

Coeur pulmonaire aigu

Philippe Vignon
Réanimation Polyvalente
Inserm CIC 1435
CHU Limoges



Généralités

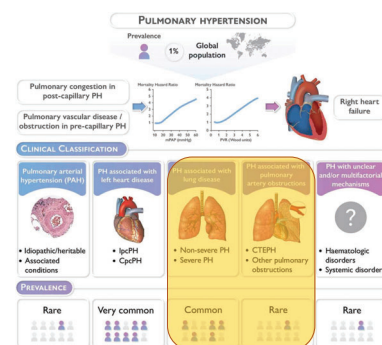
Définition

- ❖ Syndrome lié à une **élévation brutale de la post-charge du ventricule droit** secondaire à un obstacle de la circulation pulmonaire situé entre l'origine de l'artère pulmonaire et les capillaires pulmonaires
- ❖ Principales causes en réanimation :
 - ✓ **Embolie pulmonaire (EP) massive**
 - ✓ **SDRA (ventilation mécanique)**
 - ✓ **Choc septique.**

Définition

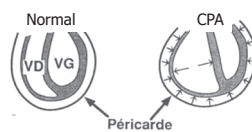
Definition	Haemodynamic characteristics
PH	mPAP >20 mmHg
Pre-capillary PH	mPAP >40 mmHg PAPWP <15 mmHg PRV <100 mL
SpPH	mPAP >20 mmHg PAPWP >15 mmHg PRV <100 mL
CcPH	mPAP >20 mmHg PAPWP >15 mmHg PRV <100 mL
Exercise PH	mPAP/DO2 slope between rest and exercise >3 mmHg/(mL/min)

Définition



Généralités

Interdépendance ventriculaire

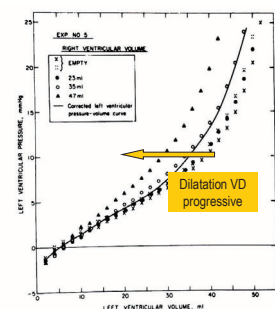


Cœur pulmonaire aigu :

- ❖ Seul le VD peut se **dilater brutalement** (paroi libre fine) suite à une augmentation de postcharge (ou à une baisse d'iotropisme)
- ❖ La somme des volumes télédiastoliques des ventricules est **constante dans le péricarde inextensible**
- ❖ Toute dilatation brutale du VD diminue le remplissage du VG, donc son éjection : risque de défaillance circulatoire +++

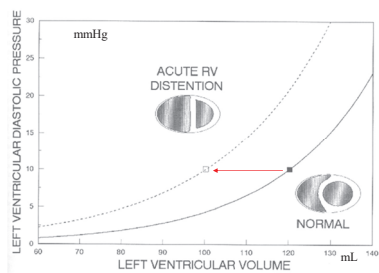
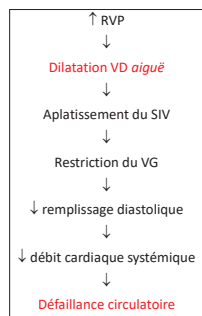
Généralités

Gène au remplissage du VG



Taylor AJP 1967

Insuffisance circulatoire



L Wood, J Hall. Principles in critical care

Atteinte VD : continuum

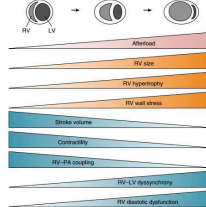
Assessment of Right Ventricular Function in the Research Setting: Knowledge Gaps and Pathways Forward

Assessment of Right Ventricular Function in the Research Setting: Knowledge Gaps and Pathways Forward

An Official American Thoracic Society Research Statement

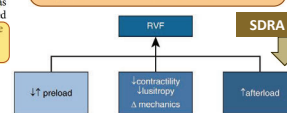
Anna R. Helms, Giovanni Kacit, Jeremy A. Kane, Todd M. Kohn, Stephen C. Matal, Otar Iwarcar, Evangelos D. Michelis, Robert Nasje, Rubin M. Tuder, Corey E. Ventetucio, Antoine Valland-Baron, Norbert F. Voelkel, Aron Vliet-Nootegraaf, and Paul M. Hassour, on behalf of the American Thoracic Society Assembly on Pulmonary Circulation

Am J Respir Crit Care Med Vol 198, Iss 4, pp e15–e43, Aug 15, 2018



- The task force defined RV failure (RVF) as a complex clinical syndrome characterized by insufficient delivery of blood from the RV in the setting of elevated systemic venous pressure at rest or exercise.
- RVF is a heterogeneous syndrome. Multiple RVF phenotypes exist.

