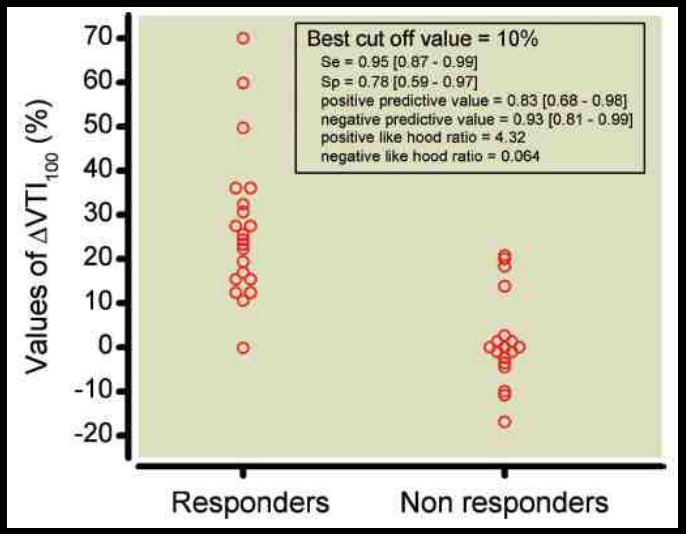


ITV = 23

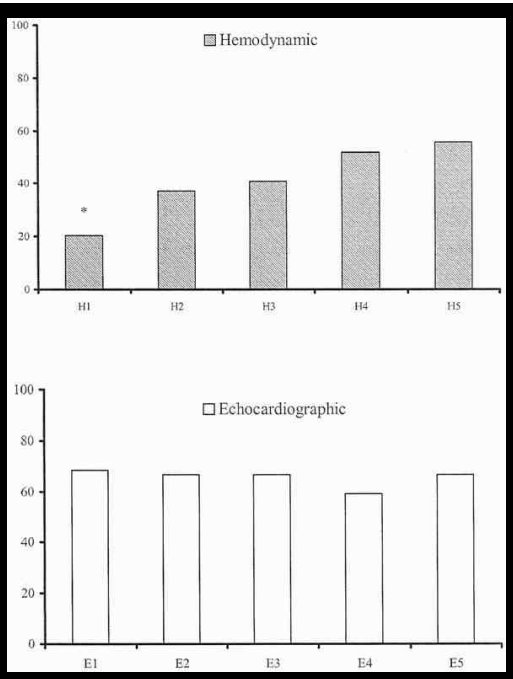
100 ml d'HEA 130 : 0.4

*Variabilité inter et intra opérateur = 5 %

Mini fluid challenge :



Muller et al Anesthesiology 2011



The hemodynamically unstable patient in the intensive care unit: Hemodynamic vs. transesophageal echocardiographic monitoring

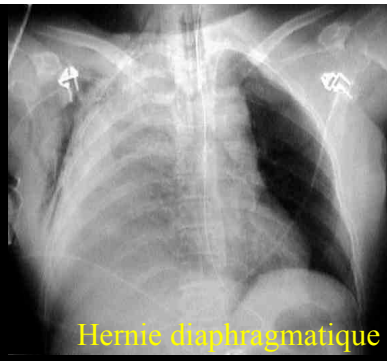
Costachescu et al **Critical Care Medicine** 2002

Post op
Chir cardiaque

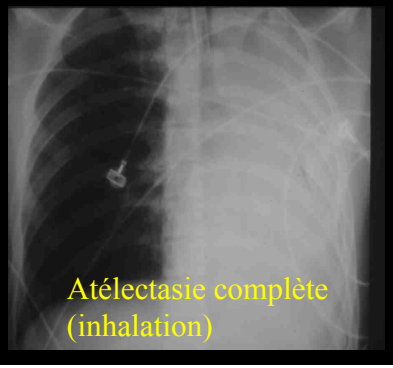
Erreur la plus fréquente :
Sous estimation de la dysfonction Gauche avec la Swan

L'échographie n'est pas opérateur dépendante !

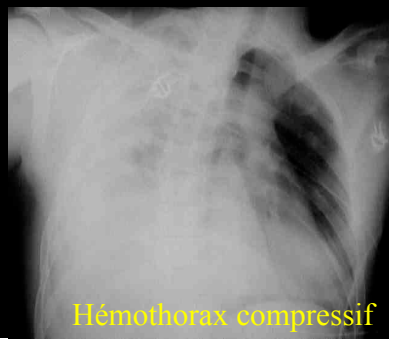
Echo = aide au diagnostic radiologique de « poumon blanc »



Hernie diaphragmatique

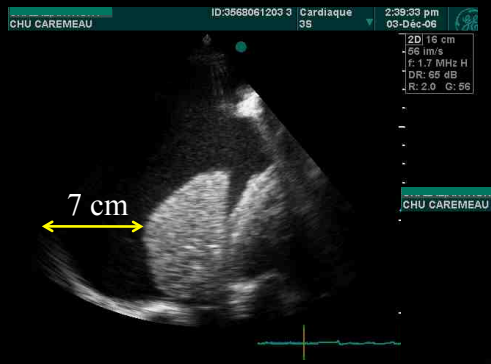


Atélectasie complète (inhalation)



