

Das recht Ventrikel ist auch noch da!

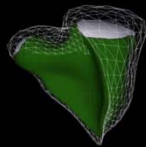
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Belgium



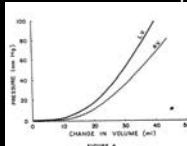
RV function

- The RV operates as
 - a low pressure, volume pump,
 - moving the blood across the low resistance pulmonary bed into the left heart
- Right ventricle is the preload of the left ventricle



Physiology

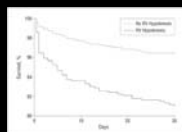
- Not very sensitive to preload
 - Good compliance of the free wall



Laks et al *Circ Res* 20:565, 1967

- Very sensitive to afterload
 - RV is failing if mean pulmonary pressure \geq 40 mmHg

Kucher et al. *Arch Intern Med* 2005; 165:1777-81



Physiology: Ventricular interdependence

- Less contractility
- Key role of the interventricular septum
- Mainly left/right **systolic** interaction
Left ventricle generates up to 70% of RV systole (pressure and flow)
• Santamore et al. Prog Cardiovasc Dis 1998;40:289-308
- Mainly right/left **diastolic** interaction
 - Change in RV volume will influence LV function
 - Diastolic coupling is stronger if the pericardium is closed



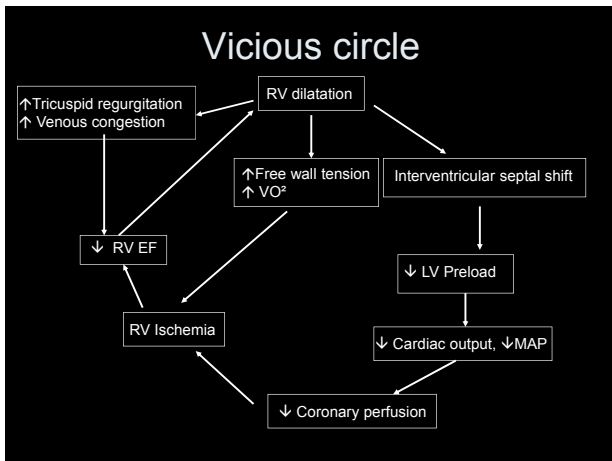
Interventricular septum

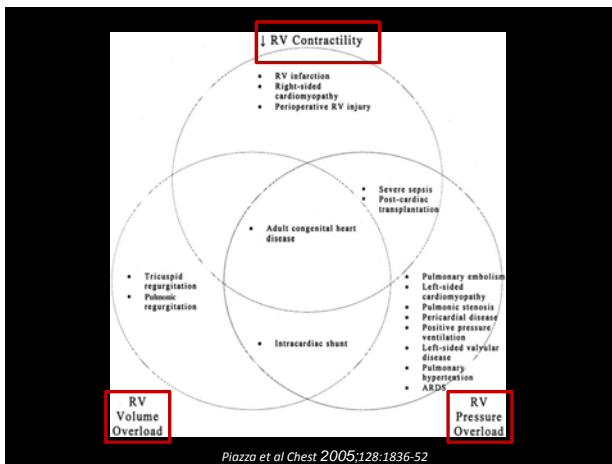


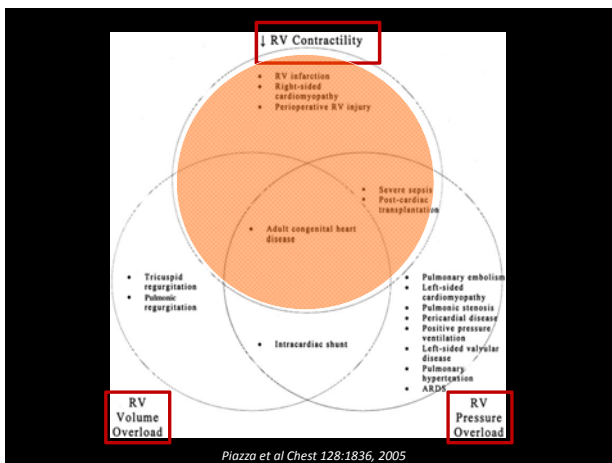
Right heart failure

- = RV is no more able to push the venous blood through the lung into the left heart
- Despite full activation of the compensatory mechanisms
- ↑ RV EDV → RV dilation
- ↓ RV contractility → Reduced RV ejection fraction
- RV wall motion abnormalities
 - Hypokinesia of the free wall
 - Flattening/Shift of the interventricular septum

Kavarana et al. Ann Thorac Surg 2002; 73:745-50







The Right Ventricle in Sepsis

Chee M. Chan, MD¹*, James R. Klinger, MD²
 Clin Chest Med 29 (2008) 661-676

Table 1
 Effect of initial and subsequent right ventricular ejection fraction on survival in patients with sepsis

