Je stále potřeba k diagnostice plicní hypertenze invazivní hemodynamické vyšetření?

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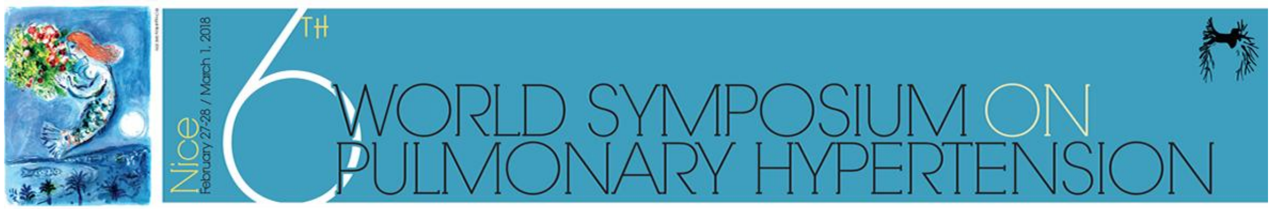
KOMPLEXNÍ KARDIOVASKULÁRNÍ CENTRUM FAKULTNÍ NEMOCNICE OLOMOUC

Lékařská fakulta Univerzity Palackého v Olomouci

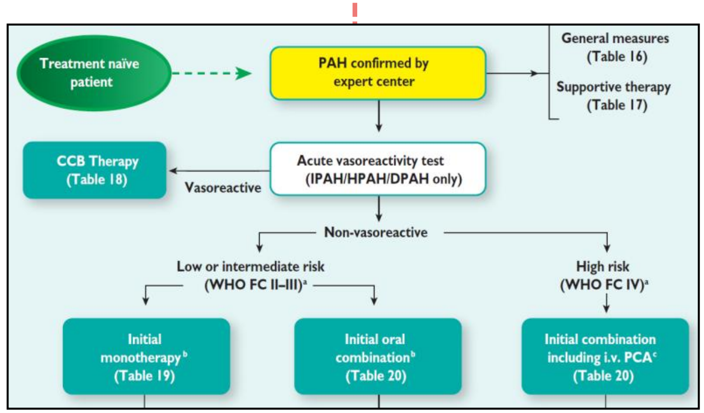
I. INTERNÍ KLINIKA KARDIOLOGICKÁ FAKULTNÍ NEMOCNICE OLOMOUC

Hemodynamická definice plicní hypertenze



Definice PH — **MPAP ≥20/25 mmHg**

Definice PAH
- **MPAP ≥20/25 mmHg**
- **PAWP ≤15 mmHg**
- **PVR >3 WU**



PAP: pulmonary arterial pressure; PAWP: pulmonary artery wedge pressure; PVR: pulmonary vascular resistance

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Plicní hypertenze - definice a klasifikace

Updated Clinical Classification of Pulmonary Hypertension

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Rogiero Souza, MD, PHD¶¶

Definition	Characteristics	Clinical group(s)[b]
Pulmonary hypertension (PH)	Mean PAP ≥25 mmHg	All
Pre-capillary PH	Mean PAP ≥25 mmHg PWP ≤15 mmHg CO normal or reduced[c]	1. Pulmonary arterial hypertension 3. PH due to lung diseases 4. Chronic thromboembolic PH 5. PH with unclear and/or multifactorial mechanisms
Post-capillary PH	Mean PAP ≥25 mmHg PWP >15 mmHg CO normal or reduced[c]	2. PH due to left heart disease
Passive	TPG ≤12 mmHg	
Reactive (out of proportion)	TPG >12 mmHg	

Prevalence of PAH in the general population
- 15–50 cases per million (0.0015–0.0050%)

Prevalence of PAH in at risk populations
- CHD: 4–15%
- Systemic sclerosis: 8–10%
- Portal hypertension: 0.5–10%
- HIV: 0.5%
- Sickle cell disease: 2%
- BMPR2 mutation carriers: 20%

1. Pulmonary arterial hypertension
   - 1.1 Idiopathic PAH
   - 1.2 Heritable PAH
   - 1.2.1 BMPR2
   - 1.2.2 ALK-1, ENG, SMAD9, CAV1, KCNK3
   - 1.2.3 Unknown
   - 1.3 Drug and toxin induced
   - 1.4 Associated with:
   - 1.4.1 Connective tissue disease
   - 1.4.2 HIV infection
   - 1.4.3 Portal hypertension
   - 1.4.4 Congenital heart diseases
   - 1.4.5 Schistosomiasis

1′ Pulmonary veno-occlusive disease and/or pulmonary capillary hemangiomatosis

1″. Persistent pulmonary hypertension of the newborn (PPHN)

2. Pulmonary hypertension due to left heart disease
   - 2.1 Left ventricular systolic dysfunction
   - 2.2 Left ventricular diastolic dysfunction
   - 2.3 Valvular disease
   - 2.4 Congenital/acquired left heart inflow/outflow tract obstruction and congenital cardiomyopathies

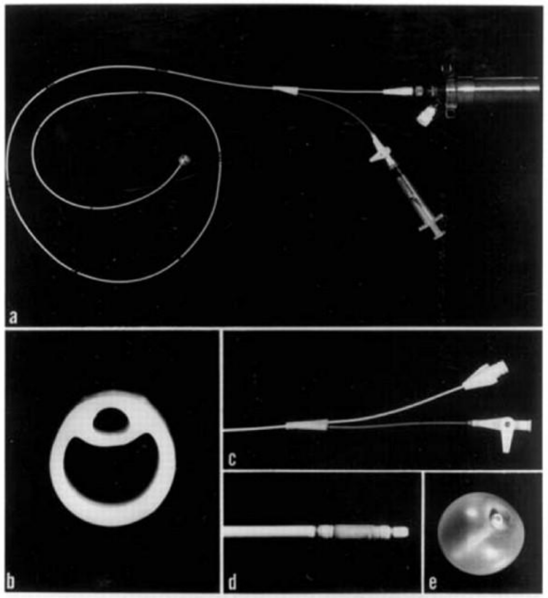
3. Pulmonary hypertension due to lung diseases and/or hypoxia
   - 3.1 Chronic obstructive pulmonary disease
   - 3.2 Interstitial lung disease
   - 3.3 Other pulmonary diseases with mixed restrictive and obstructive pattern
   - 3.4 Sleep-disordered breathing
   - 3.5 Alveolar hypoventilation disorders
   - 3.6 Chronic exposure to high altitude
   - 3.7 Developmental lung diseases

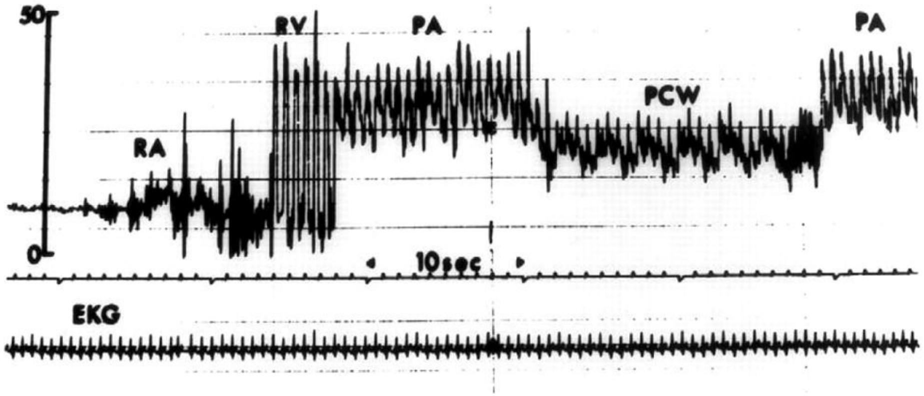
4. Chronic thromboembolic pulmonary hypertension (CTEPH)

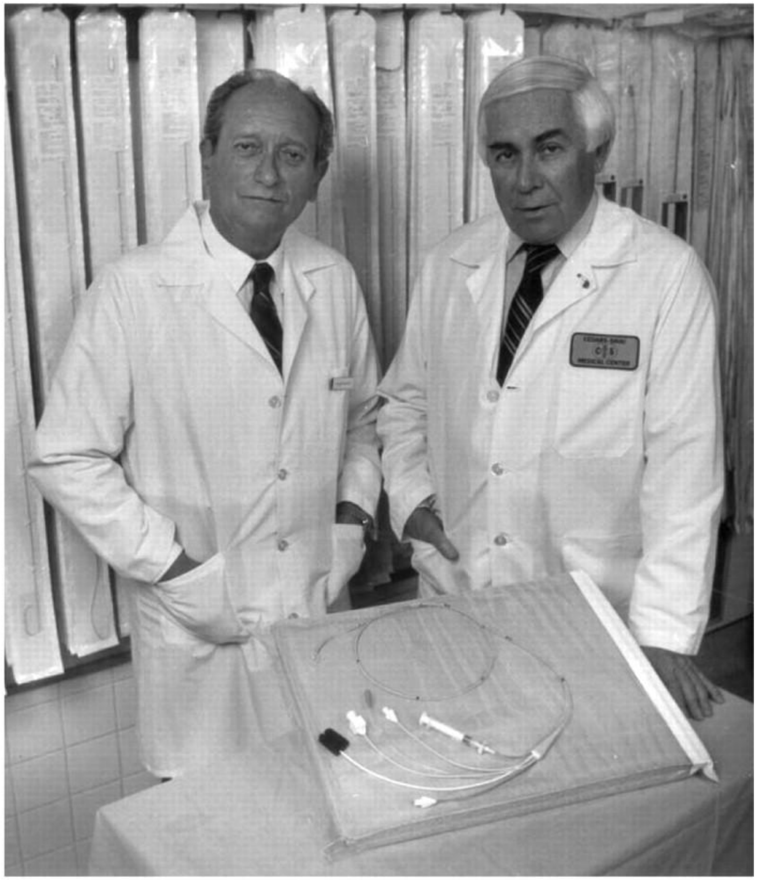
5. Pulmonary hypertension with unclear multifactorial mechanisms
   - 5.1 Hematologic disorders: chronic hemolytic anemia, myeloproliferative disorders, splenectomy
   - 5.2 Systemic disorders: sarcoidosis, pulmonary histiocytosis, lymphangioleiomyomatosis
   - 5.3 Metabolic disorders: glycogen storage disease, Gaucher disease, thyroid disorders
   - 5.4 Others: tumoral obstruction, fibrosing mediastinitis, chronic renal failure, segmental PH

Hoeper MM, *et al. J Am Coll Cardiol* 2013; 62:D42-50.

The Pulmonary Artery Catheter







William Ganz and H.J.C. Swan

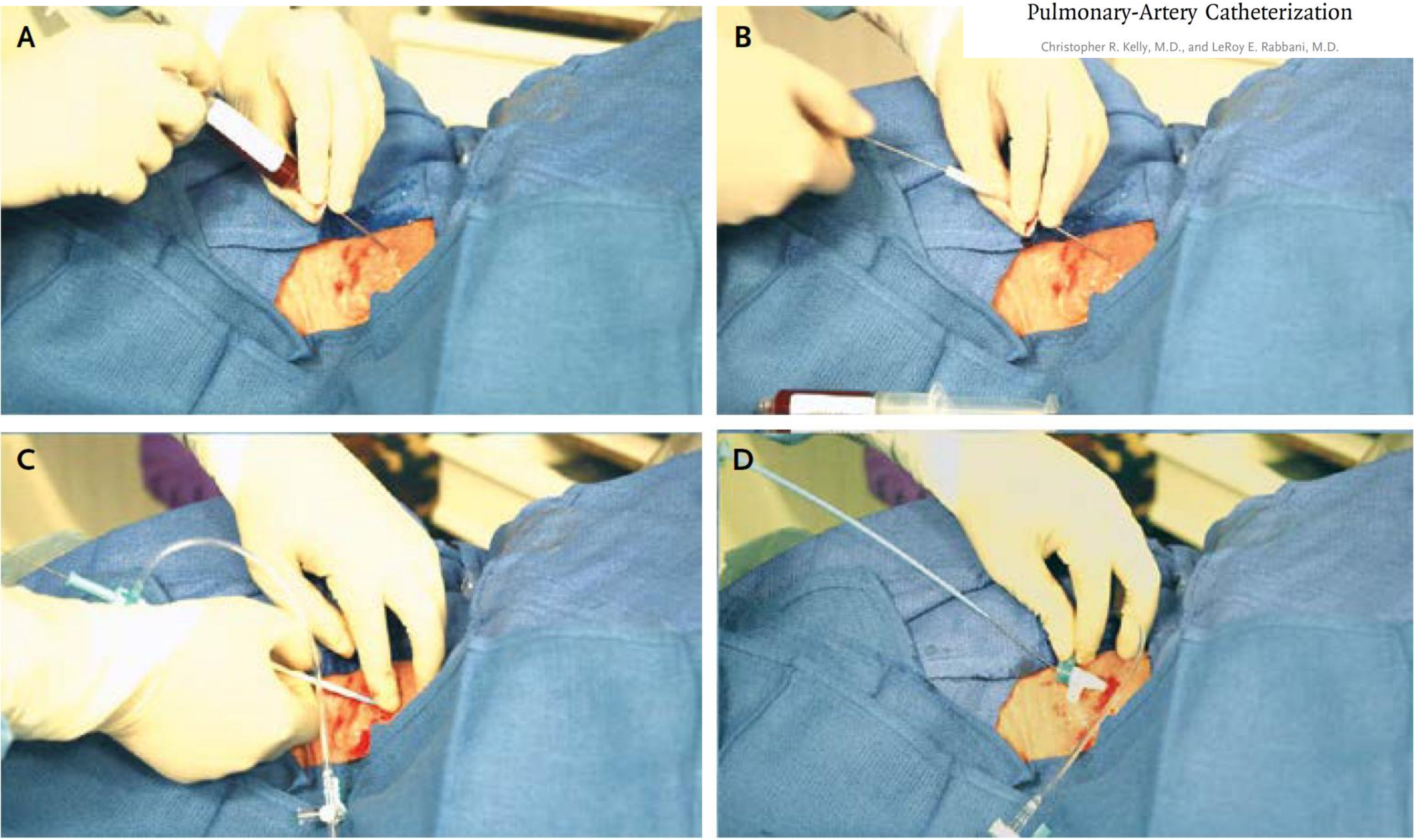
The Swan-Ganz Catheters: Past, Present, and Future, Volume: 119, Issue: 1, Pages: 147-152, DOI: (10.1161/CIRCULATIONAHA.108.811141)

The NEW ENGLAND JOURNAL of MEDICINE

VIDEOS IN CLINICAL MEDICINE
SUMMARY POINTS

Pulmonary-Artery Catheterization

Christopher R. Kelly, M.D., and LeRoy E. Rabbani, M.D.