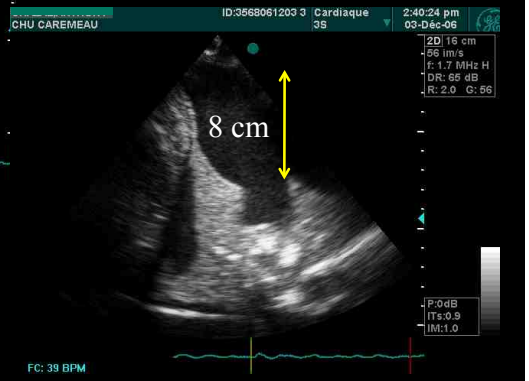
Hémothorax compressif

Echographie pulmonaire : diagnostic immédiat d'épanchement pleural



Avec une sonde cardio…

Coupe transversale

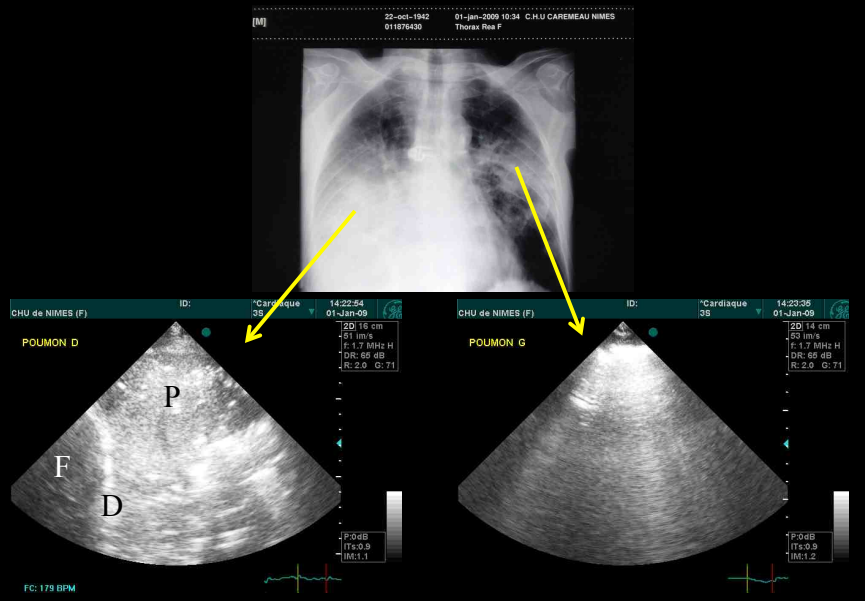


Drainage 1800 ml…

Coupe longitudinale

Echo pulmonaire : diagnostic simple de condensation pulmonaire

Echographie pulmonaire : parenchyme, résumé en un exemple



Echo pleuro pulmonaire : *réduction de l'imagerie thoracique*

The Use of Point-of-Care Bedside Lung Ultrasound Significantly Reduces the Number of Radiographs and Computed Tomography Scans in Critically Ill Patients

Table 1. Comparison of Baseline Characteristics Between Patients of Pre-LUS Period (Group C) and Patients Studied After LUS Introduction (Group S)

	Group C	Group S	P
Number	187	189	
Male sex, % (*n*)	71.1% (133)	66.7% (126)	0.393
Age (years)	51 (32–71)	52 (34–78)	0.711
BMI	25.1 (23.2–27.6)	24.8 (22.9–27.7)	0.794
SAPS II score	41 (26–54)	37 (22–51)	0.073
Admission diagnosis, % (*n*)			
Trauma patient with head injury	36.9% (69)	33.9% (64)	0.252
Trauma patient without head injury	11.8% (22)	10.1% (19)	0.145
Medical patient	34.2% (64)	48.7% (92)	0.111
Surgical patient	17.1% (32)	7.3% (14)	0.091
Chest pathology, % (*n*)			
Lung contusion	25.7%, (48)	28.1% (53)	0.092
Pneumonia	35.8% (67)	40.7% (77)	0.089
Pleural effusion	40.1% (75)	37.6% (71)	0.227
Interstitial edema	30.5% (57)	36.5% (69)	0.141
Total chest radiographs (*n*)	803	589**	<0.001
Chest radiographs for parenchymal investigation (*n*)	471	267***	<0.001
Chest radiographs for device control (*n*)	332	322	0.549
Chest CT, (*n*)	274	145***	<0.001
VAP, % (*n*)	13.1% (9)	9.4% (6)	0.089
Length of intracranial hypertension (in ICP monitoring) (days)	7 (3–11)	4 (2–7)*	0.032
Length of MV (days)	6 (2–10)	4 (1–7)	0.274
ICU LOS (days)	9 (5–14)	7 (3–11)	0.131
Mortality, % (*n*)	16.6% (31)	18.5% (35)	0.225

Peris et al Anesth Analg 2010

Echo pleuro pulmonaire : réduction des radiographies thoraciques

The Use of Point-of-Care Bedside Lung Ultrasound Significantly Reduces the Number of Radiographs and Computed Tomography Scans in Critically Ill Patients

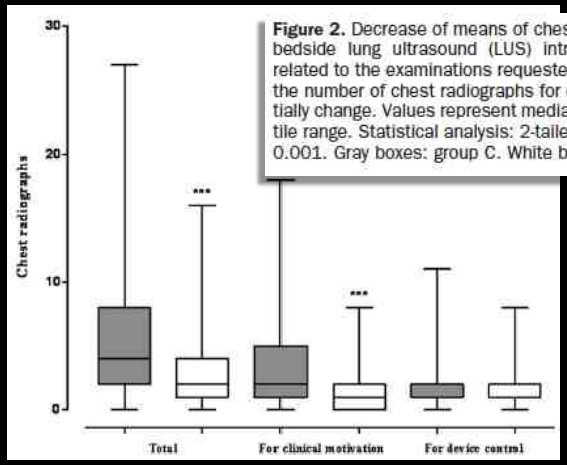


Figure 2. Decrease of means of chest radiographs per patient after bedside lung ultrasound (LUS) introduction. The reduction was related to the examinations requested for clinical reasons, whereas the number of chest radiographs for device control did not substantially change. Values represent medians with 25th to 75th interquartile range. Statistical analysis: 2-tailed Mann–Whitney test. ***$P <$ 0.001. Gray boxes: group C. White boxes: group S.

Peris et al Anesth Analg 2010

Echo pleuro pulmonaire : réduction des radiographies thoraciques

The Use of Point-of-Care Bedside Lung Ultrasound Significantly Reduces the Number of Radiographs and Computed Tomography Scans in Critically Ill Patients

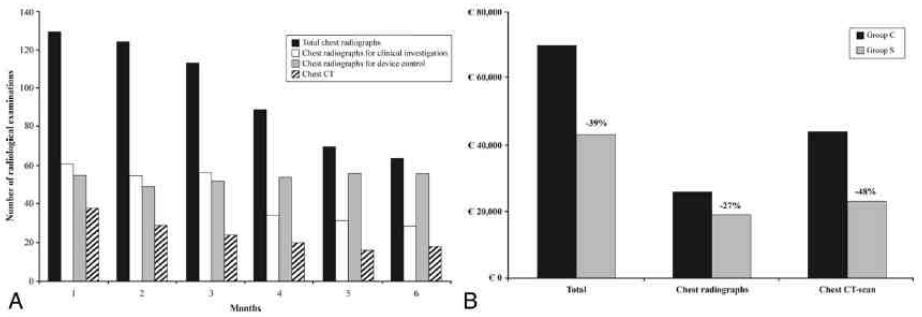
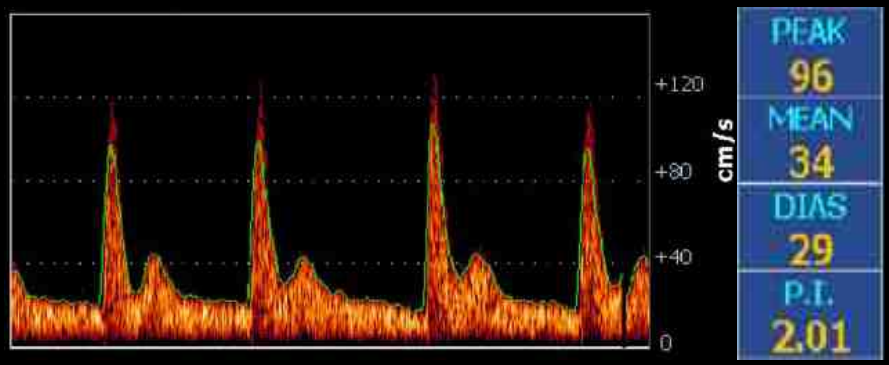


Figure 5. A, Time-dependent variation in radiological examinations during the 6 months of bedside lung ultrasound (LUS) protocol application. Total chest radiographs (black bars) and chest radiographs performed for clinical investigation (white bars) decreased significantly after the third month. Chest computed tomography (CT) scans also decreased significantly after the third–fourth month of protocol application. B, Radiological examinations cost saving in the control group (without bedside chest ultrasound) and the study group (with routine bedside chest ultrasound). Total columns represent the sum of chest radiographs and chest CT-scan.