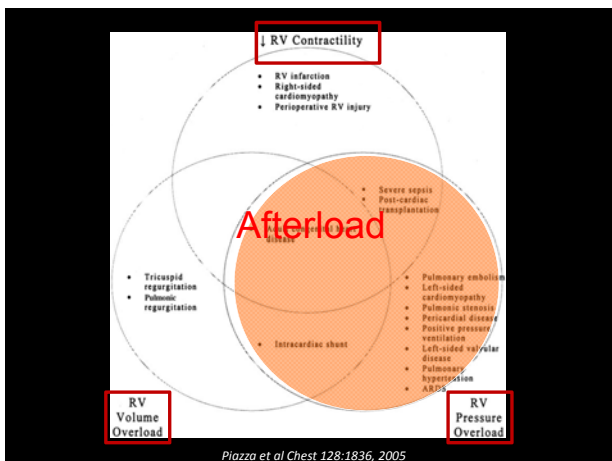
	n	Survivors Initial RVEF	Nonsurvivors Initial RVEF	Survivors Follow-up RVEF	Nonsurvivors Follow-up RVEF
Hoffman et al, 1983	9	0.29 ± 0.06	0.36 ± 0.15	0.35 ± 0.10	0.34 ± 0.07
Vincent et al, 1988	56	0.28 ± 0.09	0.21 ± 0.07	—	—
Dhainaut et al, 1988	23	0.32 ± 0.13	0.29 ± 0.11	0.31 ± 0.12	0.22 ± 0.11
Parker et al, 1990	39	0.35	0.41	0.51	0.39

Advantages of Strain Echocardiography in Assessment of Myocardial Function in Severe Sepsis: An Experimental Study*
 Hostenes, Svr; Halvorsen, Per, MD, PhD; Skulstad, Helge, MD, PhD; Remme, Espen; Espinoza, Andreas; Høyer, Stefan; Rogge, Jan, MD, PhD; Fosse, Erik, MD, PhD; Nielsen, Erik, MD, PhD; Edvardsen, Thor, MD, PhD
 Critical Care Medicine, 42(6):e432-440, June 2014.

Cytokines-mediated myocardial depression: TNF α

Right ventricular ischemia

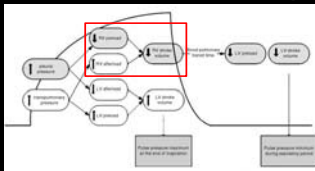
- RV myocardial infarction in 33-50% of inferior myocardial infarction
- RV dysfunction after cardiac surgery:
 - Poor myocardial protection (cardioplegia)
 - Ischemia/Reperfusion : TNF α , IL 6-8
 - Non grafted right coronary artery
 - Air embolism
 - Protamine: Pulmonary hypertension
 - OPCAB?
 - LVAD: 20-50% with RV failure



Pressure overload

- Acute increase in RV afterload
 - ARDS: endothelial dysfunction (↓ NO)
+ mechanical ventilation???
 - Hypoxia: hypoxic pulmonary vasoconstriction
!! Opening of right – left shunt
 - Hypercarbia → permissive hypercarbia
 - Acidosis
 - Peep : no impairment of RV filling/afterload ?
Mekontso Dessap et al. *Intensive Care Med* 2009;35:1850-58
 - Pulmonary embolism : Air, thrombus
 - Left heart pathologies

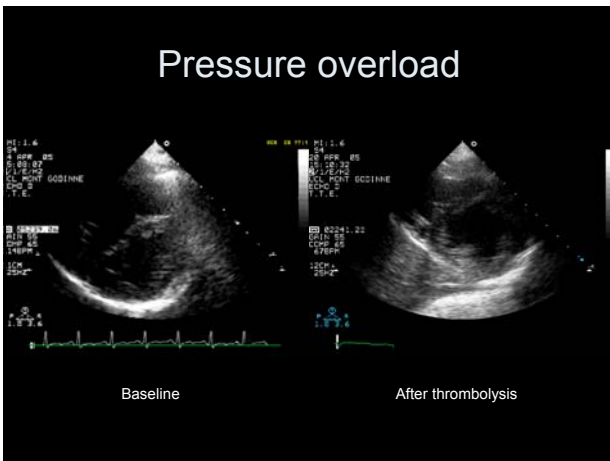
Effects of the Peep



Acute pressure overload

- Acute cor pulmonale
 - RV dilatation
 - RV hypokinesia
 - Septal shift R > L
 - totally reversible