RVF occurs as a consequence of 1) alterations in preload; 2) changes in RV mechanics, lusitropy, and/or contractility; or 3) increases in afterload



Diagnostic

Deux signes fondamentaux

- ❖ Surcharge **diastolique** ou volumique du VD (**dilatation**) : le VD a une fonction diastolique « tolérante »
- ❖ Surcharge **systolique** ou barométrique du VD (aplatissement et mouvement paradoxal du **septum** interventriculaire) : le VD a une fonction systolique « sensible » (à toute élévation de postcharge).

Jardin F et al. *Chest* 1997;111:209-17

Diagnostic différentiel

- ❖ **Cœur pulmonaire chronique :**
 - ✓ Contexte +++
 - ✓ HTAP sévère (PAPs > 60 mmHg)
 - ✓ HVD (paroi libre > 7 voire 10 mm)
- ❖ **Infarctus du VD**
- ❖ **Pièges exceptionnels :** sténose pulmonaire, compression des artères pulmonaires (tumeurs, anévrismes de l'aorte ascendante...), fistules vasculaires (aortopulmonaire...).

Epidemiol

Enlarged

Abnormal septal motion

Acute cor pulmonale (1)

**reviews**

Echocardiographic Pattern of Acute Cor Pulmonale*

(CHEST 1997; 111:209-17)

GUIDELINES AND STANDARD

Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography
Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography

Lawrence G. Babbitt, MD, FRCG, Chair; Wynne W. Lai, MD, MPH, FRCG, Jonathan Abalos, MD, MS, Lung Shun, RDCS, FRCG, Staff D. Hanchandrasekaran, BSc, Krishnawany Chandrasekaran, MD, FRCG, Scott D. Solomon, MD, Eric K. Louis, MD, and Nelson B. Schiller, MD, Montreal, Quebec, Canada; Nir-
New York, Boston, Massachusetts, Phoenix, Arizona, London, United Kingdom; San Francisco, California

- ✓ ACP associates **RV dilation** and **paradoxical septal motion**
- ✓ RV dilation: ratio of **RV/LV end-diastolic area** (diameter)
- ✓ Criteria:
 - RV/LV end-diastolic dimension > 0.6
 - **Severe if RV/LV dimension > 1**
- ✓ Paradoxical septal motion at end-systole:
 - ✓ Reflects **pressure overload**
 - ✓ Confirmed by **eccentricity index**
 - ✓ Might be associated with RV **volume overload (end-diastole)**.

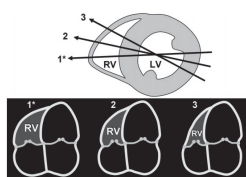
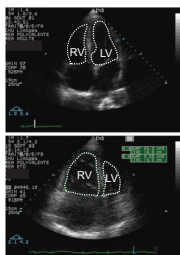
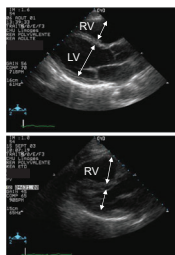
Généralités

Dialysis

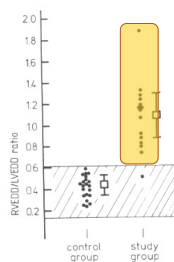
RV dilatation

Parasternal LAX

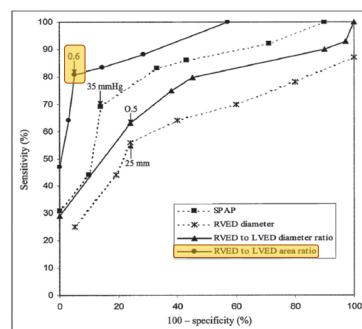
Apical 4-C



Parasternal LAX



Kasper et al. Am J Cardiol 1980; 45: 567-72



Mansencal et al. Am J Cardiol 2003 ; 92 : 116

Definition

Epidemiology

Enlarged right cavities

RA & IVC dilatation

TTE

TEE

TEE

IVC ≤ 21 mm

Definition

Epidemiology

Enlarged right cavities

Abnormal septal motion

Paradoxical septal motion

$P_{RV} > P_{LV}$

End-systole

End-diastole

Normal

ACP

END-SYSTOLE

Definition

Epidemiology

Enlarged right cavities

Abnormal septal motion

Eccentricity index

End-diastole

End-systole

Eccentricity Index = D_2/D_1

Normals

ACP

DIASTOLE

SYSTOLE

Normal n=12

RVVO n=13

RVPO n=22

Ryan et al. J Am Coll Cardiol 1985; 5: 918-24

Definition

Epidemiology

Enlarged right cavities

Abnormal septal motion

Acute cor pulmonale (2)