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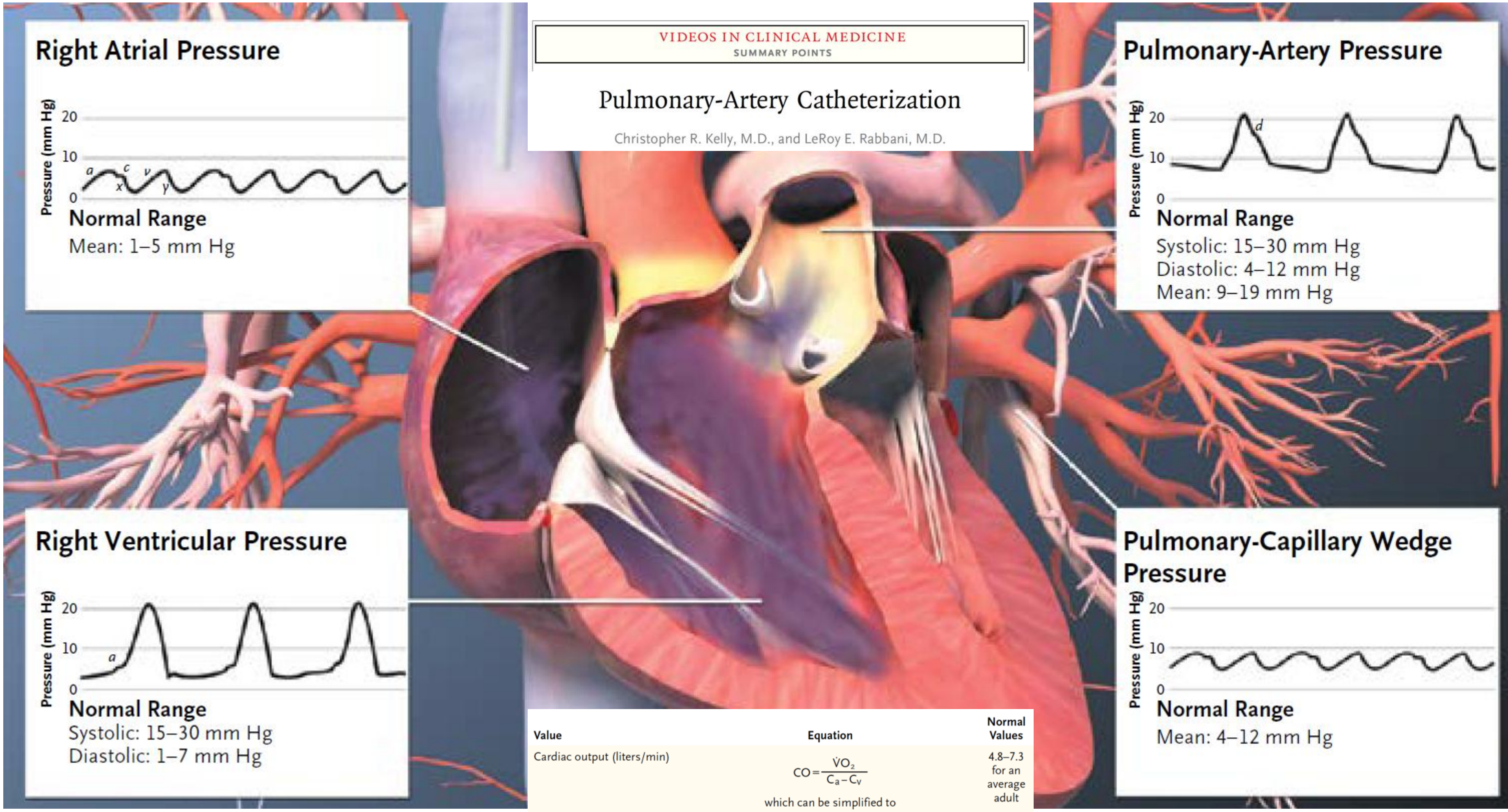
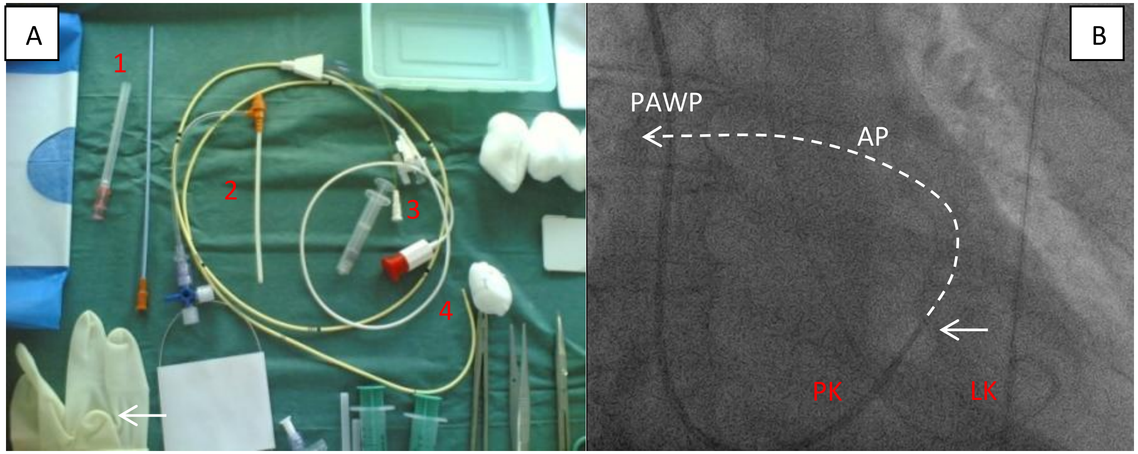
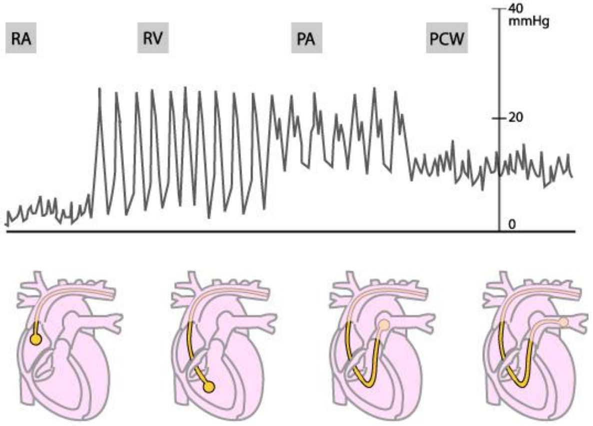
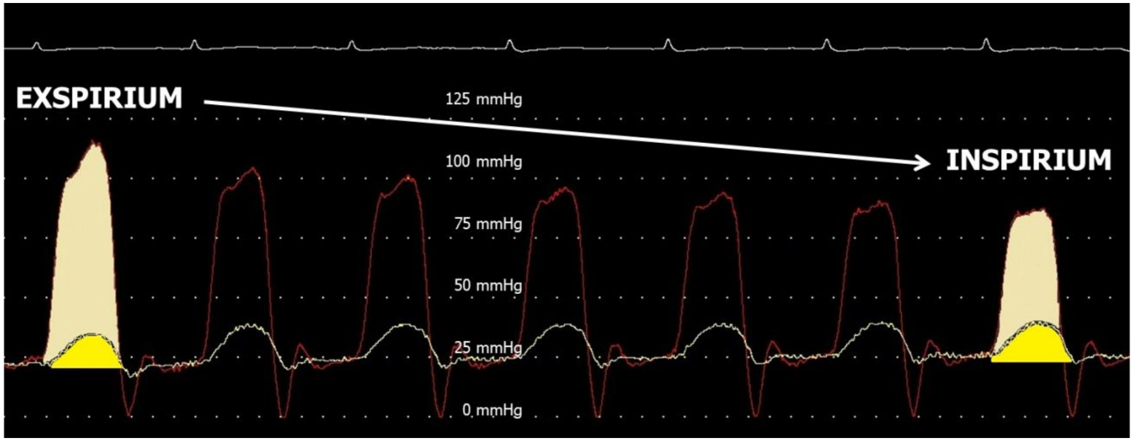


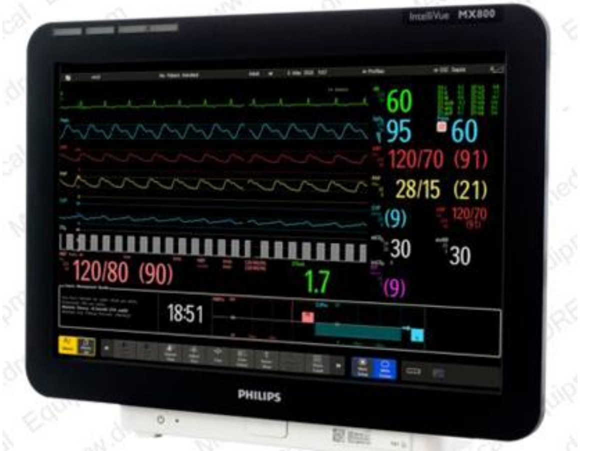
Value	Equation	Normal Values
Cardiac output (liters/min)	$CO = \frac{\dot{V}O_2}{C_a - C_v}$ which can be simplified to $CO = \frac{\dot{V}O_2}{1.36 \times Hgb \times (Sao_2 - Svo_2) \times 10}$	4.8–7.3 for an average adult
Cardiac index (liters/min/m^2)	$CI = \frac{CO}{BSA}$	2.8–4.2
Systemic vascular resistance (dyn·sec·cm^{-5})	$SVR = \frac{MAP - RA}{CO} \times 80$	700–1600
Pulmonary vascular resistance (dyn·sec·cm^{-5})	$PVR = \frac{PA - PCWP}{CO} \times 80$	20–130

