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Diastolic function
Flow, function and
haemodynamics

2012 ESC Guidelines HF

Table I Diagnosis of heart failure

The diagnosis of HF-REF requires three conditions to be satisfied:

1. Symptoms typical of HF
2. Signs typical of HF^a
3. Reduced LVEF

The diagnosis of HF-PEF requires four conditions to be satisfied:

1. Symptoms typical of HF
2. Signs typical of HF^a
3. Normal or only mildly reduced LVEF and LV not dilated
4. Relevant structural heart disease (LV hypertrophy/LA enlargement) and/or diastolic dysfunction (see Section 4.1.2)

RVH (Rob), ° 1933

- **abdominal obesity**
- **COPD, GOLD stage II**
- **1985: hypertension**
- **2003: NSTEMI inferior.
BMS stent RCA and CX.
Moderately reduced EF (0,47)**
- **2005: ulcerative colitis**

Consult, Jan 19th 2012

- **2011: edema of the legs, which I attributed to venous insufficiency and/or nifedipine treatment**
- **Edema persists. Cannot tolerate compression stockings because of latex hypersensitivity. Rob had to adapt his shoes to swollen feet.**
- **Complaints about shortness of breath when he walks swiftly or when he walks upstairs. NYHA II**
- **No angina**
- **Colitis is stable under medication**

Drug therapy

- **Cardiovascular drugs**

- Aspirin 80 mg QD
- Simvastatine 40 mg QD
- Hypertensive therapy
 - Perindopril 5 mg and HCT 12,5 mg QD
 - Bisoprolol 10 mg QD
 - Nifedipine (SR) 30mg QD
- Furosemide 40 mg 0,5 QD

- **Other drugs**

- Omeprazole 20mg, Azathioprine 100mg, tamsulozine 4mg

Clinical examination

- **181 cm 96 kg; BMI 29; waist 109 cm**
- **BP = 137/71 mmHg, PP=66mmHg, HR 56pm**
- **No elevated jugular vein pulsations**
- **Moderate edema of both legs and feet**
- **No abdominal organomegaly**
- **Clear lungs, normal heart sounds, no heart murmur**

Born: 30.03.1933
Age: 79 Y
Sex: Male
Height: 180.0 cm
Weight: 96.0 kg
BP: - / - mmHg

HR 72 /min
Axis
P 37°
QRS -5°
T 69°

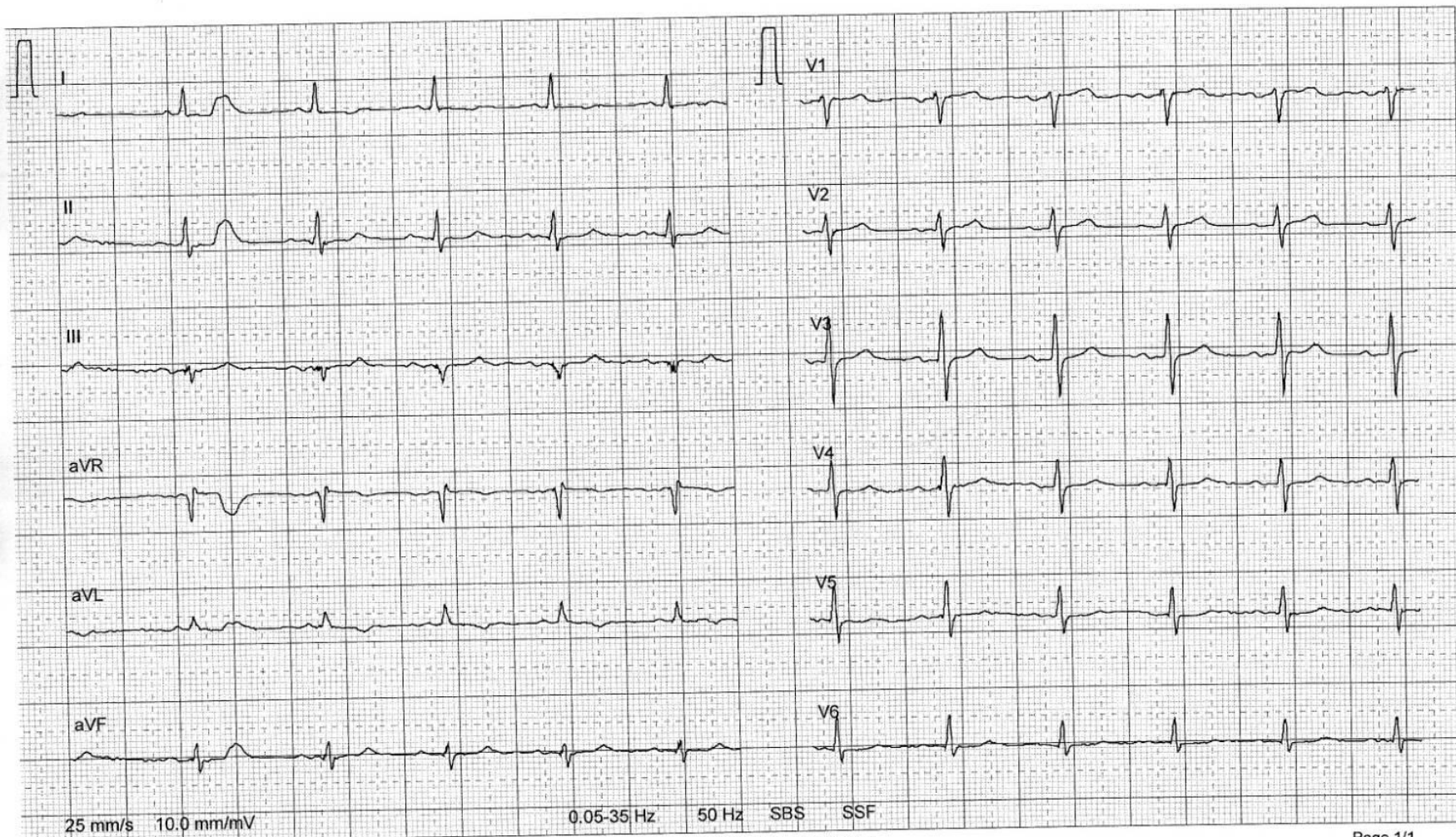
Interv:
RR 830 ms
P 134 ms
PQ 184 ms
QRS 86 ms
QT 400 ms
QTc 439 ms