Peris et al Anesth Analg 2010

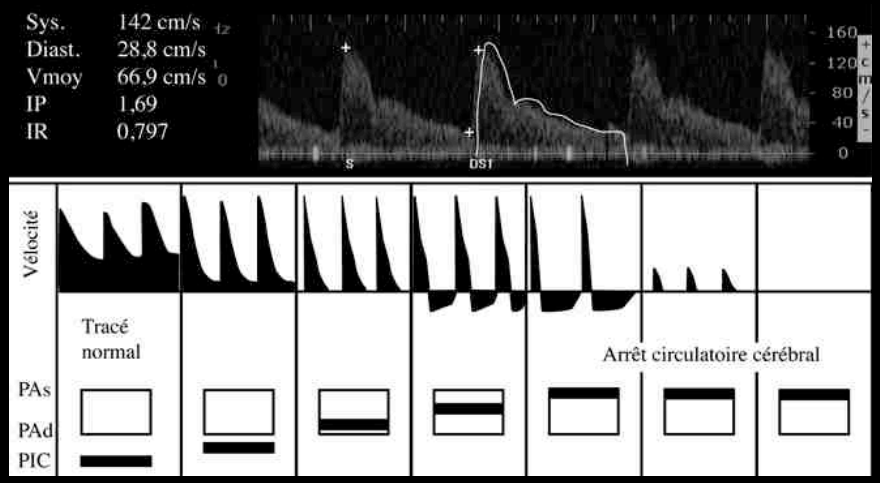
Doppler intra crânien (ACM) :

… aspect typique d'HTIC : Vs haute, Vd basse



White et al Intensive Care Med 2006

Evolution schématique du DTC lors de l'HTIC



P Zetlaoui SFAR 2009

Doppler trans crânien et « pré-diagnostic » de mort encéphalmique: *choisir le bon moment pour l'angiographie ou l'EEG*

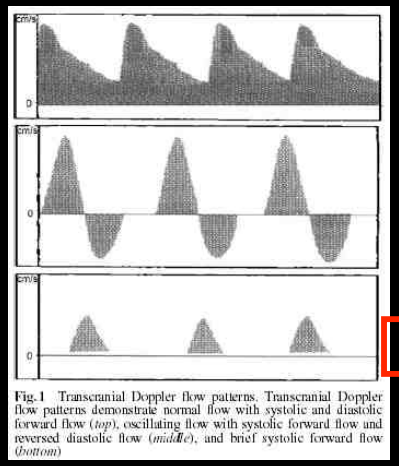


Fig. 1 Transcranial Doppler flow patterns. Transcranial Doppler flow patterns demonstrate normal flow with systolic and diastolic forward flow (*top*), oscillating flow with systolic forward flow and reversed diastolic flow (*middle*), and brief systolic forward flow (*bottom*)

Table 2 Meta-analysis of high quality studies and sensitivity analysis of all included studies. *CI* confidence interval

		95% CI	
Primary analysis: only high-quality studies			
Sensitivity (%)	95	92	97
Specificity (%)	99	97	100
Sensitivity analysis: all studies. Velthoven et al. [24]: cerebral angiography and clinical criteria as reference test			
		95% CI	
Sensitivity (%)	89	86	91
Specificity (%)	99	99	100
Sensitivity analysis: all studies. Velthoven et al. [24]: EEG and clinical criteria as reference test			
		95% CI	
Sensitivity (%)	89	86	91
Specificity (%)	99	98	100

In conclusion, CCA by TCD in the basilar and both middle cerebral arteries correctly predicted fatal brain damage in all patients; therefore, TCD could be used to determine the appropriate moment for angiography. To accept a test for defining brain death, specificity should be 100%. We do believe that further research is needed to demonstrate that repeated TCD examination is able to produce this level of specificity.

Monteiro et al Intensive Care Med 2006

Doppler transcrânien : *identification précoce des patients graves*

Transcranial Doppler to Screen on Admission Patients With Mild to Moderate Traumatic Brain Injury

TABLE 1. Univariate Analysis of Demographic and Biochemical Data Collected on Admission in 98 Patients With Mild to Moderate Traumatic Brain Injury According to Their Neurological Status on Posttrauma Day 7: Patients With and Without Secondary Neurological Deterioration[a]

	No SND (n = 77)	SND (n = 21)	P
Age, y	34 (15-84)	46 (20-80)	.04
Sex, M/F	64/13	20/1	.16
Injury type, n			.20
Motor vehicle accident	32	8	
Sports	24	3	
Others	21	10	
Initial GSC score	14 (9-15)	13 (10-15)	<.01
ISS	9 (2-43)	13 (5-41)	<.01
H-AIS	1 (1-4)	3 (3-4)	<.01
Extracranial injuries (yes/no), n	40/37	13/8	.57
Heart rate, bpm	78 (49-119)	75 (44-120)	.46
MAP, mm Hg	90 (60-114)	93 (64-158)	.69
Hemoglobin, g/dL	14.0 (8.0-18.6)	13.5 (7.0-16.8)	.03
Serum sodium, mmol/L	141 (133-149)	140 (135-146)	.33
Mechanical ventilation (yes/no), n	10/67	11/10	<.01
Vasoactive agents (yes/no), n	3/74	8/13	<.01
TCDB I/II	53/24	0/21	<.01
Injury-to-CT time, min	180 (65-540)	120 (15-210)	<.01

- SND = secondary neurological deterioration
- = perte de 2 points de Glasgow

Bouzat et al Neurosurgery 2011

Doppler transcrânien : *identification précoce des patients graves*

TABLE 2. Univariate Analysis of Transcranial Doppler Measurements Collected on Admission in 98 Patients With Mild to Moderate Traumatic Brain Injury According to Their Neurological Status on Posttrauma Day 7: Patients With and Without Secondary Neurological Deterioration[a]

	No SND (n = 77)	SND (n = 21)	P
FVm, cm/s	49 (31-80)	31 (18-60)	<.01
FVs, cm/s	84 (47-128)	69 (38-119)	<.01
FVd, cm/s	34 (18-64)	18 (11-36)	<.01
Pulsatility index	1.02 (0.66-1.83)	1.47 (1.07-2.33)	<.01
Injury-to-TCD time, min	215 (42-700)	300 (90-690)	.03