Pravostranná katetrizace – „zlatý standard“



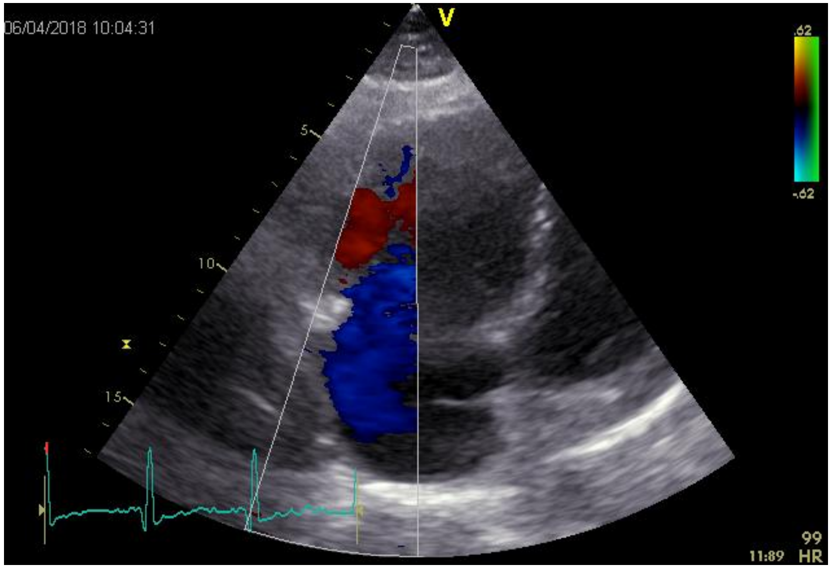


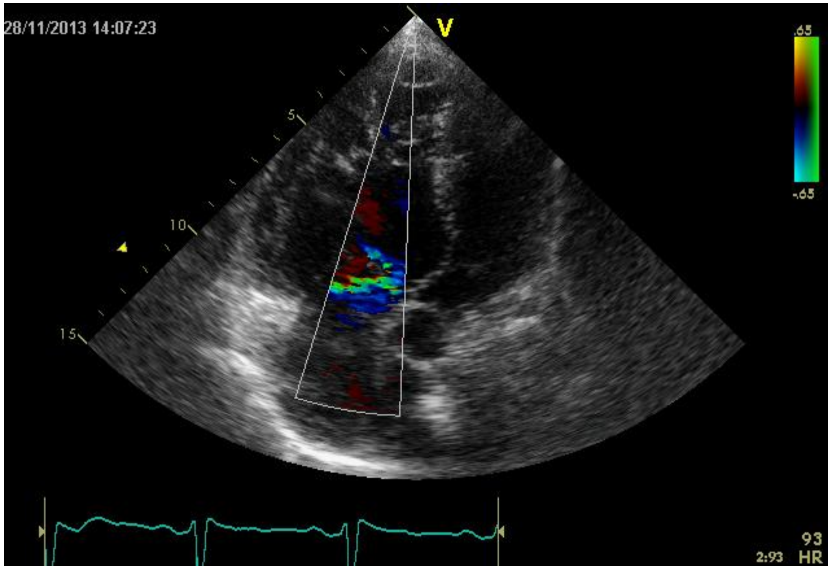


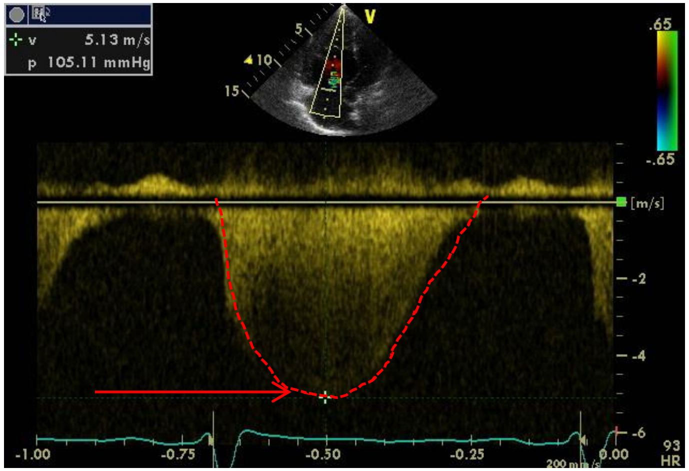


ESC guidelines. Eur Heart J 2009;30:2493-2537
Jansa P. Chronicka plicni hypertenze. Cor Vasa 2011;53(3)

Echokardiografie – klíčový screeningový nástroj



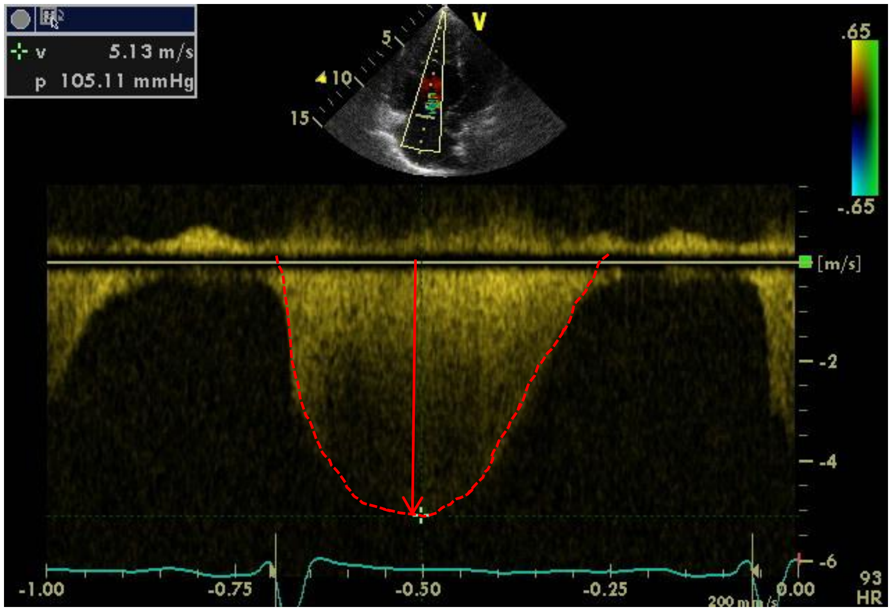


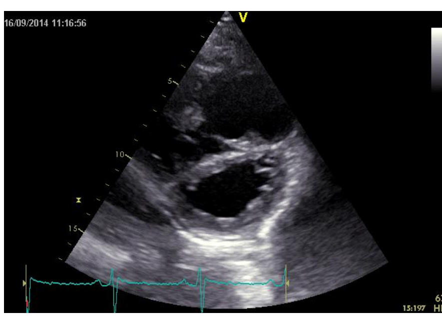


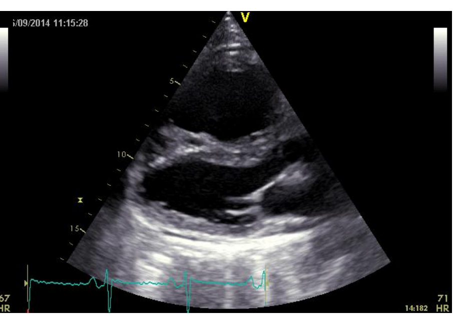

WHY


But... why?

PAH/CTEPH - screening







European Heart Journal
doi:10.1093/eurheartj/ehv317
ESC/ERS GUIDELINES

2015 ESC/ERS Guidelines for the diagnosis and treatment of pulmonary hypertension

The Joint Task Force for the Diagnosis and Treatment of Pulmonary Hypertension of the European Society of Cardiology (ESC) and the European Respiratory Society (ERS)

Peak tricuspid regurgitation velocity (m/s)	Presence of other echo 'PH signs'[a]	Echocardiographic probability of pulmonary hypertension
≤2.8 or not measurable	No	Low
≤2.8 or not measurable	Yes	Intermediate
2.9–3.4	No	
2.9–3.4	Yes	High
>3.4	Not required	

A: The ventricles[a]	B: Pulmonary artery[a]	C: Inferior vena cava and right atrium[a]
Right ventricle/ left ventricle basal diameter ratio >1.0	Right ventricular outflow Doppler acceleration time <105 msec and/or midsystolic notching	Inferior cava diameter >21 mm with decreased inspiratory collapse (<50 % with a sniff or <20 % with quiet inspiration)
Flattening of the interventricular septum (left ventricular eccentricity index >1.1 in systole and/or diastole)	Early diastolic pulmonary regurgitation velocity >2.2 m/sec	Right atrial area (end-systole) >18 cm^2
	PA diameter >25 mm.	

European Heart Journal (2014) 35, 3033–3080
doi:10.1093/eurheartj/ehu283

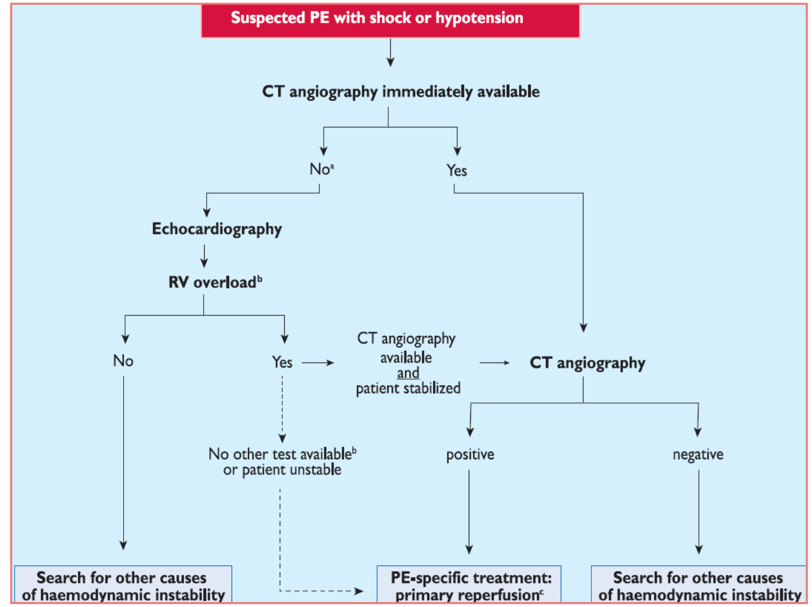
ESC GUIDELINES

PE - dg. a prognostická stratifikace

2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolism

The Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC)

Echocardiographic criteria of RV dysfunction include RV dilation and/or an increased end-diastolic RV–LV diameter ratio (in most studies, the reported threshold value was 0.9 or 1.0); hypokinesia of the free RV wall; **increased velocity of the tricuspid regurgitation jet**; or combinations of the above.



Early mortality risk		Risk parameters and scores			
		Shock or hypotension	PESI class III-V or sPESI ≥I[a]	Signs of RV dysfunction on an imaging test[b]	Cardiac laboratory biomarkers[c]
High		+	(+)[d]	+	(+)[d]
Intermediate	Intermediate–high	–	+	Both positive	
	Intermediate–low	–	+	Either one (or none) positive[e]	
Low		–	–	Assessment optional; if assessed, both negative[e]	

ESC
European Society of Cardiology
European Heart Journal (2017) **38**, 2739–2791
doi:10.1093/eurheartj/ehx391
ESC/EACTS GUIDELINES

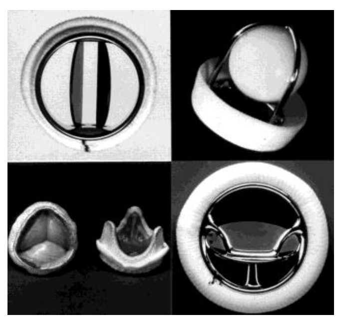
Chlopenní vady – indikace intervence

2017 ESC/EACTS Guidelines for the management of valvular heart disease

The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

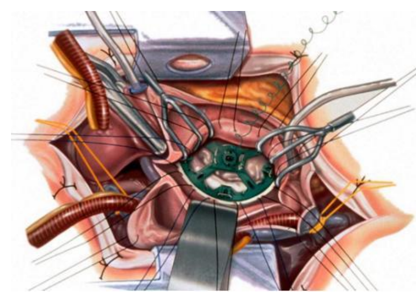
Indications for PMC and mitral valve surgery in clinically significant (moderate or severe) mitral stenosis (valve area ≤1.5 cm^2)

Recommendations	Class[a]	Level[b]
PMC is indicated in symptomatic patients without unfavourable characteristics[c] for PMC.[144,146,148]	I	B
PMC is indicated in any symptomatic patients with a contraindication or a high risk for surgery.	I	C
Mitral valve surgery is indicated in symptomatic patients who are not suitable for PMC.	I	C
PMC should be considered as initial treatment in symptomatic patients with suboptimal anatomy but no unfavourable clinical characteristics for PMC.[c]	IIa	C
PMC should be considered in asymptomatic patients without unfavourable clinical and anatomical characteristics[c] for PMC and: • high thromboembolic risk (history of systemic embolism, dense spontaneous contrast in the LA, new-onset or paroxysmal atrial fibrillation), and/or • high risk of haemodynamic decompensation (systolic pulmonary pressure >50 mmHg at rest, need for major non-cardiac surgery, desire for pregnancy).	IIa	C



Indications for intervention in severe primary mitral regurgitation

Recommendations	Class[a]	Level[b]
Mitral valve repair should be the preferred technique when the results are expected to be durable.	I	C
Surgery is indicated in symptomatic patients with LVEF >30%.[121,131,132]	I	B
Surgery is indicated in asymptomatic patients with LV dysfunction (LVESD ≥45 mm[c] and/or LVEF ≤60%).[122,131]	I	B
Surgery should be considered in asymptomatic patients with preserved LV function (LVESD <45 mm and LVEF >60%) and atrial fibrillation secondary to mitral regurgitation or pulmonary hypertension[d] (systolic pulmonary pressure at rest >50 mmHg).[123,124]	IIa	B



ESC European Society of Cardiology
European Heart Journal (2017) **38**, 2739–2791
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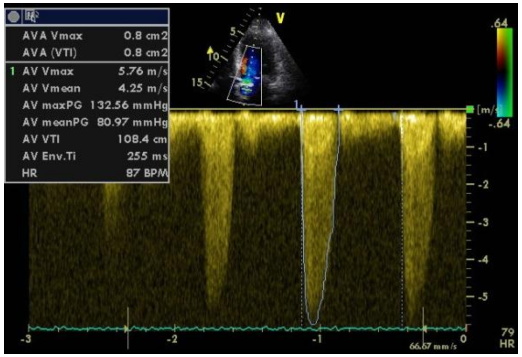
2017 ESC/EACTS Guidelines for the management of valvular heart disease

The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

C) Asymptomatic patients with severe aortic stenosis (refers only to patients eligible for surgical valve replacement)		
SAVR is indicated in asymptomatic patients with severe aortic stenosis and systolic LV dysfunction (LVEF <50%) not due to another cause.	I	C
SAVR is indicated in asymptomatic patients with severe aortic stenosis and an abnormal exercise test showing symptoms on exercise clearly related to aortic stenosis.	I	C
SAVR should be considered in asymptomatic patients with severe aortic stenosis and an abnormal exercise test showing a decrease in blood pressure below baseline.	IIa	C
SAVR should be considered in asymptomatic patients with normal ejection fraction and none of the above-mentioned exercise test abnormalities if the surgical risk is low and one of the following findings is present: • Very severe aortic stenosis defined by a V_{max} >5.5 m/s • Severe valve calcification and a rate of V_{max} progression ≥0.3 m/s/year • Markedly elevated BNP levels (>threefold age- and sex-corrected normal range) confirmed by repeated measurements without other explanations • Severe pulmonary hypertension (systolic pulmonary artery pressure at rest >60 mmHg confirmed by invasive measurement) without other explanation.	IIa	C



Indications for surgery in asymptomatic aortic stenosis

New IIa C recommendation:
Severe pulmonary hypertension (systolic pulmonary artery pressure at rest >60 mmHg confirmed by invasive measurement) without other explanation.