Interpretation

SINUS RHYTHM
LEFTWARD AXIS
LOW LIMB LEAD VOLTAGE
T ABNORMALITY IN HIGH LATERAL LEADS

Med:
Rem:

Validated by

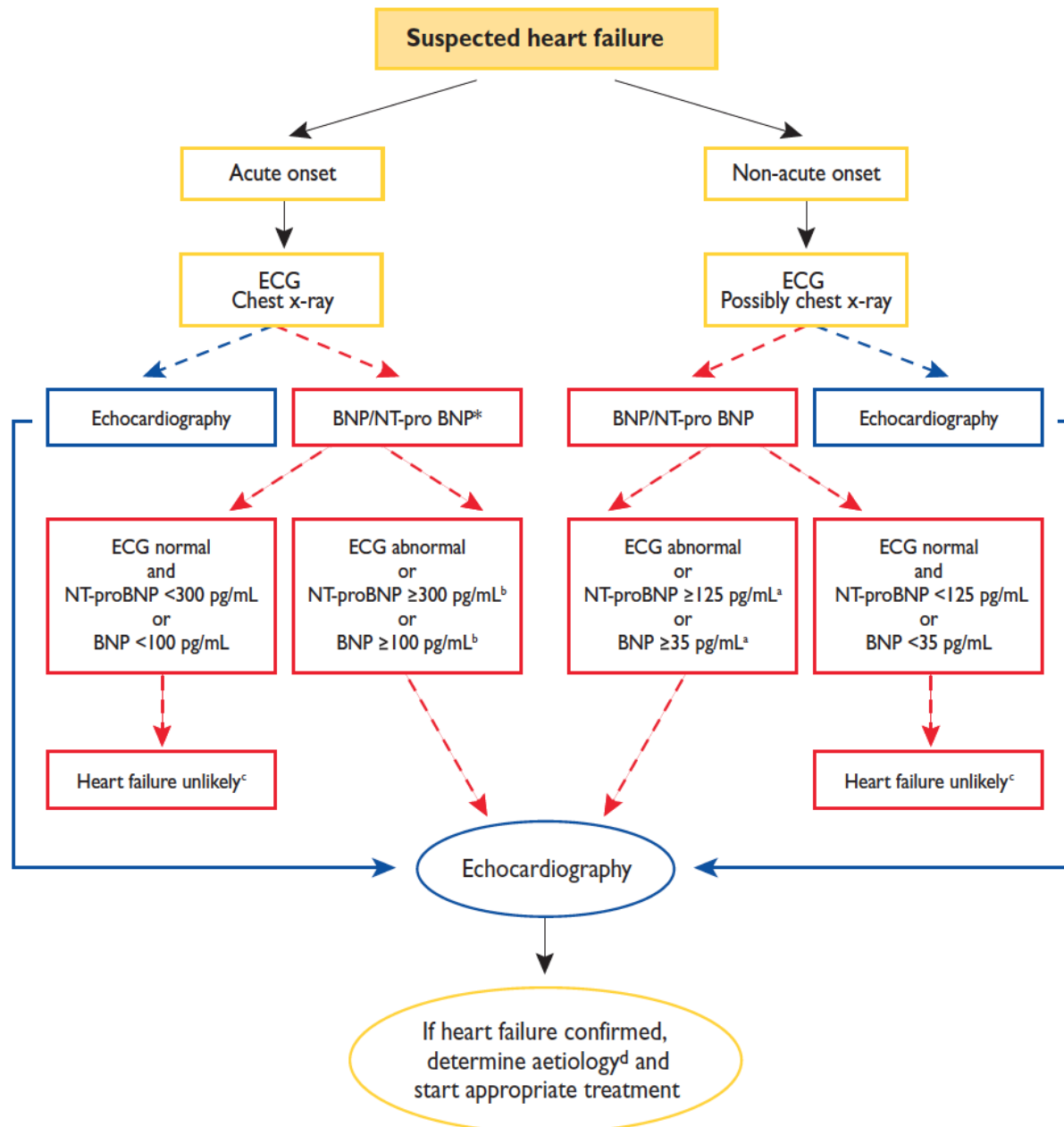


Exercise ECG

- **Protocol 25/10/1**
- **Peak workIQD 105 watt (74% of the prediction)**
- **Peak HR 105 pm; peak BP 160/100 mmHg**
- **The test was interrupted because of exhaustion**
 - No angina
 - No dyspnea
 - No repolarisation disturbances

I. What is the tentative diagnosis?

- 1. Edema of the legs attributed to venous insufficiency and/or nifedipine treatment. Dyspnea is not objectivated.**
- 2. We need additional investigations to sort out if edema and dyspnea are symptoms and signs of HF**
- 3. This definitely is heart failure and has to be treated as such**