Bouzat et al Neurosurgery 2011

Doppler transcrânien : *identification précoce des patients graves*

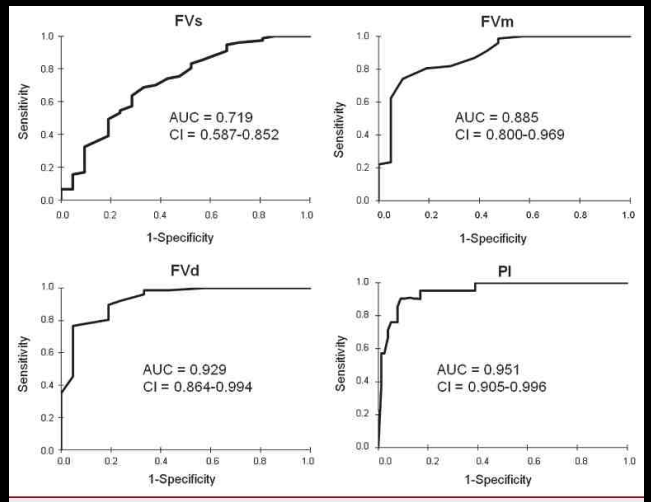
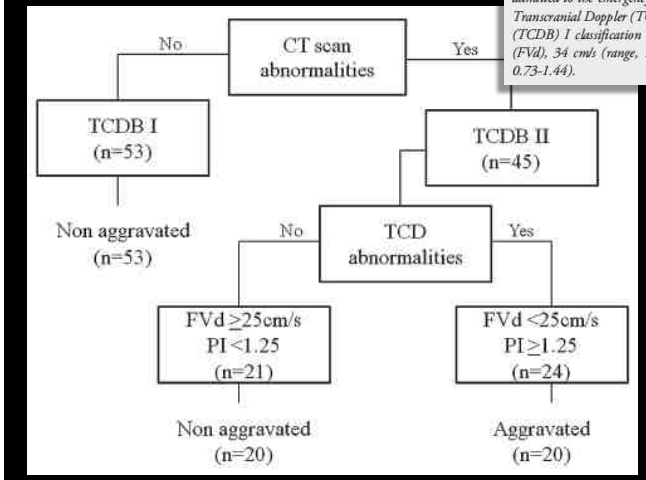


FIGURE 1. *Receiver-operating characteristic curves of the transcranial Doppler (TCD) parameters. AUC, area under the curve; CI, 95% confidence interval; FVd, FVm, and FVs, diastolic, mean, and systolic cerebral blood flow velocities, respectively; PI, pulsatility index.*

Bouzat et al Neurosurgery 2011

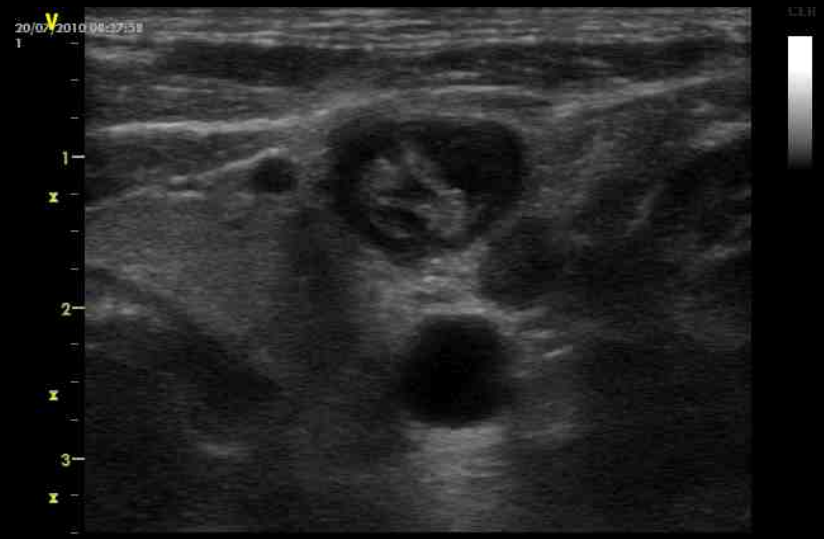
Doppler transcrânien : *identification précoce des patients graves*

FIGURE 2. *Prediction tree constructed from recursive-partitioning analysis according to the incidence of subsequent neurological deterioration in 98 patients admitted to the emergency room after mild to moderate traumatic brain injury. Transcranial Doppler (TCD) values of patients with Trauma Coma Data Bank (TCDB) I classification were as follows: diastolic cerebral blood flow velocity (FVd), 34 cm/s (range, 18-64 cm/s); and pulsatility index (PI), 1.03 (range, 0.73-1.44).*



Bouzat et al Neurosurgery 2011

Echo veineuse : veineuse profonde proximale



Échographie veineuse 4 points - Intérêt

Resident-performed Compression Ultrasonography for the Detection of Proximal Deep Vein Thrombosis: Fast and Accurate

Timothy Jang, MD, Martin Docherty, MD, Chandra Aubin, MD, Greg Polites, MD

ACAD EMERG MED d March 2004, Vol. 11, No. 3

72 patients

Contrôle Échographie 2 points		Contrôle radiologue		
Normale	45	Normale	45	Se 100%
		Thrombose	0	
Thrombose	27	Normale	4	Sp 92%
		Thrombose	23	

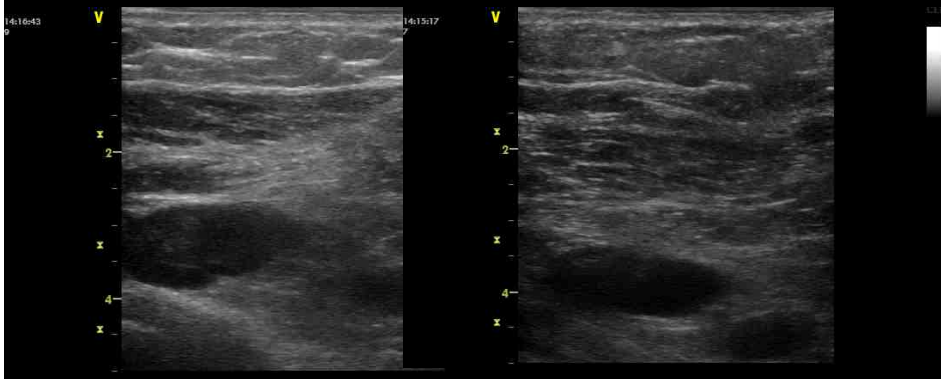
Echo veineuse : pose des cathéters

Guidelines for Performing Ultrasound Guided Vascular Cannulation: Recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