Indications for intervention in asymptomatic severe primary mitral regurgitation

New additional statement:
If pulmonary hypertension (SPAP >50 mmHg at rest) is the only indication for surgery, the value should be confirmed by invasive measurement.

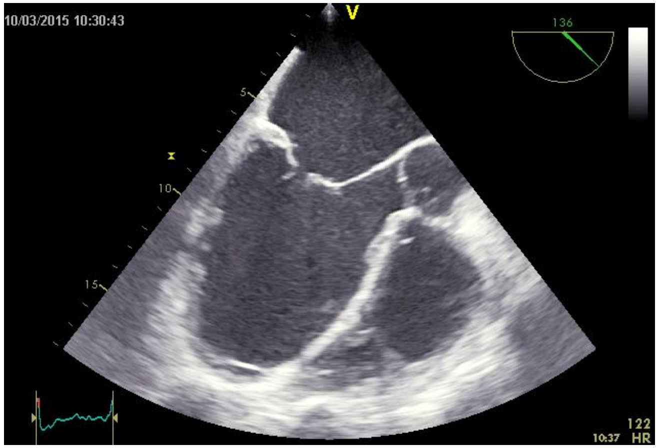
European Heart Journal (2016) **37**, 2129–2200
doi:10.1093/eurheartj/ehw128

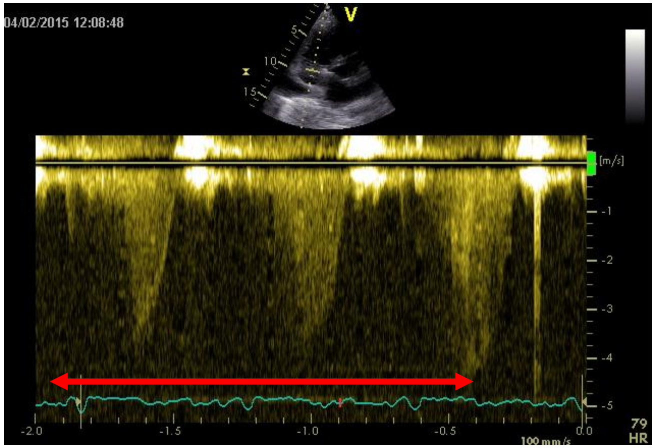
ESC GUIDELINES

Srdeční selhání – indikace LVAD/HTx

2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)





HTx

Patients to consider	End-stage HF with severe symptoms, a poor prognosis, and no remaining alternative treatment options. Motivated, well informed, and emotionally stable. Capable of complying with the intensive treatment required postoperatively.
Contra-indications	Active infection. Severe peripheral arterial or cerebrovascular disease. Pharmacologically irreversible pulmonary hypertension (LVAD should be considered with a subsequent re-evaluation to establish candidacy). Cancer (a collaboration with oncology specialists should occur to stratify each patient as to their risk of tumour recurrence). Irreversible renal dysfunction (e.g. creatinine clearance <30 mL/min). Systemic disease with multi-organ involvement. Other serious co-morbidity with poor prognosis. Pre-transplant BMI >35 kg/m² (weight loss is recommended to achieve a BMI <35 kg/m²). Current alcohol or drug abuse. Any patient for whom social supports are deemed insufficient to achieve compliant care in the outpatient setting.

LVAD

Patients with >2 months of severe symptoms despite optimal medical and device therapy and more than one of the following:
LVEF <25% and, if measured, peak VO_2 <12 mL/kg/min.
≥3 HF hospitalizations in previous 12 months without an obvious precipitating cause.
Dependence on i.v. inotropic therapy.
Progressive end-organ dysfunction (worsening renal and/or hepatic function) due to reduced perfusion and not to inadequate ventricular filling pressure (PCWP ≥20 mmHg and SBP ≤80–90 mmHg or CI ≤2 L/min/m²).
Absence of severe right ventricular dysfunction together with severe tricuspid regurgitation.

Intenzivní péče – vedení terapie

Diagnostické pravostranné srdeční katetrizace a hemodynamické monitorování pomoci plicnicového katetru se používaly na pracovištích intenzivní péče od roku 1970
Před rozvojem echokardiografie se invazivní hemodynamika široce uplatňovala v diferenciální diagnostice systémové hypotenze, šokových stavů, srdečního selhání, dalších závažných onemocnění a také ve vedení vazoaktivní a volumové terapie kriticky nemocných.
Od počátku nového tisíciletí je v intenzivistických kruzích patrný odklon od rutinně prováděné pravostranné srdeční katetrizace v rámci monitorace kriticky nemocných, a je snaha nahradit tuto metodu jinými minimálně invazivními monitorovacími systémy hemodynamiky (PiCCO, LiDCO), nebo zcela neinvazivními např. echokardiografickými přístupy.

- Use of pulmonary artery catheters reported to **decrease from about 6 per 1,000 to 2 per 1,000 medical admissions** in United States from 1993 to 2004 in retrospective record review of Nationwide Inpatient Sample *(JAMA 2007 Jul 25;298(4):423)*
- Use of pulmonary artery catheters reported to **decrease from 5.4% to 3% among patients hospitalized for acute coronary syndromes** from 2000 to 2007 in retrospective review of multinational Global Registry of Acute Coronary Events (GRACE) *(Am Heart J 2009 Aug;158(2):170)*


TELL ME HOW!

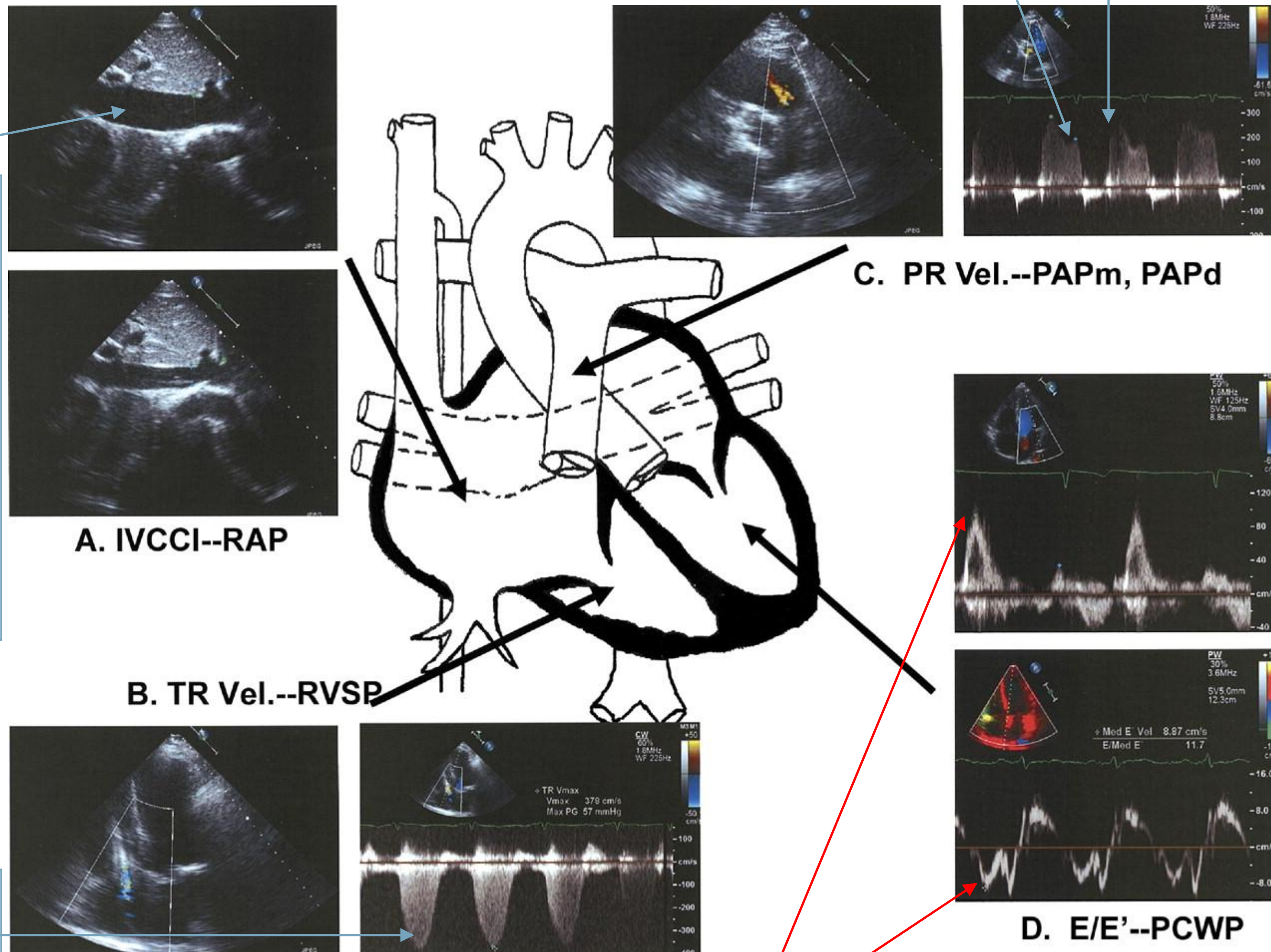
Maximální gradient regurgitace na pulmonální chlopni (PR) predikuje střední tlak v plicnici **(MAP)** .
Endiastolický gradient pulmonální regurgitace predikuje diastolický tlak v plicnici **(DAP)** .

Dolní dutá žíla **(IVC)** , její rozměr a stupeň inspiračního kolapsu predikují tlak v pravé síni **(RAP resp. CVT)**:
IVC <1.2 cm a kolaps 100% = RAP 0 mmHg

IVC 1.2-1.7 cm s >50% kolapsem = RAP 0-5 mmHg

IVC >1.7 cm s >50% kolapsem = RAP 6-10 mmHg; <50% kolapsem = RAP 10-15 mmHg

IVC >1.7 cm s 0% kolapsem = RAP >15 mmHg



Vrcholová systolická rychlost jetu trikuspidální regurgitace **(TR)** predikuje systolický tlak v plicnici **(SAP)**:

Poměr vrcholové systolické rychlosti časného mitrálního toku (E)/časná diastolická rychlost mitrálního anulu Em **(E/Em)** <8 nebo >15 přesně predikuje **PCWP** <15 mmHg resp. >15 mm Hg.

Kirkpatrick JN et al. Echocardiography in Heart Failure: Applications, Utility, and New Horizons. J Am Coll Cardiol 2007;50:381–96