Laboratory data

- **Hb = 14,8 gr/dl**
- **FG = 0,097 g/l and Hba1c 6,0% or 42 mmol/mol**
- **TC=169; HDL-C=76; LDL-C=80; TG=61 (mg/dl)**
- **Normal liver tests including gamma-GT**
- **Ureum 52 mg%; creatinine 1,23 mg%; UA 8,3 mg%**
 - GFR 57 ml/min (CKD stage 3A)
- **Sodium 143 meq/l and potassium 4,8 meq/l**

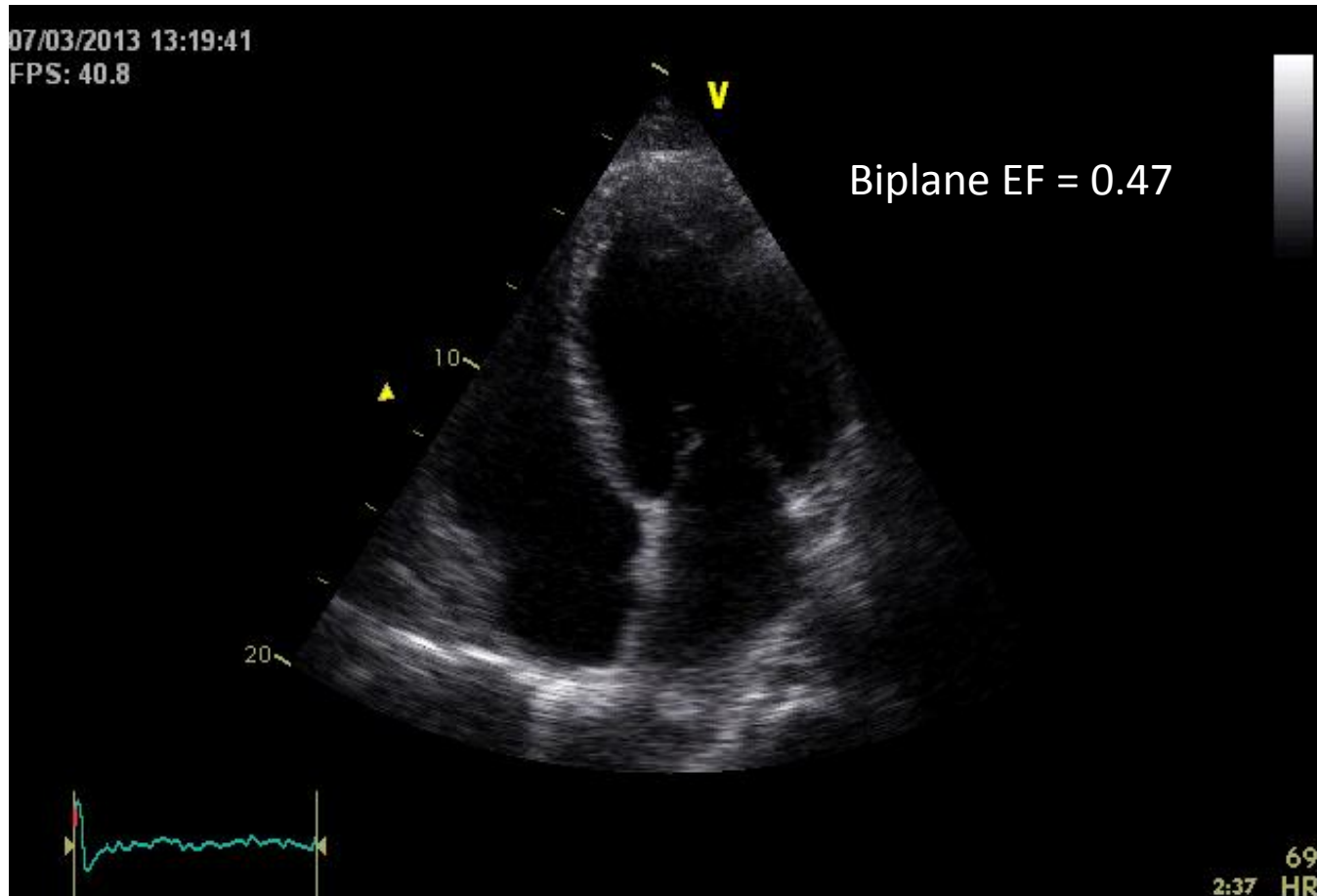
Laboratory data (1)

- **CRP = 0,10 mg% or 10 mg/l**
- **TSH = 0,345 mcU/ml**

Laboratory data (2)

- **CRP = 0,10 mg% or 10 mg/l**
- **TSH = 0,345 mcU/ml**
- **NT-pro-BNP = 465 pg/ml**

Apical 4C view



General measurements relevant for diastolic function: key points

- ▶ LV mass, optimally with three dimensional echocardiography. Scale LV mass for BSA (m^2) or for body height ($g/m^{1.7}$) depending on the clinical question
- ▶ LA volume. Scale LA volume accordingly
- ▶ Pulmonary artery systolic pressure and venous pressures