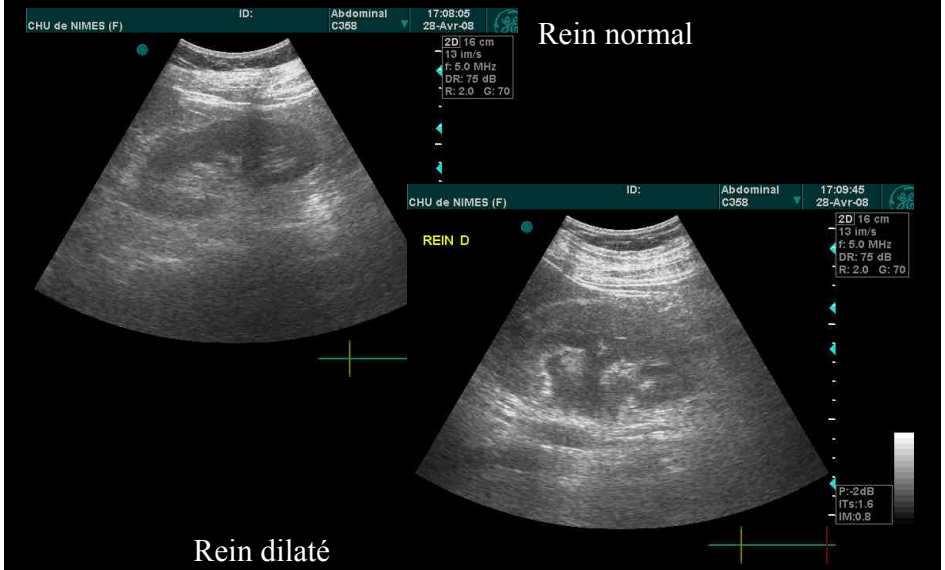
- Recommandation FORTE de pose des jugulaires internes sous écho en temps réel chez l'adulte
- Idem chez l'enfant, y compris pour fémorale
- Fémorale chez l'adulte : faire pré repérage et pose sous écho si chevauchement artère – veine.
- Sous clavière : pas de recommandation en systématique, mais admis en sauvetage si échec

Troianos et al JASE 2011

Pose des cathéters sous écho : *voie sous Clavière possible !*



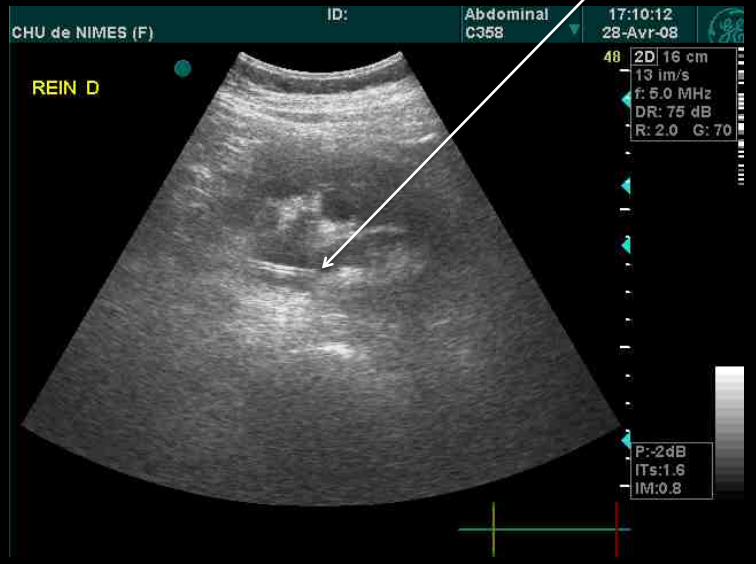
Insuffisance rénale aigue obstructive : *diagnostic*



Rein normal

Rein dilaté

Insuffisance rénale aigue obstructive : néphrostomie bouchée !

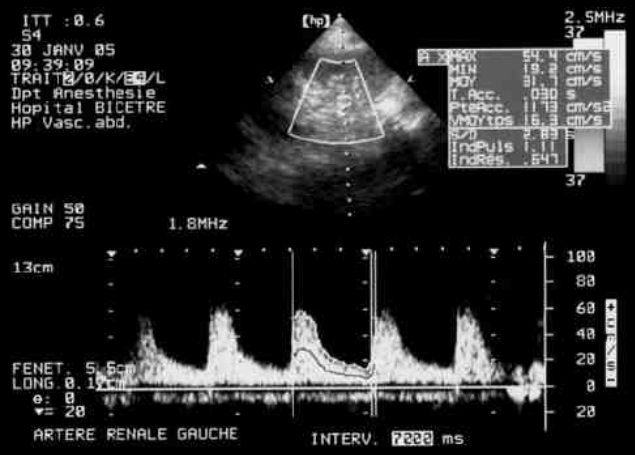


Monitorage du niveau de PAM par Doppler des artères rénales ?

Baisse de l'IR rénal

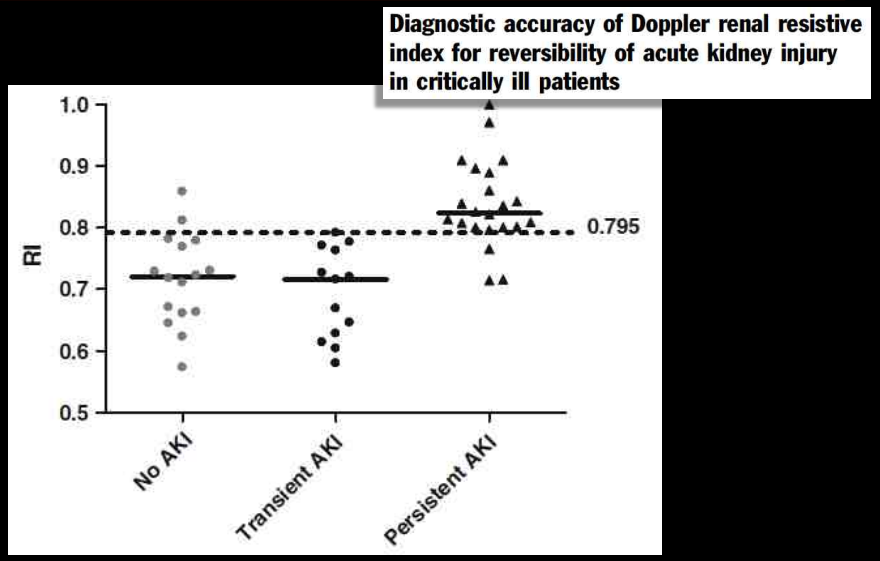
=

amélioration de la vascularisation rénale ?



Deruddre et al Intensive Care Med 2007

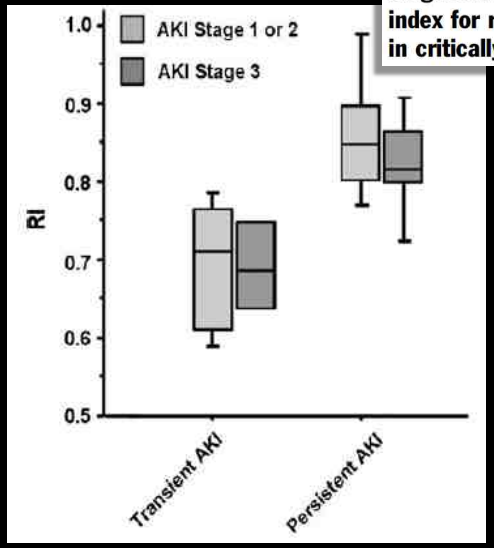
Doppler des artères rénales *: diagnostic d'IRA sévère*



Darmon et al Intensive Care Med 2011

Doppler des artères rénales : *mieux que les scores AKIN/RIFLE ?*

Diagnostic accuracy of Doppler renal resistive index for reversibility of acute kidney injury in critically ill patients



Darmon et al Intensive Care Med 2011

Echo et réanimation « générale » : un total body scanner au lit du malade ?