Moderate vs. severe

Moderate ACP

Severe ACP

RV

LV

RVEDA/LVEDA > 1

Definition

Epidemiology

Enlarged right cavities

Abnormal septal motion

PA Doppler profile

Pulmonary artery Doppler profile (1)

TTE

TEE

Pw Doppler positioning

Definition

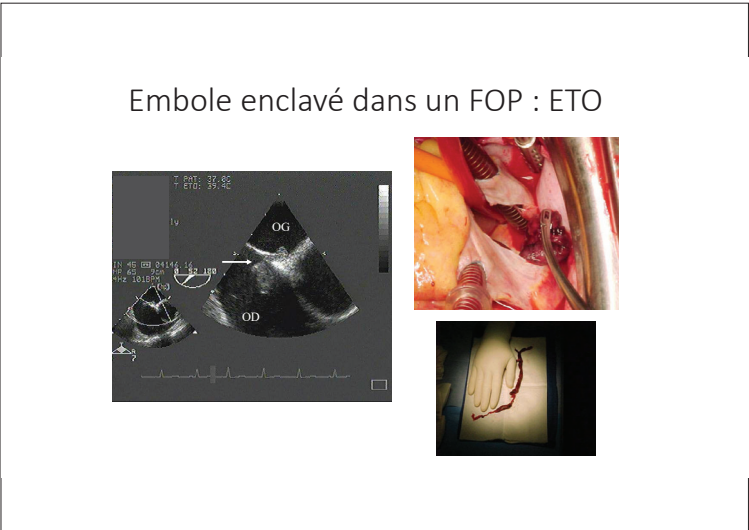
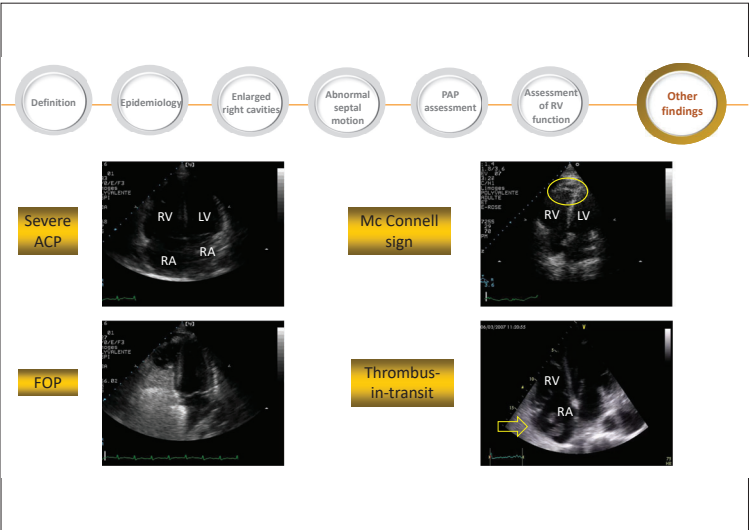
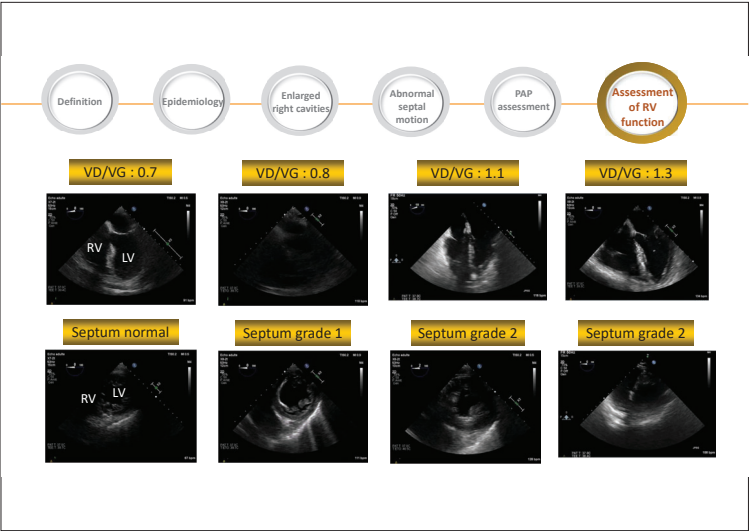
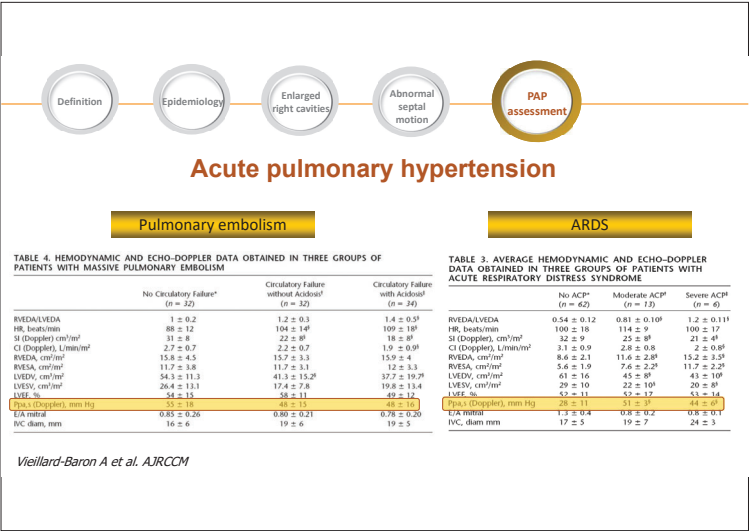
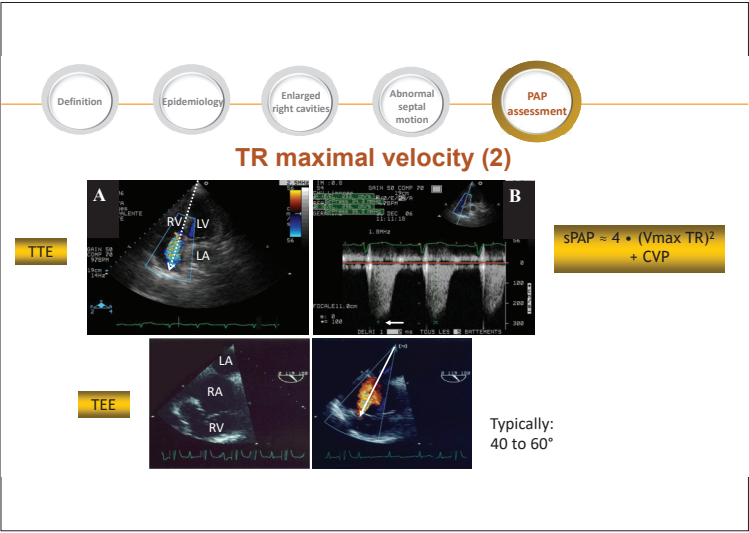
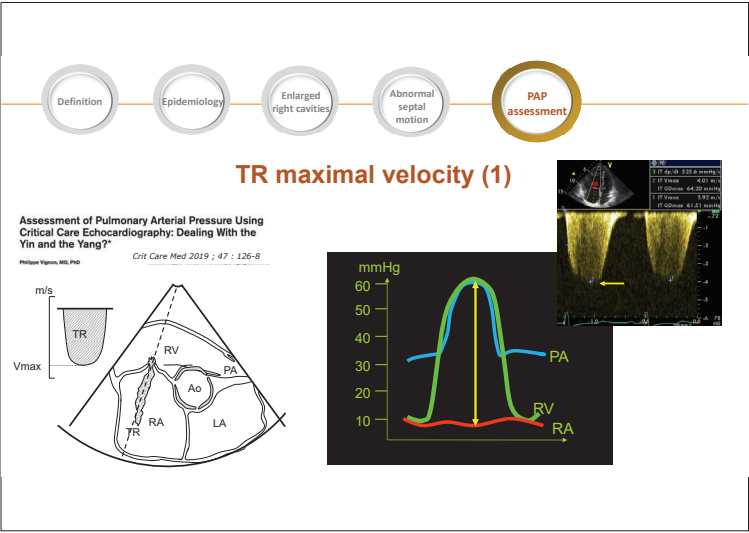
Epidemiology