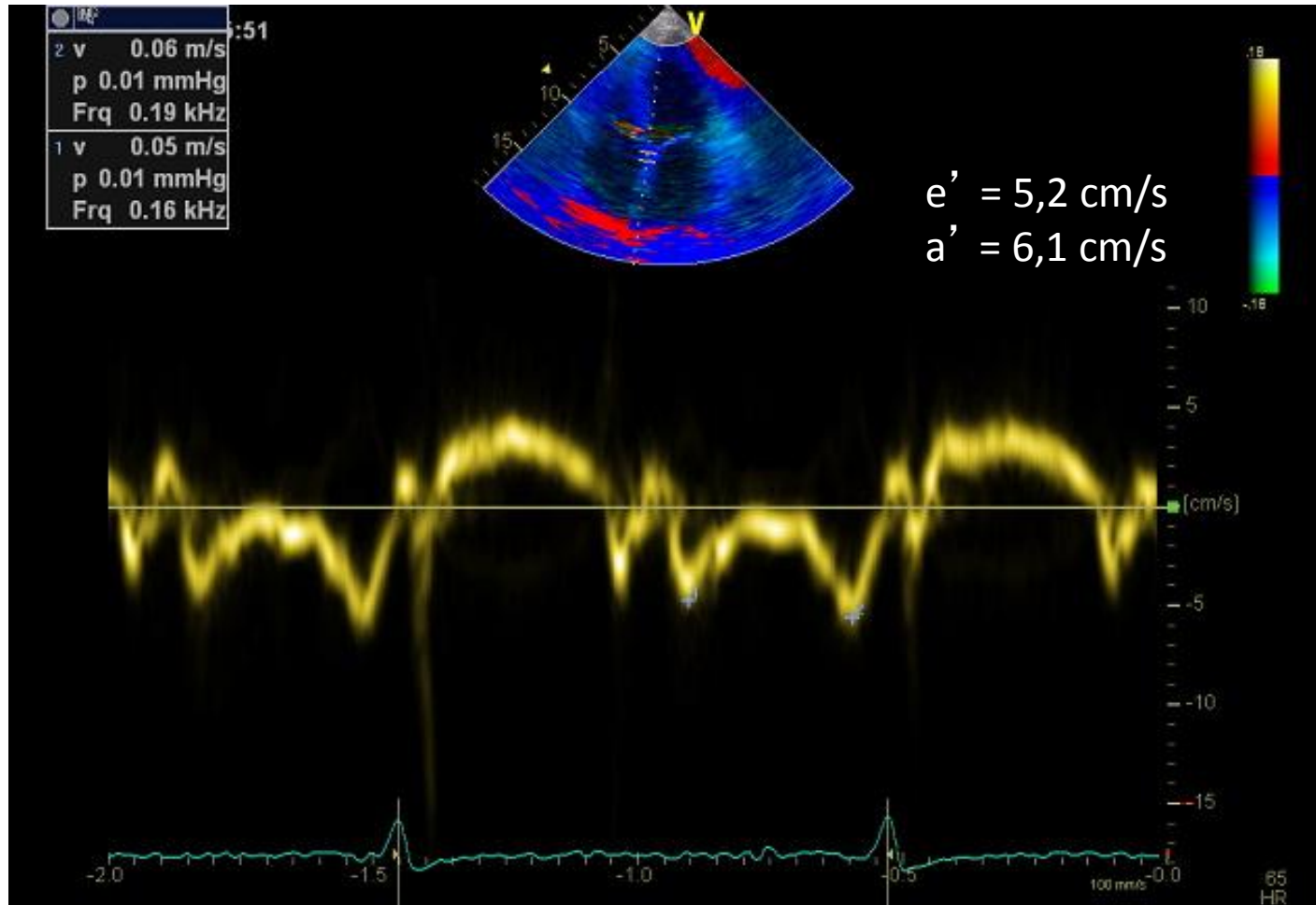
Echocardiography

- **LV mass index ($<115 \text{ gr/m}^2$) = $168,74 \text{ gr/m}^2$**
- **RWT ($0,32-0,42$) = $0,45$**
- **LAV index ($<34 \text{ ml/m}^2$) = 58 ml/m^2**
- **No tricuspid regurgitation recorded**
- **Vena cava ($<1,5 \text{ cm}$): max $1,8 \text{ cm}$ with respiratory variation**

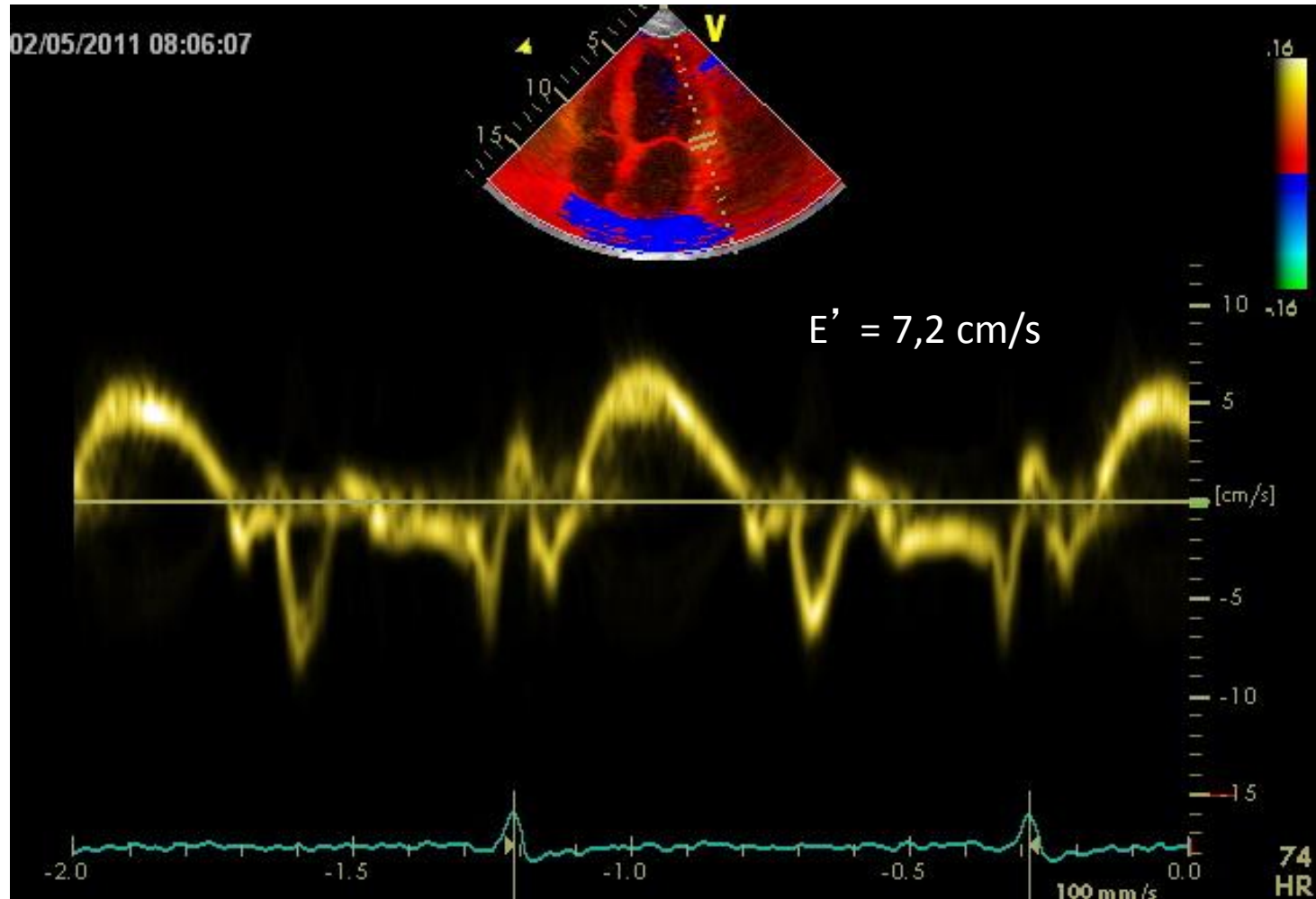
Measurements of diastolic function: key points