Deep Impact of Ultrasound in the Intensive Care Unit

The "ICU-sound" Protocol

What This Article Tells Us That Is New

- Transthoracic ultrasound examination can be used to diagnose a multitude of abnormalities, helped modify admitting diagnoses in 26% of patients, led to changes in medical therapy in 18% of patients, and prompted invasive procedures in 22% of patients

Manno et al Anesthesiology 2012

Echo et réanimation « générale » : un total body scanner au lit du malade ?

Clinical Diagnosis	Ultrasound Finding
Neurologic examination	—
Intracranial hypertension	Optic nerve sheath diameter more than 5 mm
Thoracic examination	—
Pneumothorax	Absence of "lung sliding," absence of B-lines, detection of the "lung point"
Lung consolidation	Hypoechoic area with an air bronchogram: static or dinamic
Cardiogenic pulmonary edema	More than 3 B-lines/examinated area; extended from the lung bases to the medium and superior fields, bilaterally, symmetrically, without pleural line abnormalities
ARDS/ALI	Nonhomogeneous B-line distribution (more than 3 B-lines/examinated area); presence of spared areas and pleural line abnormalities; subpleural consolidations
Pleural effusion	Echo-poor or echo-free space between the pleura visceralis and parietal pleura
Asthma/COPD/Normal lung aeration	Bilateral A lines with lung sliding
Heart examination	—
Valvular disease	Moderate/severe valvular insufficiency/stenosis
EF <35%	EF less than 35%
LV, LA dilatation	LA more than 5 cm, LV more than 6 cm
Dilated RV, RA with overload pattern	—
Pericardial effusion	Moderate/severe pericardial effusion more than 2 cm
Valve vegetation	Valve vegetation
LVH	—
Abnormal abdomen examination	—
Peritoneal effusion	Anechogenic or moderately echogenic pattern
Cholecystitis	Gallbladder distension, pericholecystic fluid, gallbladder wall more than 3.5 mm, Echo–Murphy sign
Hydronephrosis	Dilatated pelvis and collecting system, hypoechoic area in the kidney hilum
Parenchymal abnormalities (pancreas, spleen liver, kidney, bladder)	Parenchimal abnormalities, bladder assessment for retention
Abnormal venous system examination	—
DVT positive vein compression test	Positive vein compression test

Manno et al Anesthesiology 2012

Echo et réanimation « générale » : un total body scanner au lit du malade ?

Table 4. Study Population Stratified According to Admitting Diagnosis, SAPS II Score at Admission, and Number of New Ultrasound Abnormalities

Diagnostic Group	No. of Patients	%	SAPS II Score* (95% CI)	No. of New Ultrasonographic Abnormalities
Cardiac arrest	14	11.2	52 (43–60)	19
COPD-Asthma	16	12.8	39 (32–46)	13
Trauma	9	7.2	29 (19–38)	3
Acute Cardiac Decompensation	27	21.6	40 (36–45)	34
ARDS/Pneumonia	11	8.8	42 (32–55)	13
Postoperative complications	14	11.2	40 (33–47)	14
Meningo-encephalitis	5	4	42 (35–49)	2
Neurologic disease	5	4	36 (18–55)	2
Septic shock	18	14.4	47 (39–55)	28
Other	6	4.8	42 (34–50)	8
Total/average	125	—	41 (39–44)	136

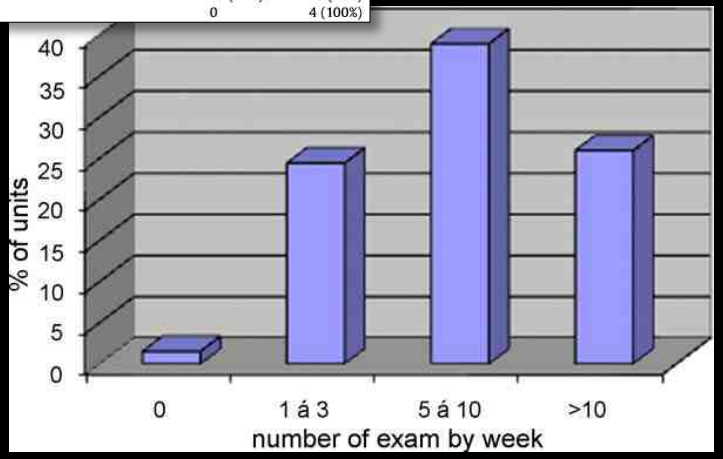
Manno et al Anesthesiology 2012

Echographie en réanimation

- Certification
- Impact sur les soins
- Avantages et limites
- Développements technologiques

Echocardiographie en réanimation en pratique : pas encore le gold standard !

Average mean number of exams per week by type of ICU, n (%)	5–10	>10
Medical	44 (70%)	18 (30%)
Surgical	46 (77%)	16 (23%)
Cardiac surgery	0	4 (100%)



Quintard et al Ann Fr Anesth Reanim 2011

Echocardiographie en réanimation : plus de machines que d'hommes !

Echograph availability by type of centre (percentage responding by type of center)	
University and public community centers	94%
Private centers	79%
Echograph availability by type of ICU, n (percentage responding by type of ICU)	
Medical	58 (96%)
Surgical	56 (89%)
Cardiac surgery	4 (100%)

Number of units with at least one staff member with a diploma, n (%)	
Medical	47 (78)
Surgical	41 (66)
Cardiac surgery	3 (75)

Quintard et al Ann Fr Anesth Reanim 2011

Echocardiographie : bonne à tout faire ?

- Ne remplace pas un monitorage continu
- Examen échographique long
- Attention à l'échocardiographie « contemplative »
- Une question, une réponse

Echographie en réanimation

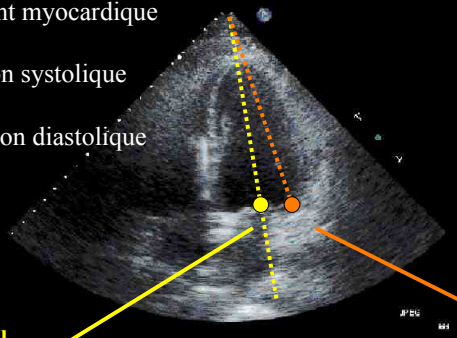
- Certification
- Impact sur les soins
- Avantages et limites
- Développements technologiques