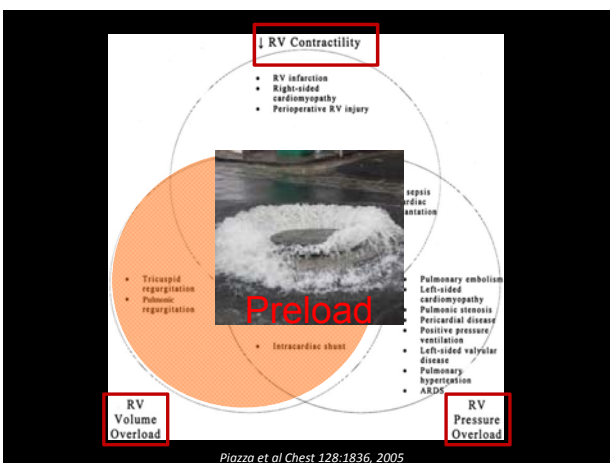





Prevalence and prognosis of cor pulmonale during protective ventilation for acute respiratory distress syndrome


Prevalence of acute cor pulmonale : 22%
 Boissier et al. *Intens Care Med* 2013; 39:1725-33
 Mekontso-Dessap et al. *Intens Care Med* 2016; 42:862-70


PFO in a context of pulmonary hypertension: ARDS (19% of PFO R > L shunt)
 Prevalence and prognosis of shunting across patent foramen ovale during acute respiratory distress syndrome® Armand Mekontso Dessap
 Crit Care Med 2010 Vol. 38, No. 1



Diagnosis









MI: 0.5
PAT T: 37.0C
TEE T: 37.0C
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Continuous Cardiac outp
Pulmonary pressures

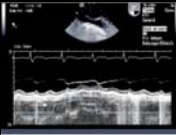
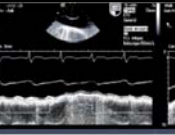
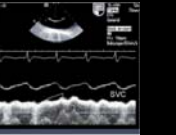
RV Preload

- *RV dilation*
 - ↳ RV EDA / LV EDA < 0.6 : normal RV
 - ↳ RV EDA / LV EDA = 0.6-1 : mild RV dilation
 - ↳ RV EDA / LV EDA > 1 : severe RV dilation
- Opening of the RV apical angle

Fluid responsiveness: Vena Cava

➤ Collapsibility index of the vena cava

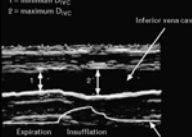
SVC collapsibility index: 68% SVC collapsibility index: 43% SVC collapsibility index: 12%

Fluid responsiveness : collapsibility index > 36%

Vieillard-Baron et al. *Intensive Care Med* 2004;30:1734-39

Inferior vena cava: distensibility index > 18%

Barbier et al. *Intensive Care Med* 2004;30:1740-6



1 = maximum Dvc
2 = maximum Dvc
Inferior vena cava
Expiration Inspiration

Really?

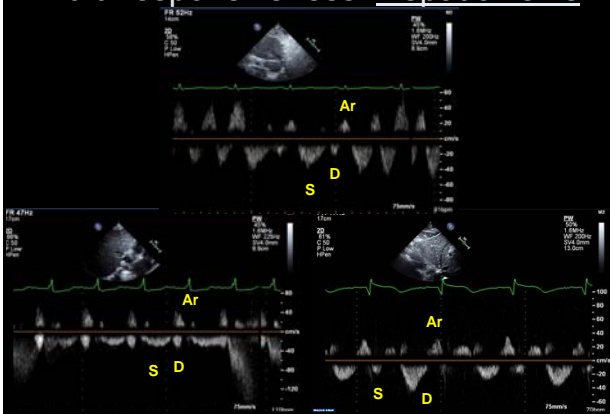
Does a positive end-expiratory pressure-induced reduction in stroke volume indicate preload responsiveness? An experimental study

P. LAMBERT¹, E. SLOTH²
Acta Anaesthesiol Scand 2007; 51: 415-425

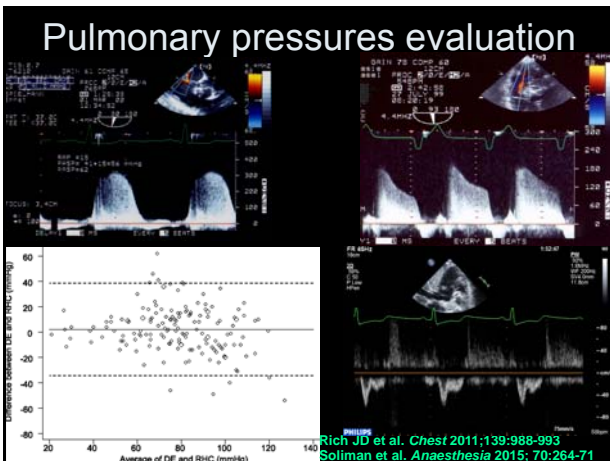
Table 2
 Measured variables obtained by echocardiography at 10% hypo-, normo- and hypervolemia and at 0, 10 and 20 cm H₂O of positive end-expiratory pressure (PEEP)