- ▶ Annular motion during rapid filling (e') at the septal and lateral annulus.
 - Septal and lateral e' values are averaged
 - In selected cases septal or lateral e' is not a reliable marker of diastolic function
 - E' is reduced in all degrees of diastolic dysfunction
- ▶ The mitral inflow signal
The mitral inflow signal varies with varying filling pressures and is the best parameter of filling pressures when consecutive examinations are considered in a given patient
Mitral inflow patterns include normal, impaired relaxation, pseudo-normal and restrictive signal

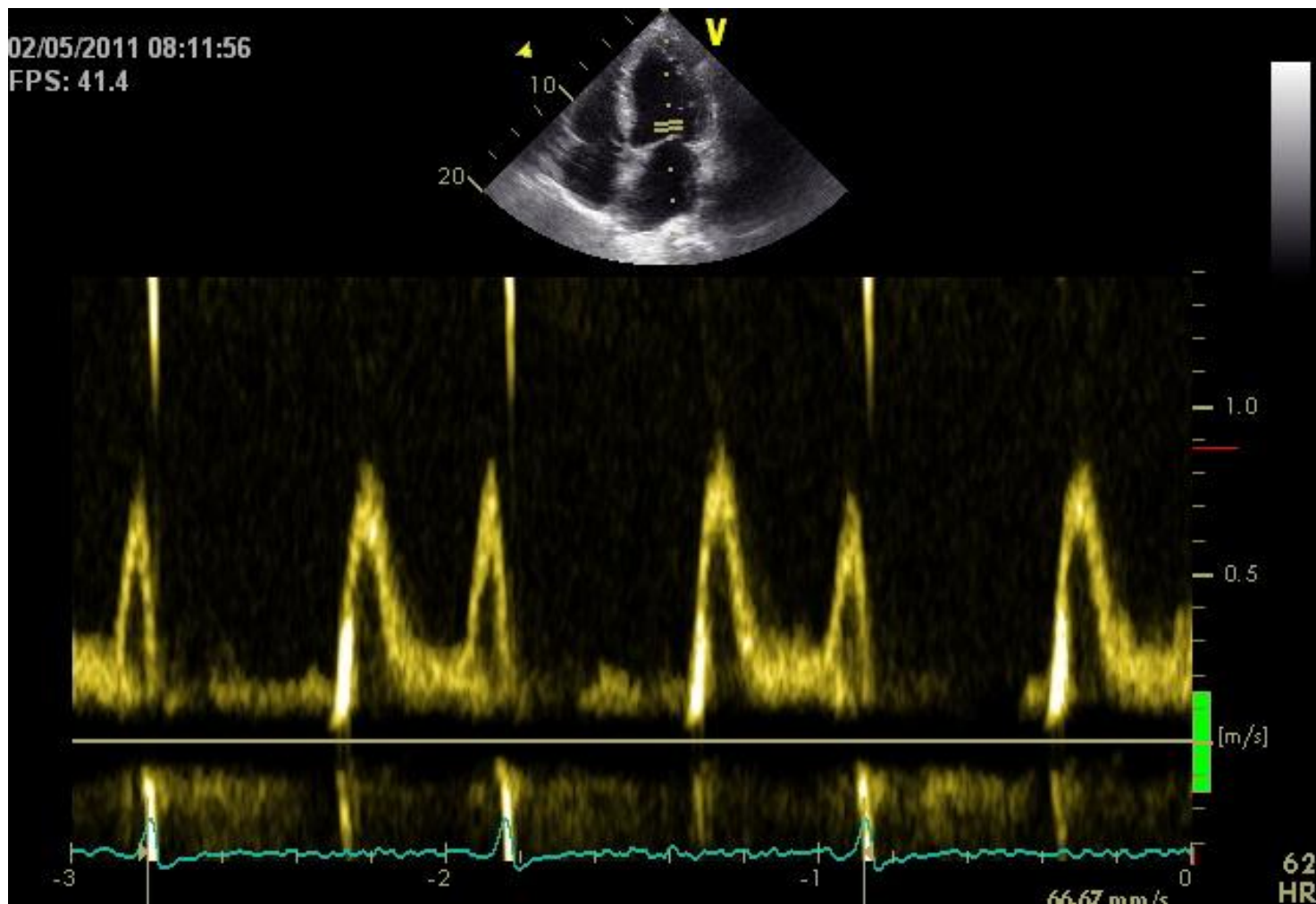
Septal annulus



Lateral annulus

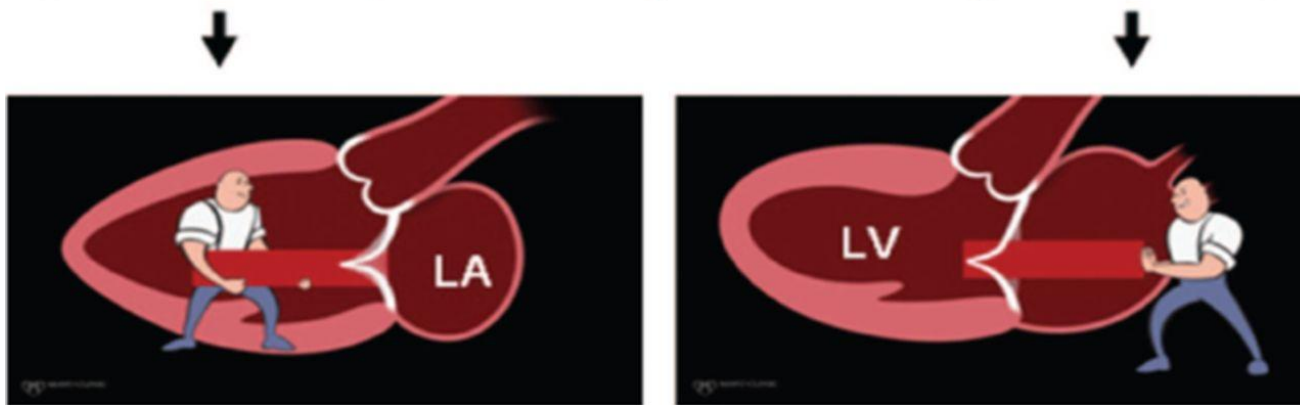
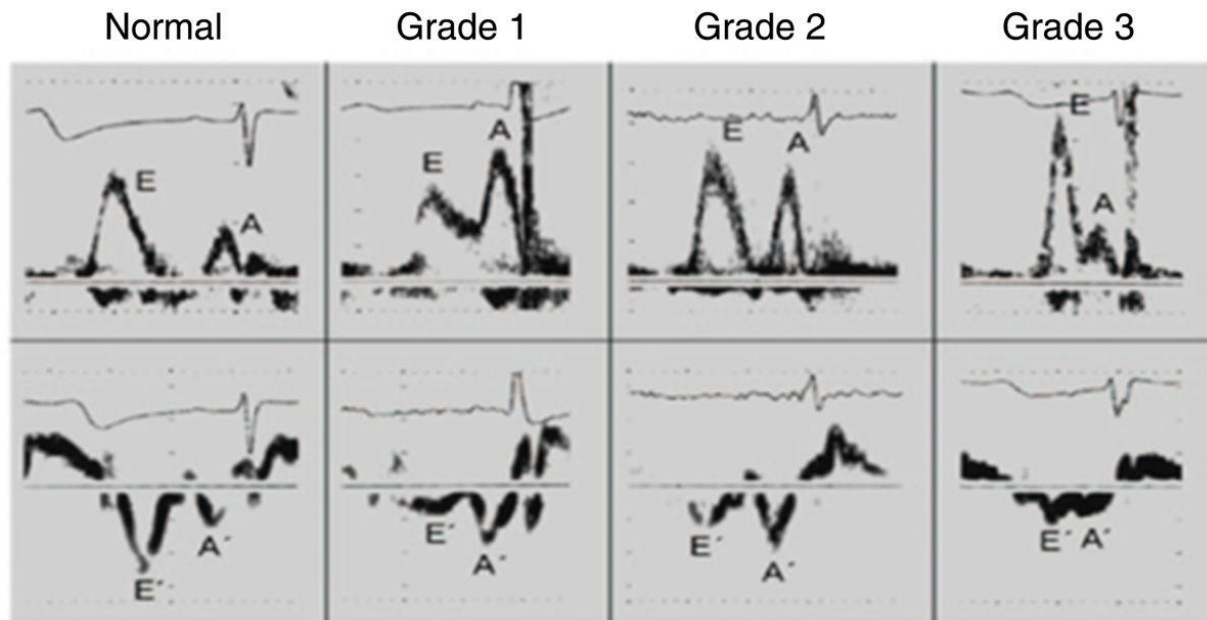


Mitral inflow



Rob's data

- **Septal e' = 5,2 cm/s**
- **Lateral e' = 7,2 cm/s**
- **Mitral E = 88 cm/s**
- **Mitral A = 78 cm/s**
- **Computations:**
 - $E/A = 1,3$
 - E/e' septal = 17
 - E/e' lateral = 12
 - E/e' mean = 14,6



Oh, JK, Park, SJ, Nagueh, SF.

Established and novel clinical applications of diastolic function assessment by echocardiography. *Circ Cardiovasc Imaging*. 2011 Jul;4(4):444-55. doi: 10.1161/CIRCIMAGING.110.961623.