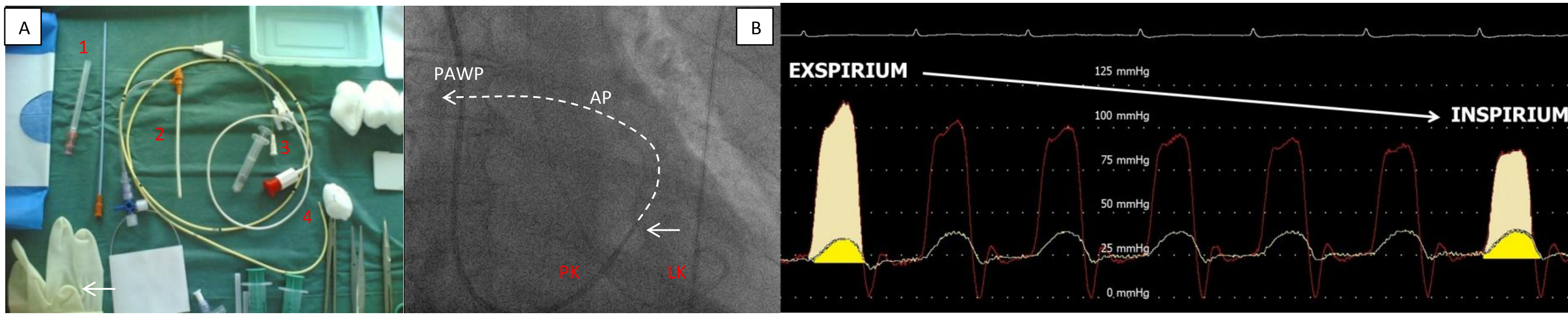
PAWP – LAP - LVED

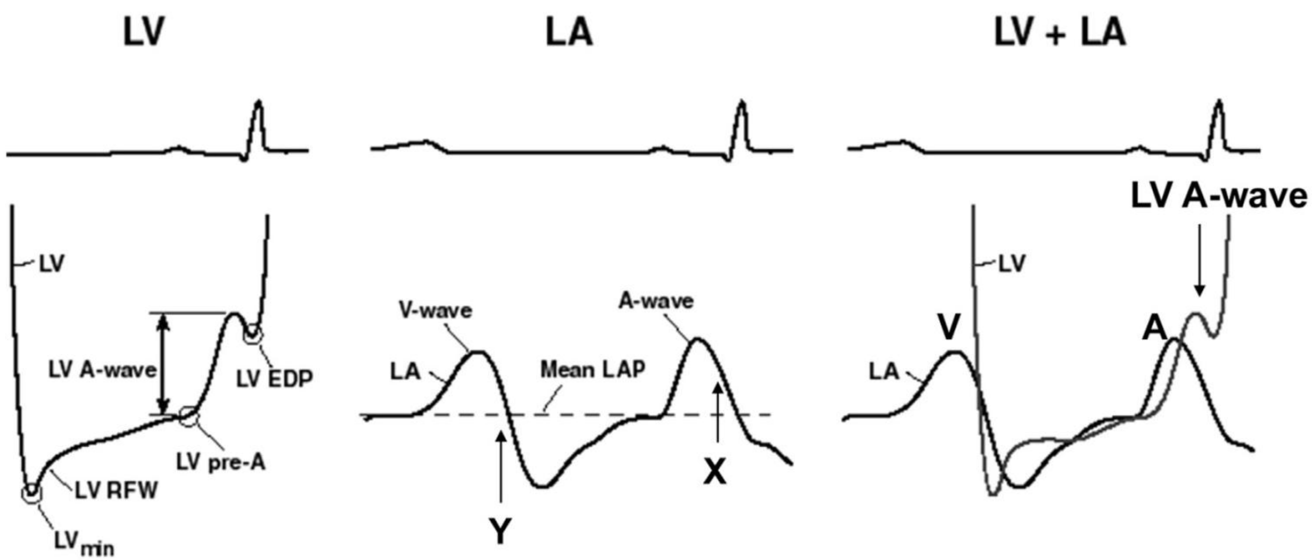
ASE/EACVI GUIDELINES AND STANDARDS

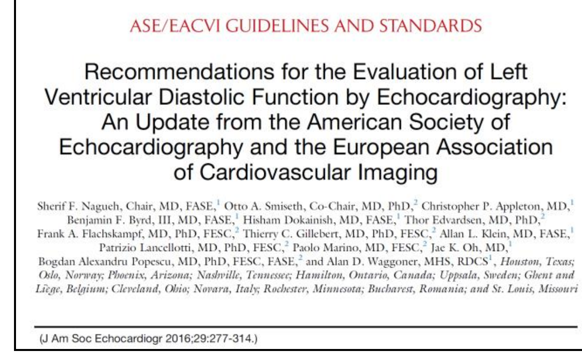
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Sherif F. Nagueh, Chair, MD, FASE,[1] Otto A. Smiseth, Co-Chair, MD, PhD,[2] Christopher P. Appleton, MD,[1] Benjamin F. Byrd, III, MD, FASE,[1] Hisham Dokainish, MD, FASE,[1] Thor Edvardsen, MD, PhD,[2] Frank A. Flachskampf, MD, PhD, FESC,[2] Thierry C. Gillebert, MD, PhD, FESC,[2] Allan L. Klein, MD, FASE,[1] Patrizio Lancellotti, MD, PhD, FESC,[2] Paolo Marino, MD, FESC,[2] Jae K. Oh, MD,[1] Bogdan Alexandru Popescu, MD, PhD, FESC, FASE,[2] and Alan D. Waggoner, MHS, RDCS[1], *Houston, Texas; Oslo, Norway; Phoenix, Arizona; Nashville, Tennessee; Hamilton, Ontario, Canada; Uppsala, Sweden; Ghent and Liège, Belgium; Cleveland, Ohio; Novara, Italy; Rochester, Minnesota; Bucharest, Romania; and St. Louis, Missouri*

(J Am Soc Echocardiogr 2016;29:277-314.)





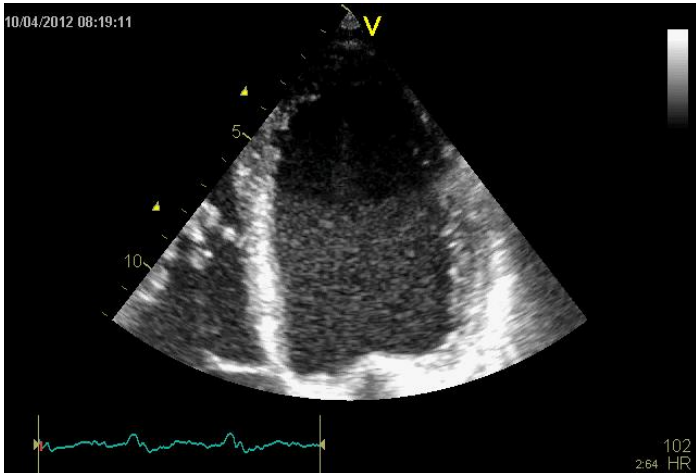

ASE/EACVI GUIDELINES AND STANDARDS

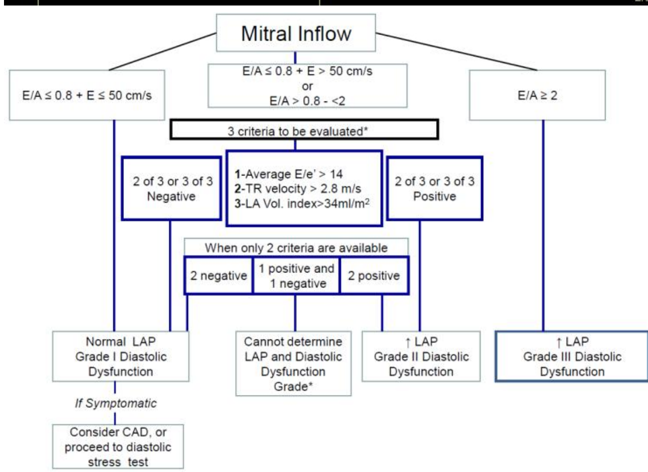
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

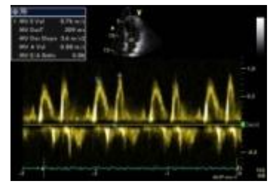
Sherif F. Nagueh, Chair, MD, FASE,[1] Otto A. Smiseth, Co-Chair, MD, PhD,[2] Christopher P. Appleton, MD,[1] Benjamin F. Byrd, III, MD, FASE,[1] Hisham Dokainish, MD, FASE,[1] Thor Edvardsen, MD, PhD,[2] Frank A. Flachskampf, MD, PhD, FESC,[2] Thierry C. Gillebert, MD, PhD, FESC,[2] Allan L. Klein, MD, FASE,[1] Patrizio Lancellotti, MD, PhD, FESC,[2] Paolo Marino, MD, FESC,[2] Jae K. Oh, MD,[1] Bogdan Alexandru Popescu, MD, PhD, FESC, FASE,[2] and Alan D. Waggoner, MHS, RDCS[1], *Houston, Texas; Oslo, Norway; Phoenix, Arizona; Nashville, Tennessee; Hamilton, Ontario, Canada; Uppsala, Sweden; Ghent and Liège, Belgium; Cleveland, Ohio; Novara, Italy; Rochester, Minnesota; Bucharest, Romania; and St. Louis, Missouri*

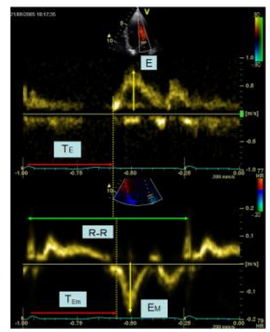
(J Am Soc Echocardiogr 2016;29:277-314.)

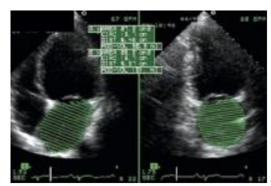
Odhad PAWP – LAP - LVED

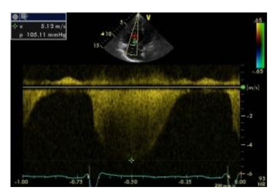


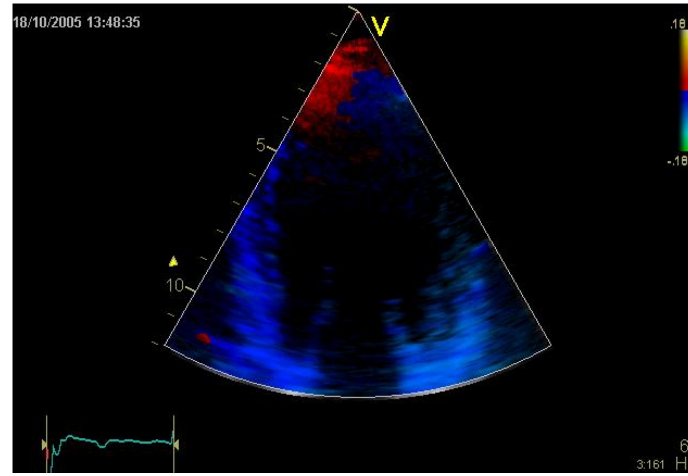


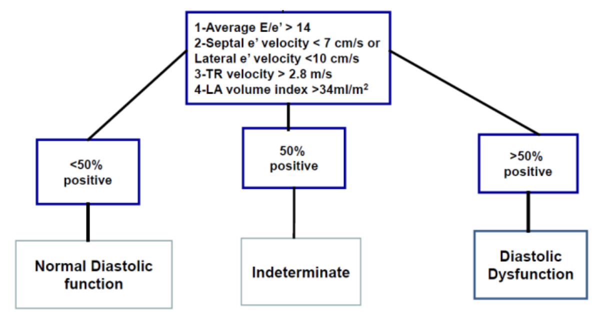












Snížená EF LK

Normální EF LK

Odhad tlaku v pravé síni

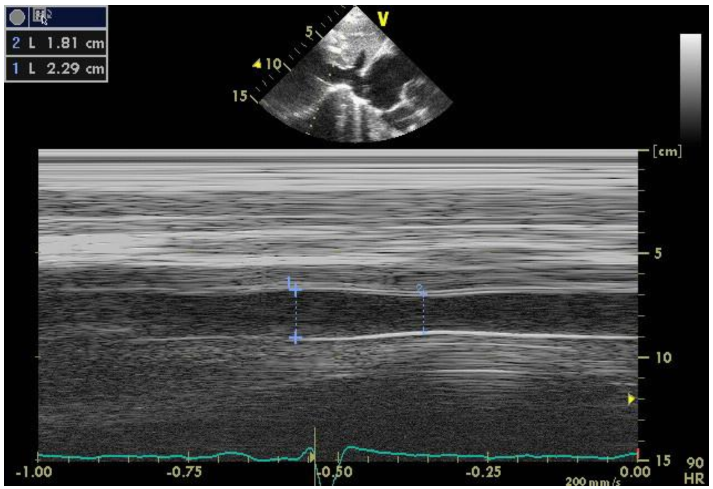
GUIDELINES AND STANDARDS

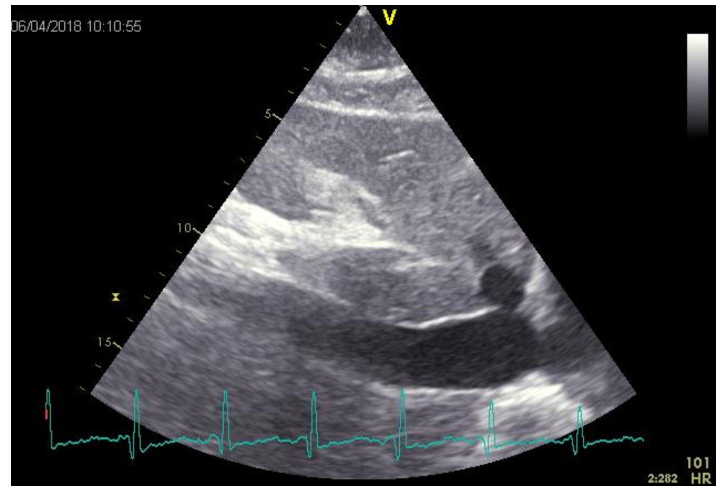
Guidelines for the Echocardiographic Assessment of the Right Heart in Adults: A Report from the American Society of Echocardiography

Endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography

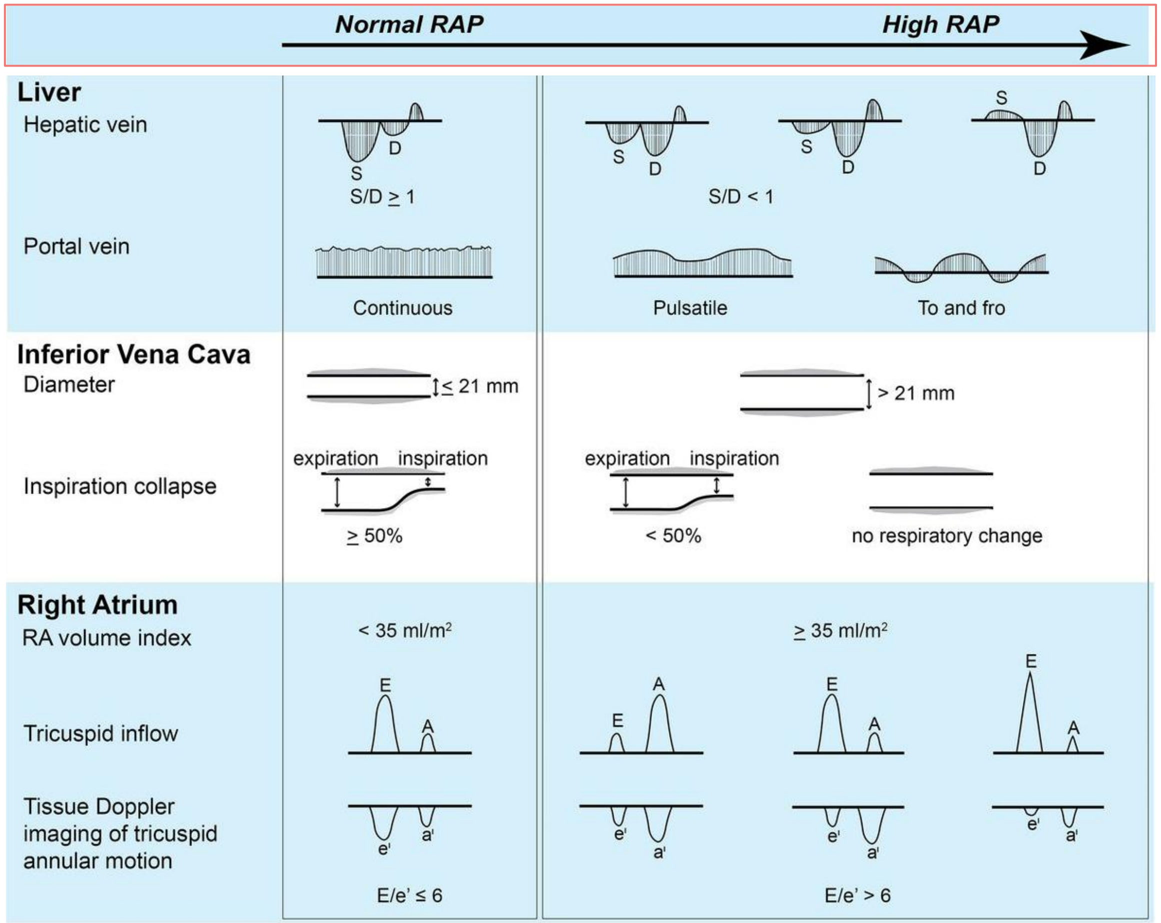
Lawrence G. Rudski, MD, FASE, Chair, Wyman W. Lai, MD, MPH, FASE, Jonathan Afilalo, MD, Msc, Lanqi Hua, RDCS, FASE, Mark D. Handschumacher, BSc, Krishnaswamy Chandrasekaran, MD, FASE, Scott D. Solomon, MD, Eric K. Louie, MD, and Nelson B. Schiller, MD, *Montreal, Quebec, Canada; New York, New York; Boston, Massachusetts; Phoenix, Arizona; London, United Kingdom; San Francisco, California*

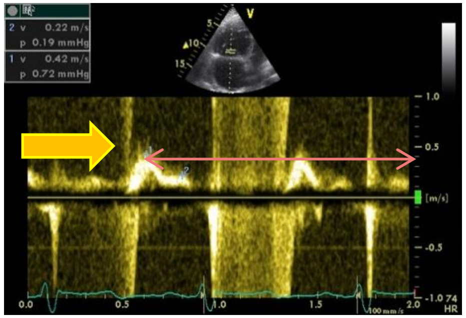
(J Am Soc Echocardiogr 2010;23:685-713.)

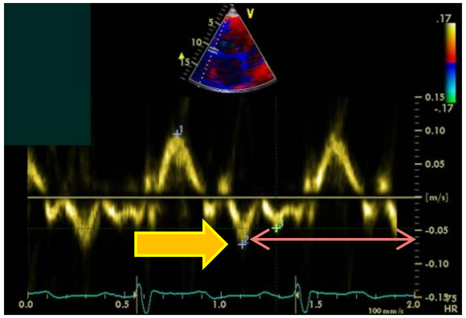


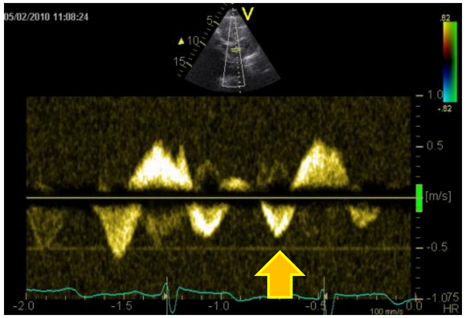


- IVC diameter ≤2.1 cm that collapses >50% with a sniff suggests **normal RA pressure** of 3 mmHg (range, 0-5 mm Hg).
- IVC diameter 2.1 cm that collapses <50% with a sniff suggests **high RA pressure** of 15 mmHg (range, 10-20 mm Hg).
- IVC diameter and collapse do not fit this paradigm, an **intermediate value** of 8 mm Hg (range, 5-10 mm Hg) may be used.
- TV E/E_T >6 suggests **high RA pressure**









W.H. Wilson Tang, and Takeshi Kitai JCHF 2016;4:683-686

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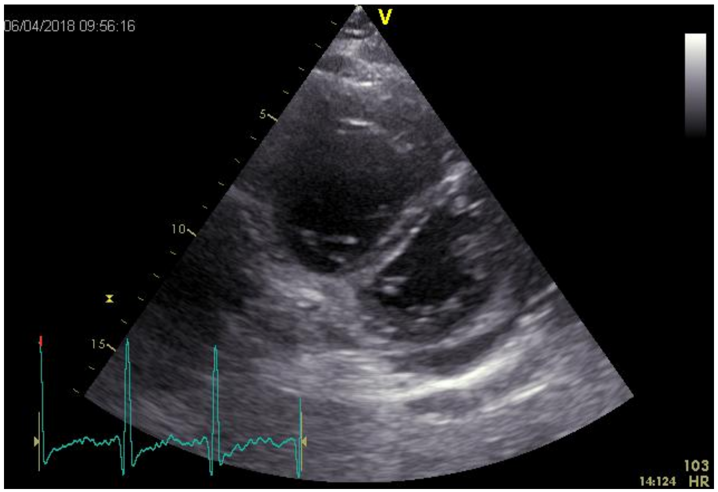
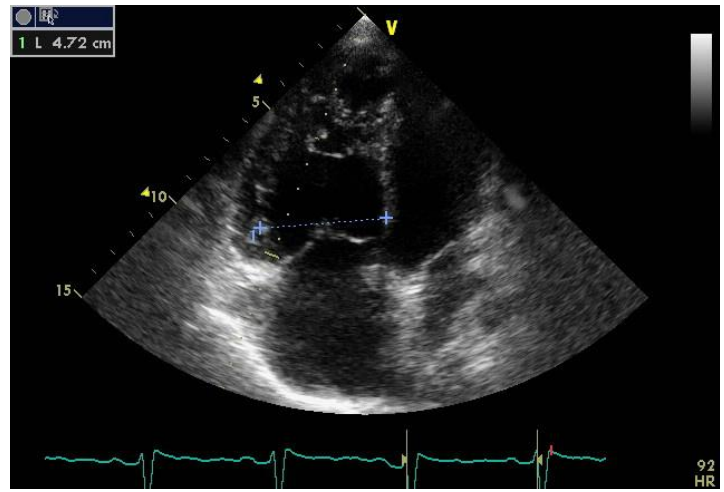
(J Am Soc Echocardiogr 2010;23:685-713.)

Geometrie a morfologie PK





- Visual assessment of ventricular septal curvature looking for a D-shaped pattern in systole and diastole should be used to help in the **diagnosis of RV volume and/or pressure overload**.
- Although a D-shaped septum is not diagnostic in RV overload, with its presence, additional emphasis should be placed on the confirmation, as well as determination, of the etiology and severity of right-sided pressure and/or volume overload.

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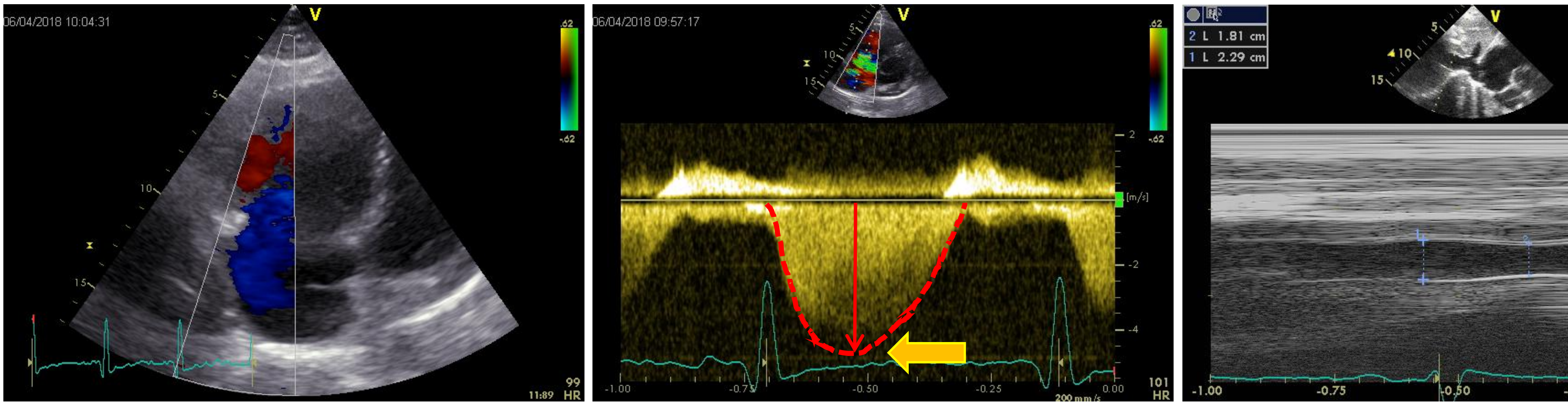
(J Am Soc Echocardiogr 2010;23:685-713.)

Odhad systolického tlaku v AP



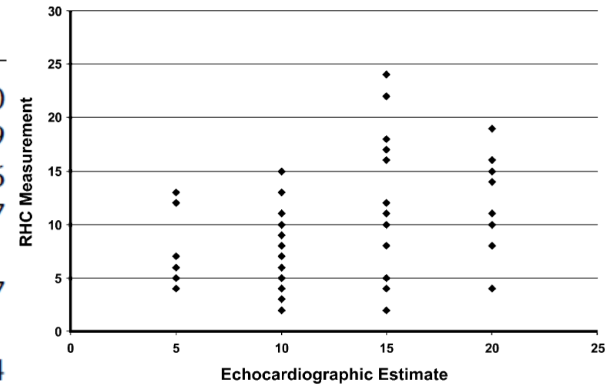
- The normal cutoff value for invasively measured **mean PA pressure** is 25 mmHg. In the echolab, SPAP is more commonly measured and reported. **RVSP** can be determined from peak TR jet velocity, using Bernoulli equation and combining this value with an estimate of the RA pressure: RVSP = $4V^2$ + RAP.
- In cases in which RVSP is elevated, **obstruction at RVOT or PV should be excluded**, especially in patients with congenital heart disease.
- **Normal resting values** are usually defined as a peak TR gradient of 2.8-2.9 m/s or a peak systolic pressure of 35/36 mm Hg, assuming an RA pressure of 3-5 mm Hg. This value may increase with age and increasing BSA.

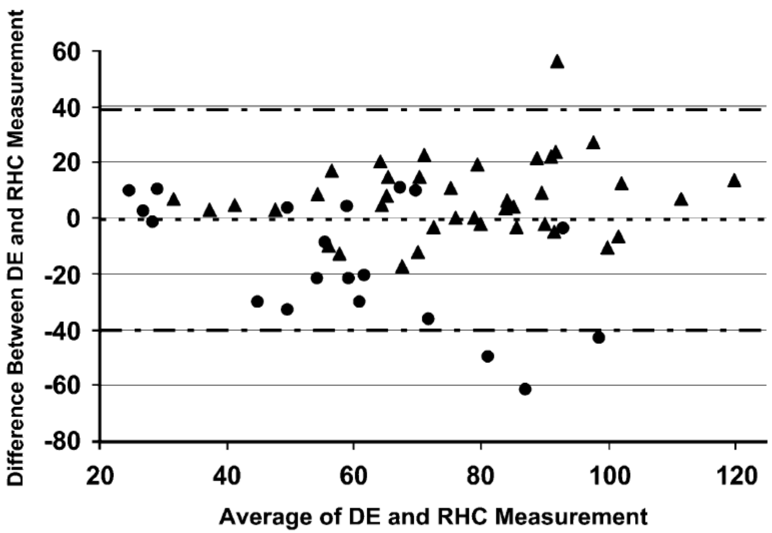
Accuracy of Doppler Echocardiography in the Hemodynamic Assessment of Pulmonary Hypertension