Doppler tissulaire, principe : un Doppler pulsé myocardique

Etude du déplacement myocardique

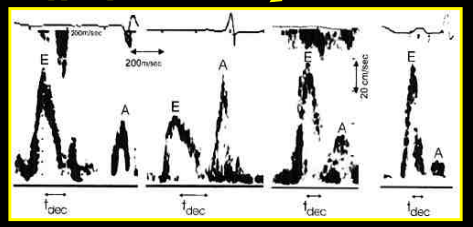
• *En systole :* fonction systolique

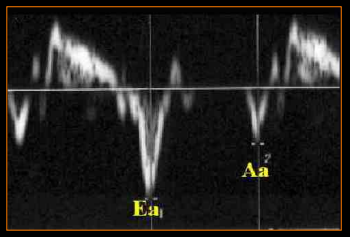
• *En diastole :* fonction diastolique



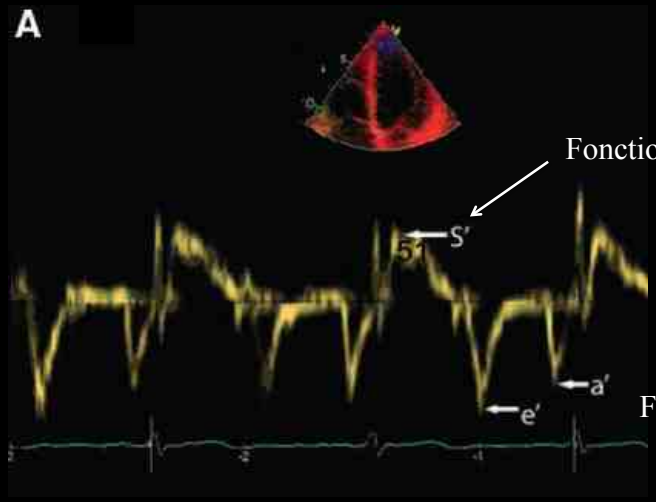
Doppler tissulaire De l'anneau mitral

Doppler pulsé mitral





Doppler tissulaire : *propriétés intrinsèques du myocarde*



Dalen et al Circulation 2010

Doppler tissulaire anneau mitral : *fonctions systolique et diastolique*

Reference Values and Distribution of Conventional Echocardiographic Doppler Measures and Longitudinal Tissue Doppler Velocities in a Population Free From Cardiovascular Disease

Table 3. Age- and Sex-Specific Mean Annular Velocities by pwTDI and cTDI

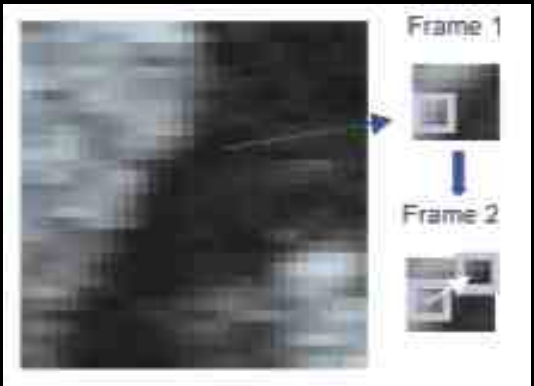
	Systole	LV (Mean of 4 Walls)	Diastole	
	S' (pwTDI)	S' (cTDI)	e' (pwTDI)	a' (pwTDI)
Female sex				
Feasibility, no. (%)	652 (98%)	657 (99%)	652 (98%)	652 (98%)
<40 y, cm/s	8.9±1.1	7.2±1.0	14.6±2.3	8.8±1.9
40–60 y, cm/s	8.1±1.2	6.5±1.0	11.3±2.4	10.0±1.9
>60 y, cm/s	7.2±1.2	5.7±1.1	8.2±3.2	10.6±1.9
All, cm/s	8.2±1.3	6.6±1.1	11.8±3.2	9.7±2.0
Male sex				
Feasibility, no. (%)	590 (98%)	601 (99%)	590 (98%)	590 (98%)
<40 y, cm/s	9.4±1.4	7.6±1.2	14.1±2.7	9.1±1.7
40–60 y, cm/s	8.6±1.3	6.9±1.3	10.7±2.3	10.4±1.6
> y, cm/s	8.0±1.3	6.4±1.2	8.2±1.9	11.1±1.6
All, cm/s	8.6±1.4	6.9±1.3	10.8±3.0	10.3±1.7

Dalen et al Circulation 2010

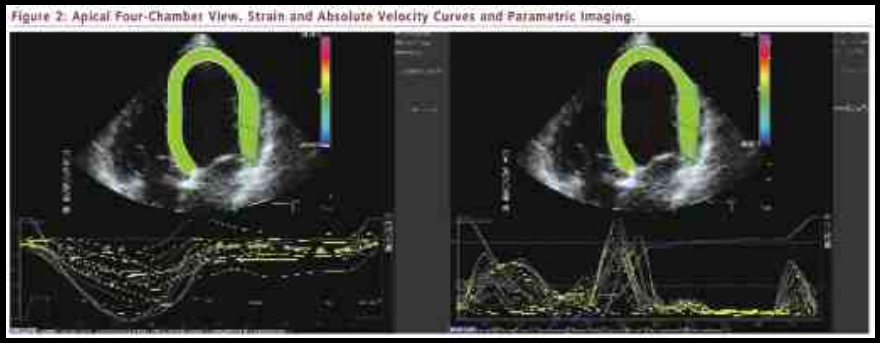
Nouvelles techniques d'imagerie

- 2D strain, Speckle tracking
- Imagerie 3D et 4D

2D strain, Speckle (moucheture) tracking (suivi)



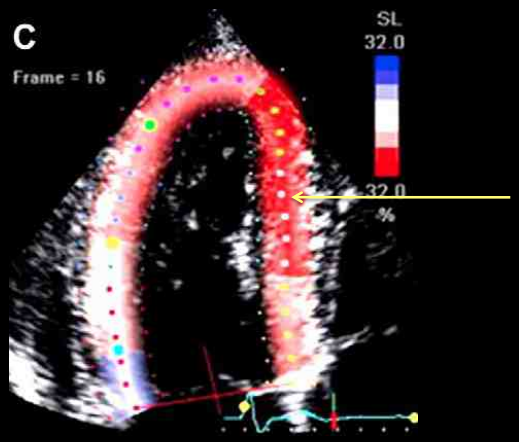
2D strain (déformation) , Speckle (moucheture) tracking (suivi)