Table 1 Grades of diastolic dysfunction

Normal subjects	Normal/athletes/ constriction	Grade 1 Impaired relaxation	Grade 2 Pseudonormal filling	Grade 3 Restrictive filling
Septal $e' \geq 8$	Septal $e' \geq 8$	Septal $e' < 8$	Septal $e' < 8$	Septal $e' < 8$
Lateral $e' \geq 10$	Lateral $e' \geq 10$	Lateral $e' < 10$	Lateral $e' < 10$	Lateral $e' < 10$
LA $< 34 \text{ ml/m}^2$	LA $\geq 34 \text{ ml/m}^2$	LA $\geq 34 \text{ ml/m}^2$	LA $\geq 34 \text{ ml/m}^2$	LA $\geq 34 \text{ ml/m}^2$
		E/A < 0.8	E/A 0.8–1.5	E/A ≥ 1.5
		DT $> 200 \text{ ms}$	DT 160–200 ms	DT $< 160 \text{ ms}$
		Average E/ $e' \leq 8$	Average E/ $e' 9–12$	Average E/ $e' \geq 13$
		Ar-A $< 0 \text{ ms}$	Ar-A $\geq 30 \text{ ms}$	Ar-A $\geq 30 \text{ ms}$
		Valsalva $\Delta E/A < 0.5$	Valsalva $\Delta E/A \geq 0.5$	Valsalva $\Delta E/A \geq 0.5$

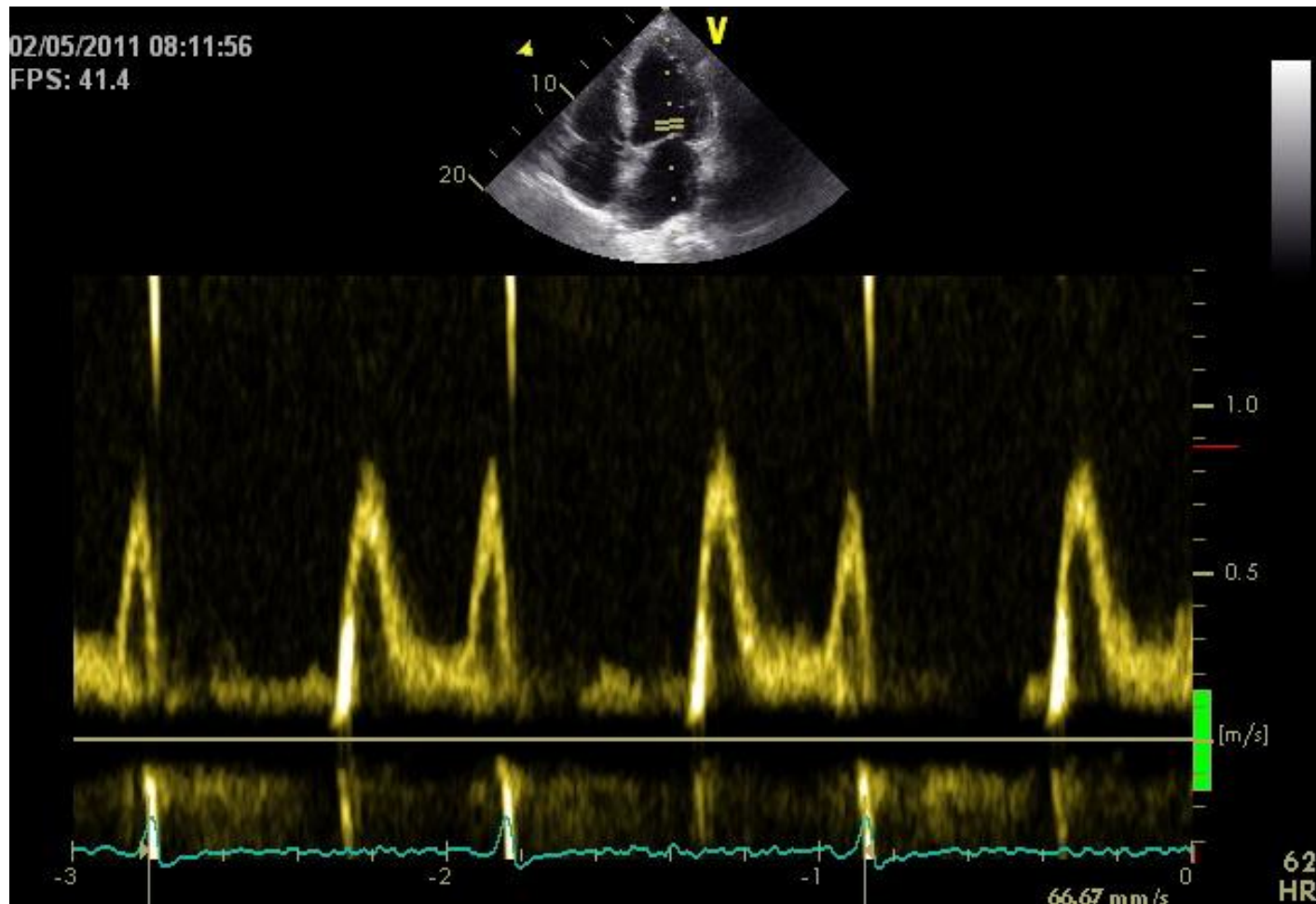
Modified after Nagueh *et al.*,² with permission.

DT, deceleration time; LA, left atrium; see text for explanation of other abbreviations.

Grading of diastolic dysfunction: key points

- ▶ The presence or absence of diastolic dysfunction relies on the annular velocity e' and the size of the left atrium.
- ▶ Once diastolic dysfunction is deemed present, the mitral inflow and the ratio E/e' allow the distinction between grade 1 (impaired relaxation), 2 (pseudo-normal filling) and 3 (restrictive filling).
- ▶ In case of uncertainty, the pulmonary vein signal or the mitral inflow signal during the Valsalva manoeuvre may help to classify.