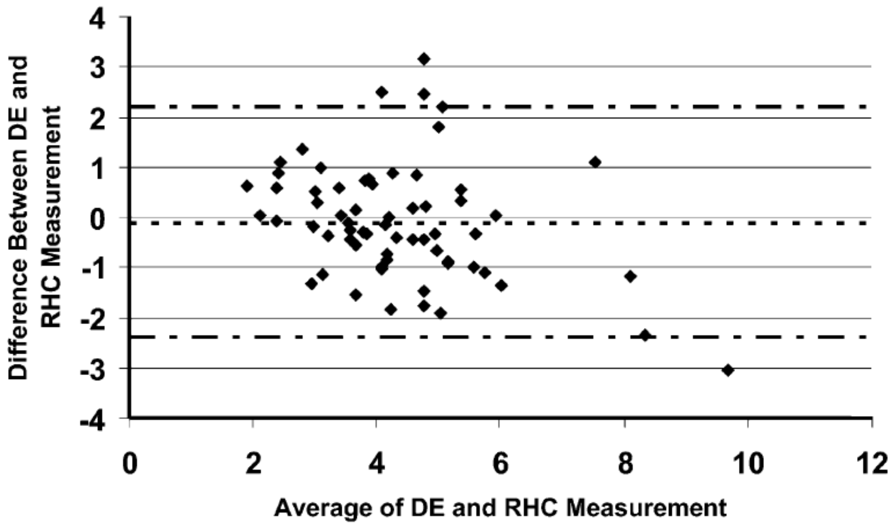
Micah R. Fisher[1]*, Paul R. Forfia[2†], Elzbieta Chamera[2], Traci Housten-Harris[1], Hunter C. Champion[2], Reda E. Girgis[1], Mary C. Corretti[2], and Paul M. Hassoun[1]

[1]Division of Pulmonary and Critical Care Medicine; [2]Division of Cardiology, Department of Medicine, Johns Hopkins University, Baltimore, Maryland

Right-Heart Catheterization	n	Mean	SD
RAP, mm Hg	65	9.4	5.0
PASP, mm Hg	65	68.5	23.9
mPAP, mm Hg	65	41.4	14.6
CO, L/min	65	4.4	1.7
Echocardiogram			
RAP, mm Hg	65	12.4	4.7
RVSP, mm Hg	59	70.2	25.1
CO, L/min	64	4.3	1.4







Micah R. Fisher et al. Am J Respir Crit Care 2009, Med Vol 179. pp 615–621,

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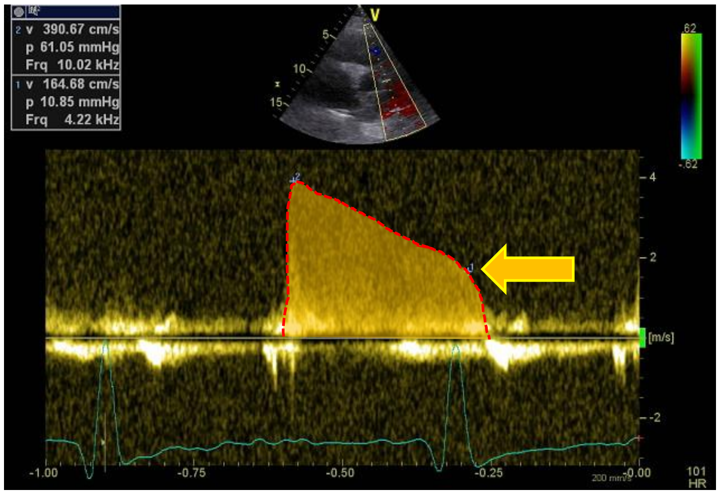
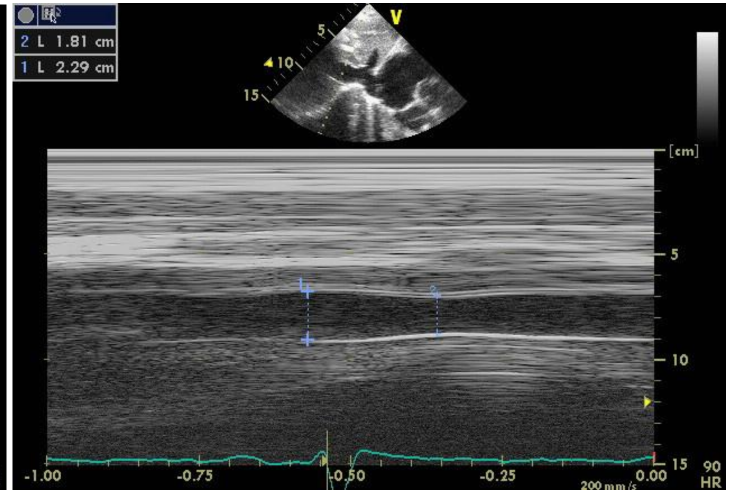
(J Am Soc Echocardiogr 2010;23:685-713.)

Odhad diastolického tlaku v AP





- PADP can be estimated from the velocity of the end-diastolic pulmonary regurgitant jet using the modified Bernoulli equation: [PADP = 4 (end-diastolic pulmonary regurgitant velocity)2 + RA pressure].

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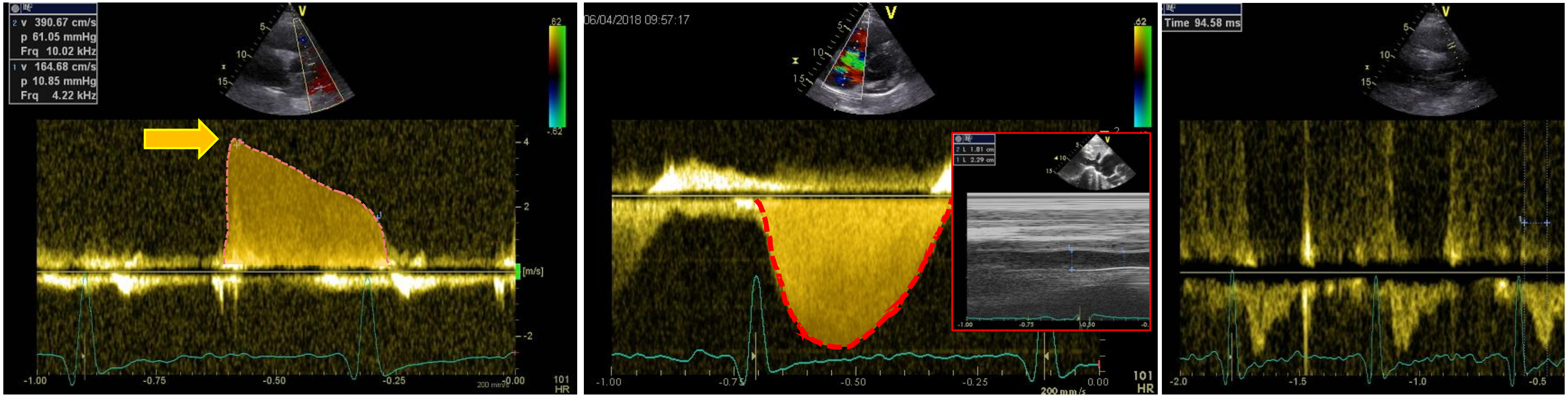
(J Am Soc Echocardiogr 2010;23:685-713.)

Odhad středního tlaku v AP



- **Standard formula mean PA pressure** = 1/3(SPAP) + 2/3(PADP).

- Mean PA pressure may also be estimated by using **PAT measured by pulsed Doppler of the pulmonary artery** in systole, whereby mean PAP = 79 x (0.45 AT). In patients with PAT <120 ms, the formula for mean PAP is 90 x (0.62 AT) performed better.
- The mean PA pressure can be estimated as 4 x (early **PR velocity**) 2+ estimated RAP.

- An additional recently described method adds estimated RA pressure to the **velocity-time integral of the TR jet** to calculate a mean systolic pressure.

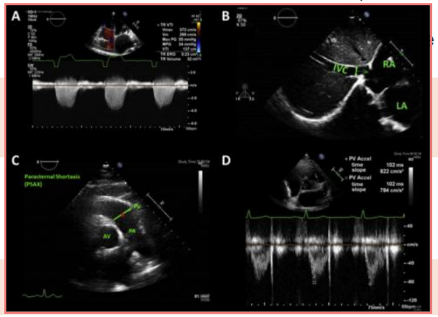
Srovnání metod

Echocardiographic Estimation of Mean Pulmonary Artery Pressure: A Comparison of Different Approaches to Assign the Likelihood of Pulmonary Hypertension

Kristian Hellenkamp, MD, Bernhard Unsöld, MD, Sitali Mushemi-Blake, PhD, Ajay M. Shah, MD, Tim Friede, PhD, Msc, Gerd Hasenfuß, MD, and Tim Seidler, MD, *Göttingen and Regensburg, Germany; and London, United Kingdom*

J Am Soc Echocardiogr 2018;31:89-98

Method	Publication	Number of patients included in this study (*n*)	Maximal time frame between RHC and echocardiography	Study design	Formula/abbreviation
Methods for estimating PAPm					
TR-derived methods					
RA-RV mean gradient (TR Pmean) + RAP* (obtained by tracing the TR time-velocity integral added to the estimated RAP)	Aduen *et al*[4]	102	Simultaneously	Prospective	PAPm = TR Pmean + RAP
	Er *et al*[5]	164	Within 120 min	Prospective	
Empirical; using PAPsys	Chemla *et al*[6,†]	31	—[‡]	Prospective	PAPm = 0.61 × PAPsys + 2
	Steckelberg *et al*[9,†]	307 (RHC), 109 (echocardiography)	Within 1 mo	Retrospective	PAPm = 0.61 × PAPsys + 1.95
	Amsallem *et al*[10,†]	307	Within 5 d	Retrospective	PAPm = 0.60 × PAPsys + 2.1
	Friedberg *et al*[8]	17	Within 30 d	Retrospective	PAPm = 0.69 × PAPsys − 0.22
	Syyed *et al*[7]	65	—[#]	Retrospective	PAPm = 0.65 × PAPsys + 0.55
PAT-derived method					
Empirical; using PAT	Dabestani *et al*[11]	39	Within 6 d	Not specified,	PAT ≥120 msec: PAPm = 79 − (0.45 × PAT) PAT <120 msec: PAPm = 90 − (0.62 × PAT)
Other echocardiographic parameters that may correlate with invasive PAPm					
RA-RV maximal velocity (TR Vmax) (obtained by tracing the TR time-velocity integral without addition of RAP)	ESC[1]	No study specified within the guideline			TR Vmax
RA-RV maximal gradient (TR Pmax) added to estimated RAP	Rudski *et al*[3]	No study specified			PAPsys = TR Pmax + RAP
PAT (without empirical calculation of PAPm)	Dabestani et al[11]	39	Within 6 d	Prospective	PAT
	Granstam *et al*[12]	29	Within 2 d	Retrospective	
	Yared *et al*[14]	371	—[§]	Retrospective and prospective (*n* = 100)	
	Kitabatake *et al*[15]	33	Within 1 wk	Not specified, probably prospective	



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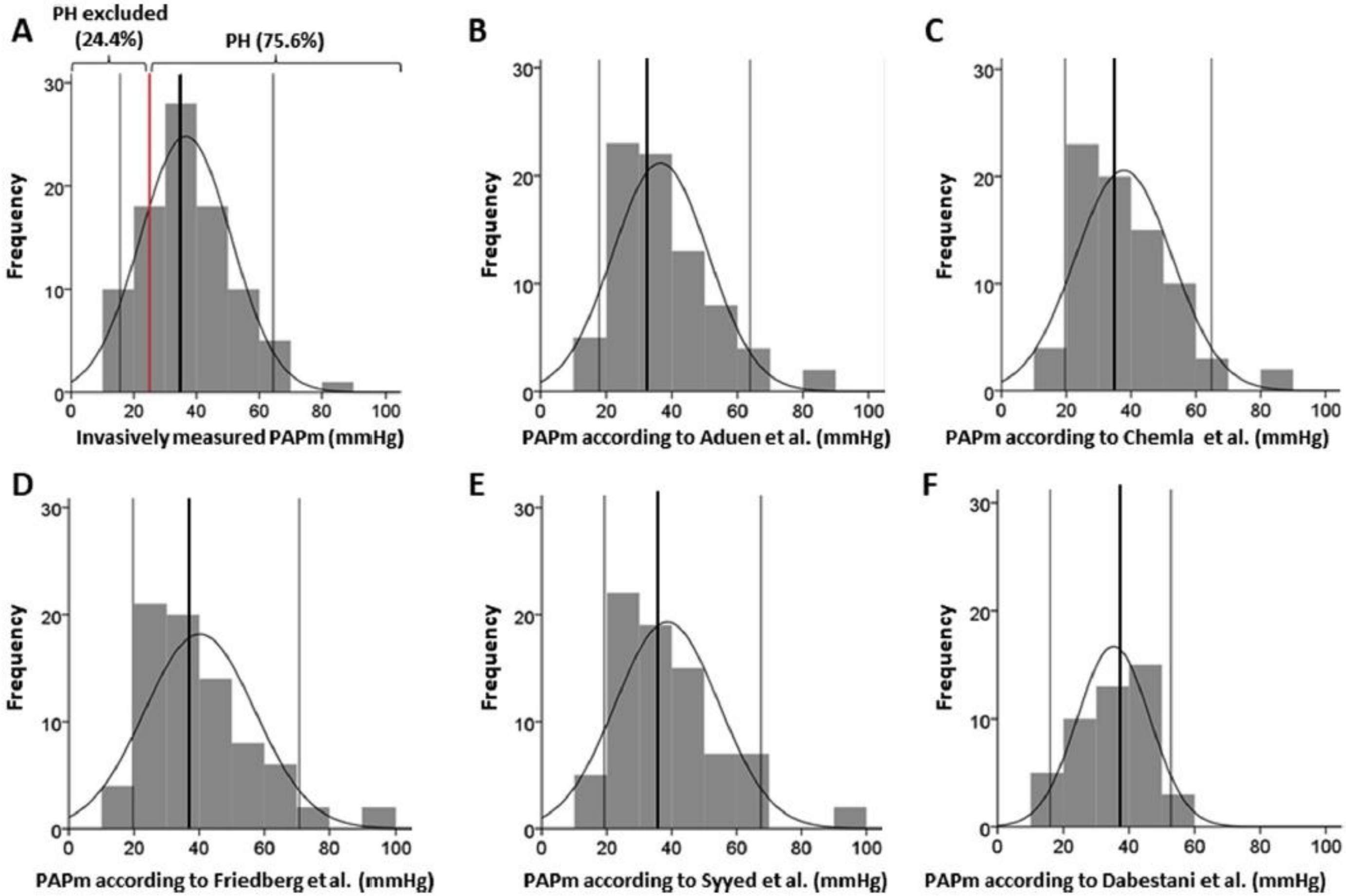