Enlarged right cavities

Abnormal septal motion

PA Doppler profile

Pulmonary artery Doppler profile (2)



Embole enclavé dans l'AP (ETO)

	Sensibilité	Spécificité
Viellard-Baron et al. (n=19)	84%	84%
Pruszczyk et al. (n=49)	80%	100%
Wittlich et al. (n=60)	97%	88%
Steiner et al. (n=35)	82%	92%
Krivec et al. (n=12)	92%	100%

Viellard-Baron A. et al. Intensive care Med 1997;24:429-33
Pruszczyk P. et al. Chest 1997;112:722-8
Wittlich N. et al. J Am Soc Echocardiogr 1992;5:515-24
Steiner P. et al. Am J Roentgenol 1996;167:931-6
Krivec B. et al. Chest 1997;112:1310-6.

Intensive Care Med 2017; 36(12):1734-1742
DOI: 10.1177/1077551217341734

ORIGINAL

Guillaume Lhéritier
Annick Legros
Agnes Colla
Thierry Lheron
Armand Mathonet
Jean-Pierre Frot
Anne Cuvry
Laurent Martin-Lefevre
Jean-Paul Gaudin
Jean-Benoît Ansel
Philippe Vigani

Prevalence and prognostic value of acute cor pulmonale and patent foramen ovale in ventilated patients with early acute respiratory distress syndrome: a multicenter study

Floriane Bédier
Nathalie Karamian
Kerou Bonard
Armand S. Thibault
Florence Legros
Renaud Lenoir
Emmanuel Viallet
Laurent Martin-Lefevre
Guillaume Lhéritier
Armand Mathonet
Philippe Vigani

Prevalence and prognosis of cor pulmonale during protective ventilation for acute respiratory distress syndrome



- Multicentrique
- 200 patients SDR persistant (P/F ≤ 200)
- Ventilation protectrice
- CPA : 22.5% (CI 95% : 16.9 – 28.9%)
- ARDS I documenté : 45%
- Autres sepsis : 9%

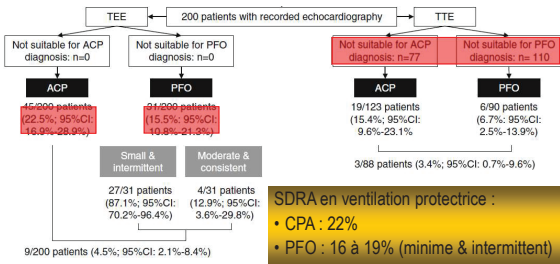
- Monocentrique
- 236 patients SDR (P/F ≤ 200)
- Ventilation protectrice
- CPA : 22% (CI 95% : 16 – 27%)
- ARDS I documenté : 53%
- Autres sepsis : 10%

Intensive Care Med 2017; 36(12):1734-1742
DOI: 10.1177/1077551217341734

ORIGINAL

Guillaume Lhéritier
Annick Legros
Agnes Colla
Thierry Lheron
Armand Mathonet
Jean-Pierre Frot
Anne Cuvry
Laurent Martin-Lefevre
Jean-Paul Gaudin
Jean-Benoît Ansel
Philippe Vigani

Prevalence and prognostic value of acute cor pulmonale and patent foramen ovale in ventilated patients with early acute respiratory distress syndrome: a multicenter study



Intensive Care Med 2017; 36(12):1743-1752
DOI: 10.1177/1077551217341735

SEVEN-DAY PROFILE PUBLICATION

Armand Mathonet Despont
Floriane Bédier
Cyril Charron
Emmanuel Vigier
Xavier Regaud
Annick Legros
Christophe Riviere
Philippe Vigani
Armand Mathonet

Acute cor pulmonale during protective ventilation for acute respiratory distress syndrome: prevalence, predictors, and clinical impact

- Trois séries de patients en SDRA modéré à sévère (P/F ≤ 200) sous VM protectrice
- 752 patients avec une incidence du CPA : 22% (CI 95% : 19 – 25%)
- Seul le CPA sévère (VD/IVG > 1) est associé à la mortalité