Etude de la déformation longitudinale

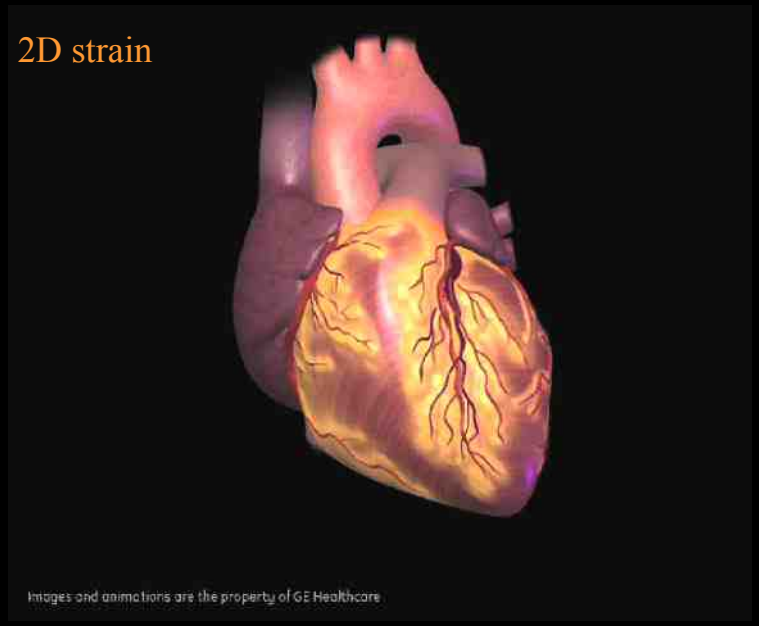
Goffinet et al Eur Cardiovasc Dis 2007

Speckle tracking : quantification de la contractilité segmentaire

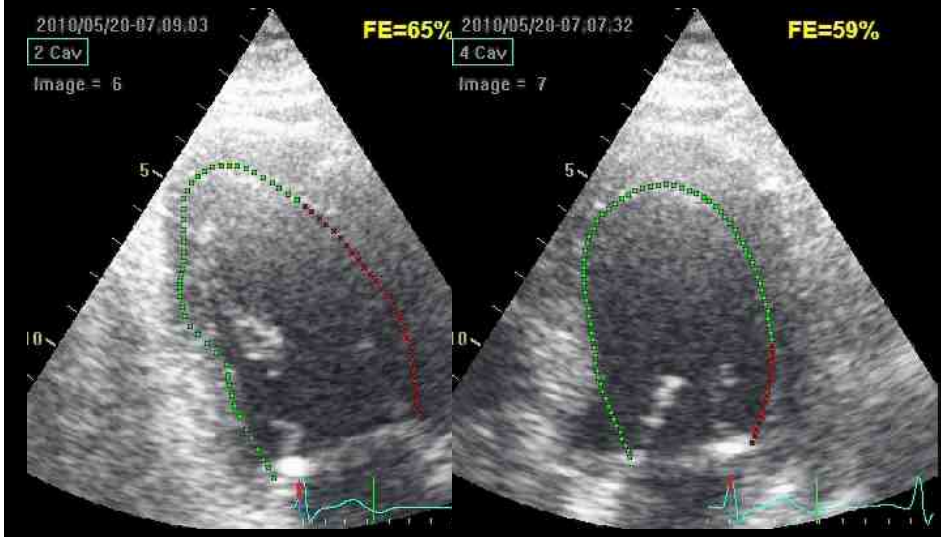


Geyer et al JASE 2010

2D strain

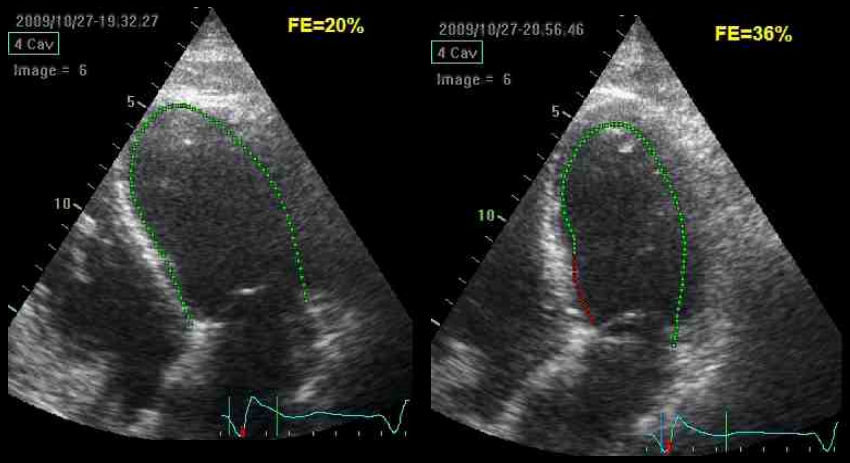


Fonction systolique VG : FEVG (Simpson) auto et 4 cavités



FEVG = VTDVG – VTSVG / VTDVG

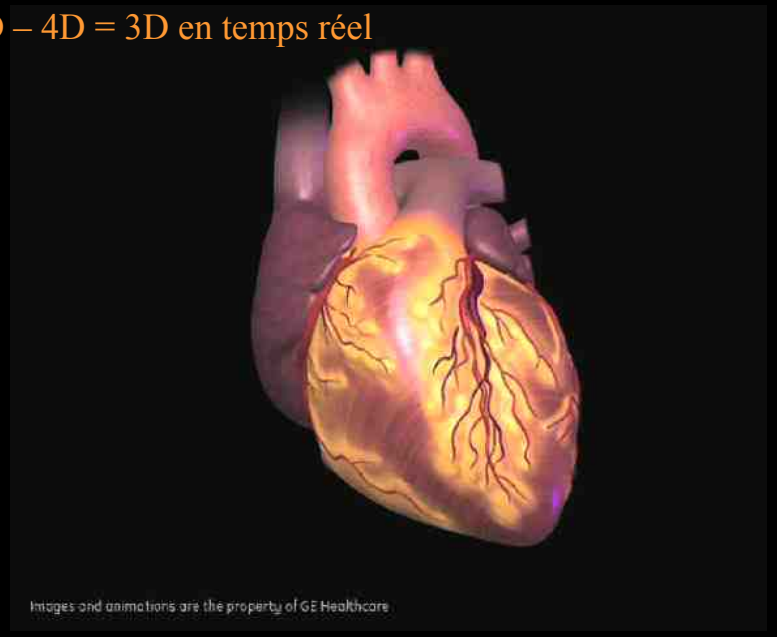
FEVG automatique : réponse aux inotropes



Norad seule

Norad + dobu

3D – 4D = 3D en temps réel



Echocardiographie en réanimation : *incontournable ?*

POINTS OF VIEW

All intensivists need echocardiography skills in the 21st century

Critical Care and Resuscitation • Volume 9 Number 3 • September 2007

Ian M Seppelt

For a patient whose condition becomes unstable at 03:00, it is reasonable to expect a focused echo examination to answer the following questions:

- Is the heart working?
- Is it really full or really empty?
- Is there an acute valve rupture with torrential regurgitation?
- Is there an acute cardiac rupture or ventricular septal defect?
- Is there a tamponade?

There are thus three levels of echocardiography training for intensive care practice:

- Level 1— the focused clinical examination, 24 hours per day, to answer immediate clinical questions.
- Level 2 — the trained echocardiographer, with more advanced knowledge and skills, and ongoing maintenance of skills and quality assurance. Ideally there will be at least one of these in every ICU.
- Level 3 — the program director or researcher in critical care echocardiography.

Most intensive care trainees recognise and want this. The challenge for us now is to make it happen.

Focused = 1 question simple
1 réponse simple

Seppelt IM Crit Care Resusc 2007

Echographie en réanimation

- Ne pas reproduire les erreurs de la Swan
- Formation +++
- Pas de syndrome du « super héro »
- « *Situations require cardiology consultation. These include prosthetic valve function, complex congenital heart disease, cardiac source of systemic embolism, and stress echocardiography* ». ACCP SRLF recommnadations Chest 2009
- Echo en réa = rigueur, humilité et collaboration !