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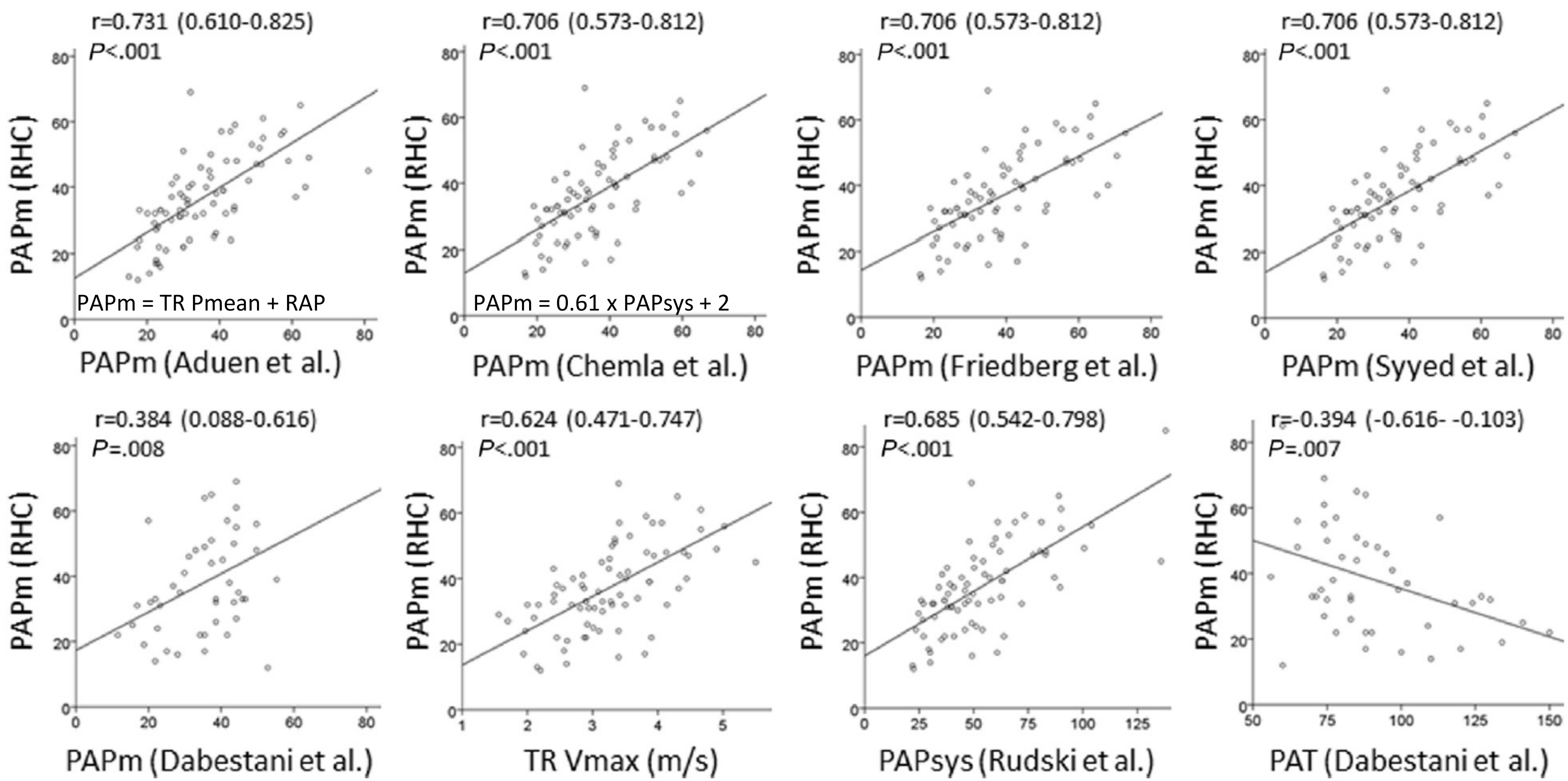

PAT ≥120 ms: PAPm = 79 (0.45 x PAT)
PAT <120 ms: PAPm = 90 (0.62 x PAT)

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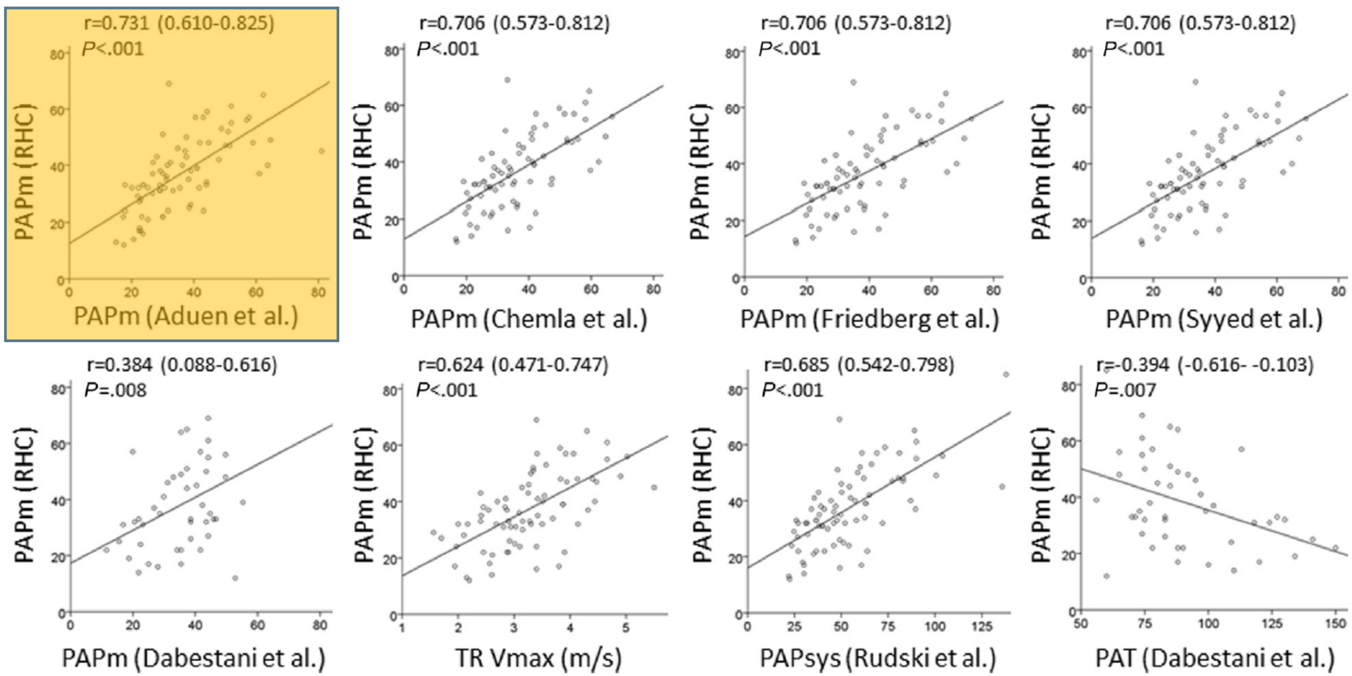
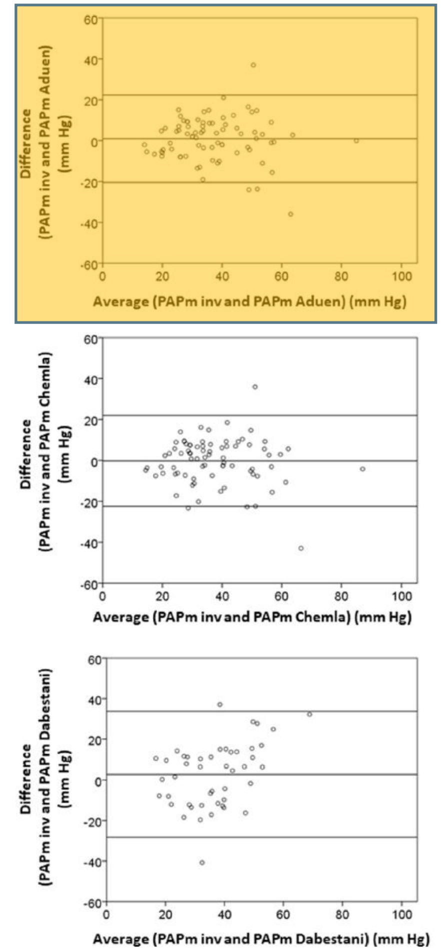
PAPm = TR Pmean + RAP

PAPm = 0.61 x PAPsys + 2





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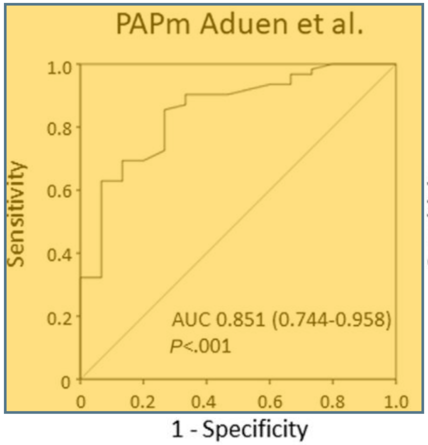
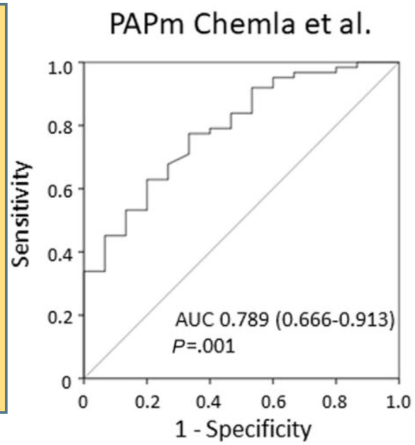
Srovnání přesnosti



PAPm = TR Pmean + RAP



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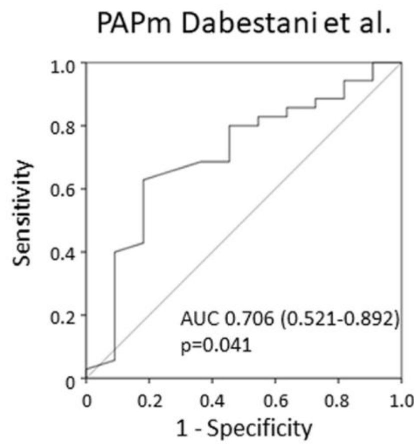

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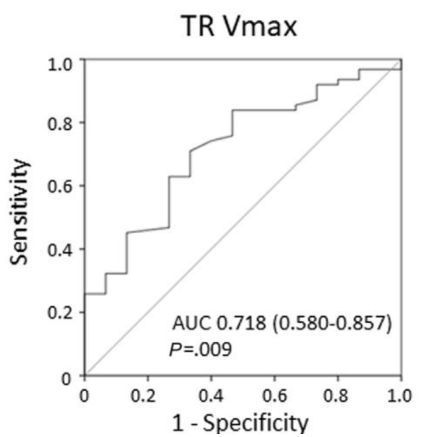
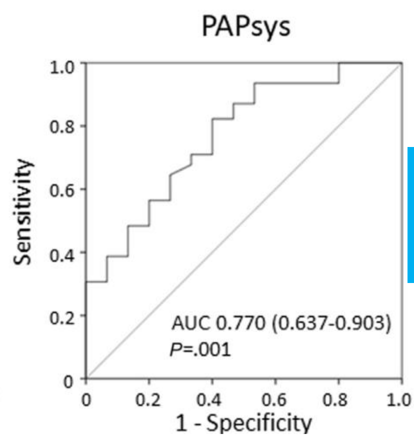
PAT <120 ms: PAPm = 90 (0.62 x PAT)





TR Vmax: sensitivity 0.81; specificity 0.53
PAPm: sensitivity 0.87; specificity 0.67

Závěry

Echokardiograficky stanovené odhady tlakových poměrů v plicnici/LAP jsou standardem **screeningových** aktivit PAH/CTEPH, **prognostické** stratifikace PE, **diagnostického** algoritmu srdečního selhání a **indikačních** úvah u chlopenních vad

Klíčové je **kvalitativní** stanovení pravděpodobnosti PH a její etiologie (prekapilární vs. postkapilární)

Kvantitativní a tedy specifickou léčbu PAH indikující měření tlaků by mělo být provedeno na základě precizně provedení invazivního hemodynamického vyšetření, které je „zlatým standardem“…

…i přesto, že v akutní medicíně je plicnicový katetr je (téměř) zcela opuštěn.


IT IS BORING!