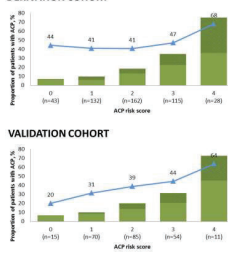
Table 4 Factors associated with hospital mortality in patients with acute respiratory distress syndrome

Variable	Odds ratio (95 % CI)	Multivariable logistic regression*
Male gender	1.35 (0.99-1.84), p = 0.06	1.46 (1.03-2.11), p = 0.045
Age ≥ 58 years	2.33 (1.73-3.14), p < 0.01	2.42 (1.71-3.45), p < 0.01
SAPS II ≥ 36 points	2.79 (2.06-3.76), p < 0.01	1.88 (1.32-2.69), p < 0.01
Respiratory rate ≥ 30 cycles/min	2.06 (1.41-3.02), p < 0.01	3.29 (2.07-5.23), p < 0.01
PEEP ≥ 15 cmH ₂ O	0.64 (0.45-0.91), p = 0.01	0.64 (0.45-0.91), p = 0.01
Plateau pressure ≥ 25 cmH ₂ O	1.40 (1.04-1.89), p = 0.03	1.40 (1.04-1.89), p = 0.03
Compliance < 35 ml/cmH ₂ O	1.46 (1.07-2.00), p = 0.02	1.46 (1.07-2.00), p = 0.02
Driving pressure ≥ 15 cmH ₂ O	1.90 (1.40-2.58), p < 0.01	2.26 (1.58-3.23), p < 0.01
PaO ₂ /FiO ₂ ratio < 100 mmHg on TEE day	1.45 (1.09-1.95), p = 0.01	1.45 (1.05-1.98), p = 0.04
Severe cor pulmonale	1.80 (1.06-3.00), p = 0.03	2.08 (1.03-3.85), p = 0.04
Shock on TEE day	3.25 (2.32-4.56), p < 0.01	2.57 (1.73-3.80), p < 0.01
Final mortality during ARDS	0.72 (0.52-0.99), p = 0.045	0.76 (0.57-1.01), p = 0.051

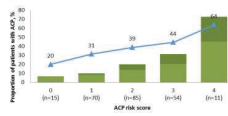
Table 3 The acute cor pulmonale risk score

Parameter	Score
Pneumonia as cause of ARDS	1
Driving pressure ≥ 18 cmH ₂ O	1
PaO ₂ /FiO ₂ ratio < 150 mmHg	1
PaCO ₂ ≥ 48 mmHg	1
Total score	0-4

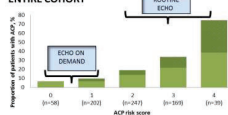
DERIVATION COHORT



VALIDATION COHORT



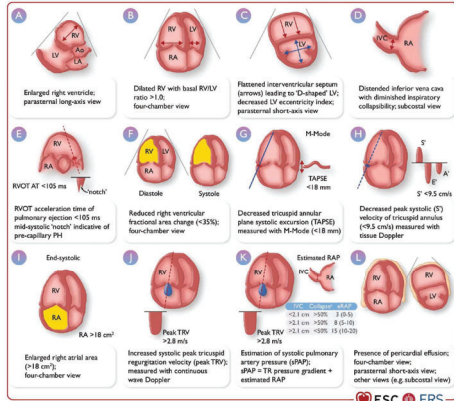
ENTIRE COHORT



2022 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension

Developed by the task force for the diagnosis and treatment of pulmonary hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS).
Endorsed by the International Society for Heart and Lung Transplantation (ISHLT) and the European Reference Network on rare respiratory diseases (ERN-RTD).

View Helder et al. (2022) "Guidelines for the diagnosis and treatment of pulmonary hypertension" and the ESC/ERS Scientific Document Group.



Acute cor pulmonale



- ✓ RV **diastolic** impairment: **dilatation** of right cardiac cavities & IVC ± **volume overload (TR)**
- ✓ RV **systolic** impairment: **paradoxical septal motion (end-systole)**
- ✓ **Acute cor pulmonale (ACP)** associates RV dilatation and paradoxical septal motion
- ✓ ACP links RV dilatation to excessive afterload
- ✓ Pulmonary artery pressure can be assessed using Bernouilli's equation (TR & PR)
- ✓ Increase of RV afterload leads to **progressive VA uncoupling (RV failure)**
- ✓ Systemic venous congestion can be assessed (IVC size & respiratory variation, VExUS).