Before Valsalva



During Valsalva manoeuvre

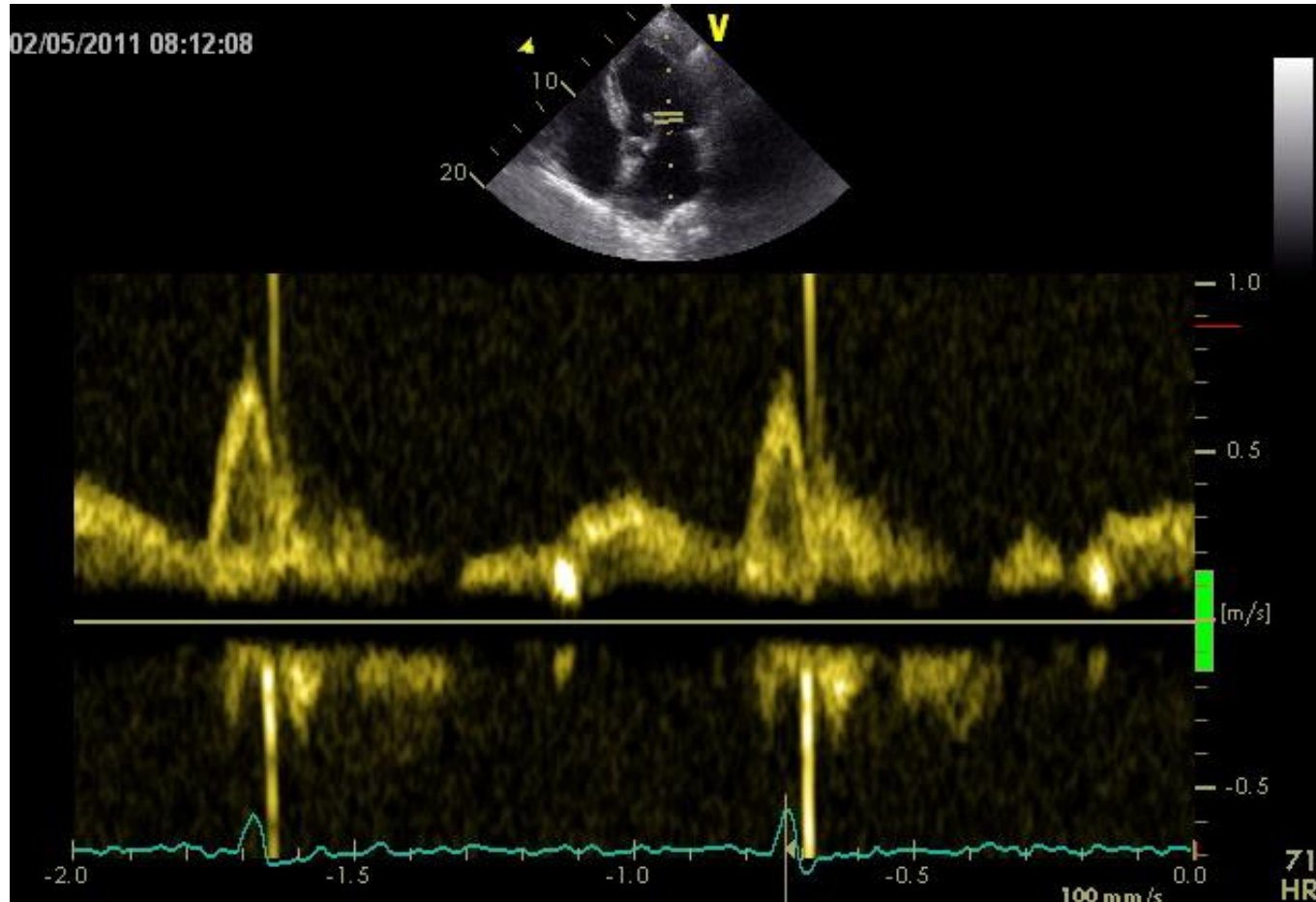


Table 2 Evaluation of filling pressures in patients

Normal LA pressures	Elevated if...	Elevated LA pressures
Septal $E/e' \leq 8$	Septal E/e' 9–14	Septal $E/e' \geq 15$
Lateral $E/e' \leq 8$	Lateral E/e' 9–11	Lateral $E/e' \geq 12$
Average $E/e' \leq 8$	Average E/e' 9–12	Average $E/e' \geq 13$
Mitral $E/A < 1$ $E \leq 50$ cm/s	Mitral E/A 1–2 Mitral $E/A < 1$ and $E > 50$ cm/s	Mitral $E/A > 2$

Elevated if LA volume ≥ 34 ml/m², $E/Vp \geq 2.5$, pulmonary vein flow S/D < 1 , pulmonary Ar-A ≥ 30 ms, Valsalva $\Delta E/A \geq 0.5$, pulmonary artery pressure > 35 mm Hg. Please note that this table is not applicable to normal subjects, as defined in table 1.

Modified after Nagueh *et al*,² with permission.

LA, left atrium; see text for explanation of other abbreviations.

Evaluation of filling pressures with echocardiography and cardiac Doppler: key points

- ▶ Is feasible in most patient populations including severe systolic heart failure
- ▶ Is mainly based on the E/e' ratio and the mitral inflow signal
- ▶ Requires additional measurements when values of E/e' are in the intermediary range or when the mitral inflow is (pseudo)-normal
- ▶ In selected disease states E/e' is not reliable as a predictor of filling pressures

HEART FAILURE

Echo-Doppler assessment of diastole: flow, function and haemodynamics

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