	Hypovolemia			Normovolemia			10% hypervolemia		
PEEP (cm H ₂ O)	0	10	20	0	10	20	0	10	20
SVV percentage	44 (15, 56)	7 (4, 10)*	4 (0, 10)*	9 (6, 12)	5 (4, 15)	2 (0, 5)*	12 (5, 13)	12 (10, 13)	6 (4, 9)

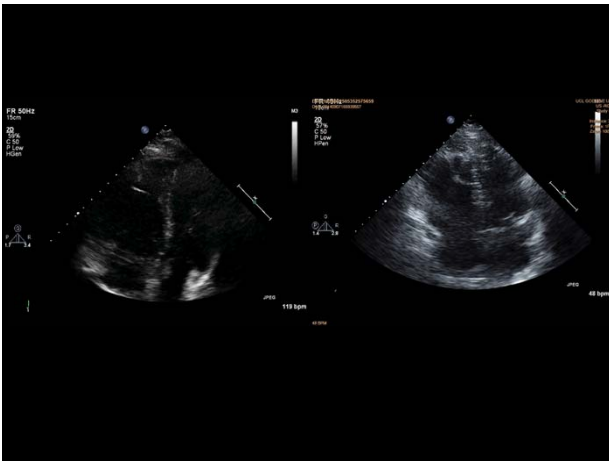
Fluid responsiveness: Hepatic veins



Pulmonary pressures evaluation



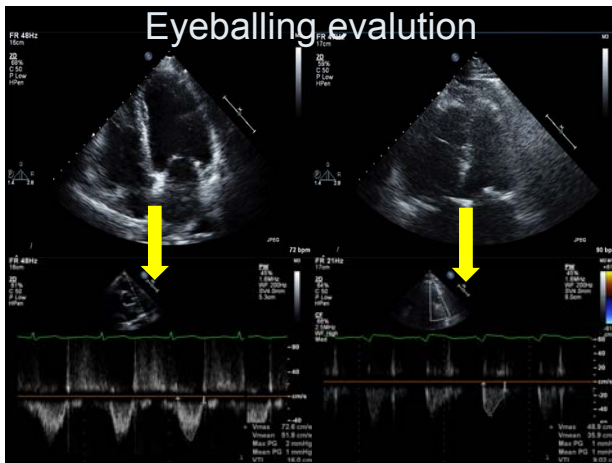
Rich JD et al. *Chest* 2011;139:988-993
 Soliman et al. *Anaesthesia* 2015; 70:264-71



Mc Connell sign

- Normal RV apex contractility
- Severe hypokinesia of the mid-part of the RV free wall
 - Acute pulmonary embolism
Sensitivity : 77%, specificity : 94%
Mc Connell et al. Am J Card 1996; 78:469-73
 - Sensitivity: 23%
Rydman et al. Echocardiography 2010; 27:286-93
 - RV myocardial infarction
Casazza et al. Eur J Echocard 2005; 6; 11-4

**Echocardiographic evaluation of the right heart :
Systolic function**



RV systolic function

- RV normal stroke volume
- RVOT VTI > 15 cm
 - under general anaesthesia
 - Lambert-Litner A. Referenzwerte für intraoperative transösophageale Echokardiographie. Inauguraldissertation. In: Basel MFdU, ed. Basel; 1997.
 - awaken
 - Soma et al. *J Heart Lung Transpl* 2013; 32:S106

RV systolic function

- RV Fractical Area Change

$$= (EDA - ESA / EDA) \times 100$$

- > 35%
- Maslow et al. *Anesth Analg* 2002 Dec; 95: 1507

$$RV FAC = ((28-21.3)/28) \times 100 = 23.9\%$$

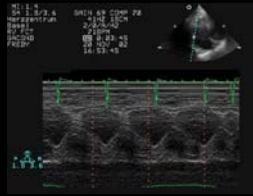
RV systolic function

- Tricuspid annular motion

- TAPSE

TTE: > 17 mm

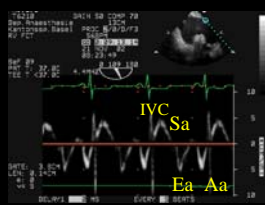
Land et al. *JASE* 2015; 28:1-39.e14



- TDI

TTE: Sa peak > 10 cm/s

Land et al. *JASE* 2015; 28:1-39.e14



Thank you for your attention

