An Integrated Approach to Study LV Diastolic Function

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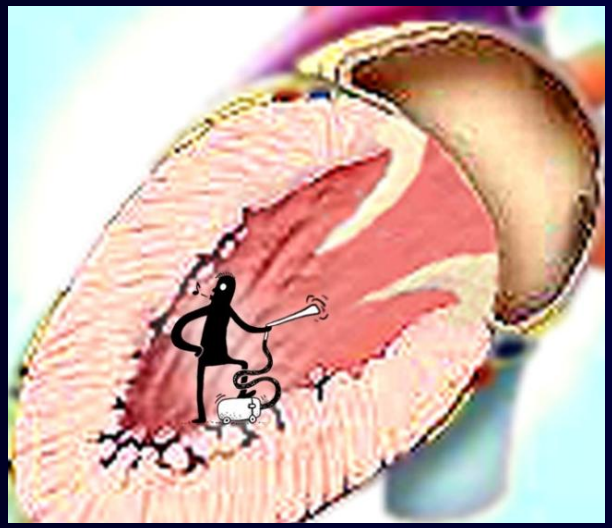
LV Diastolic Dysfunction

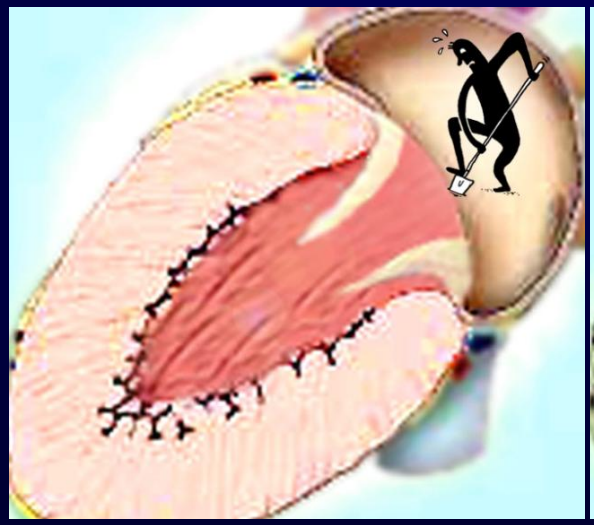
impaired relaxation
(early diastole)

↓ compliance
(mid – late diastole)

LV resistance to filling

LV filling pressures must increase

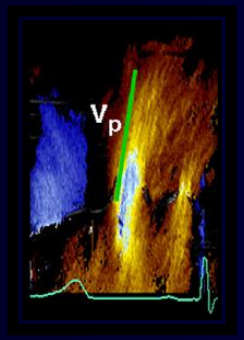


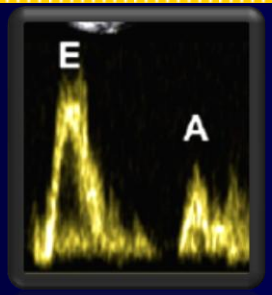


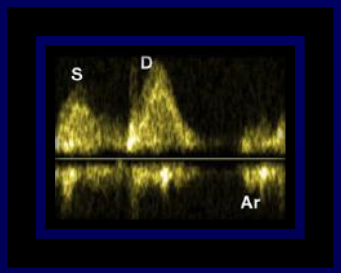
Normal diastolic function

LV diastolic dysfunction

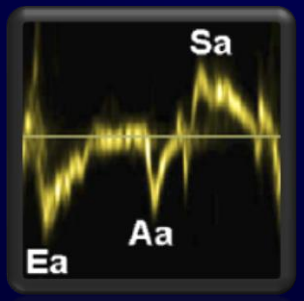
Echocardiography in LV Diastolic Dysfunction







Doppler indices



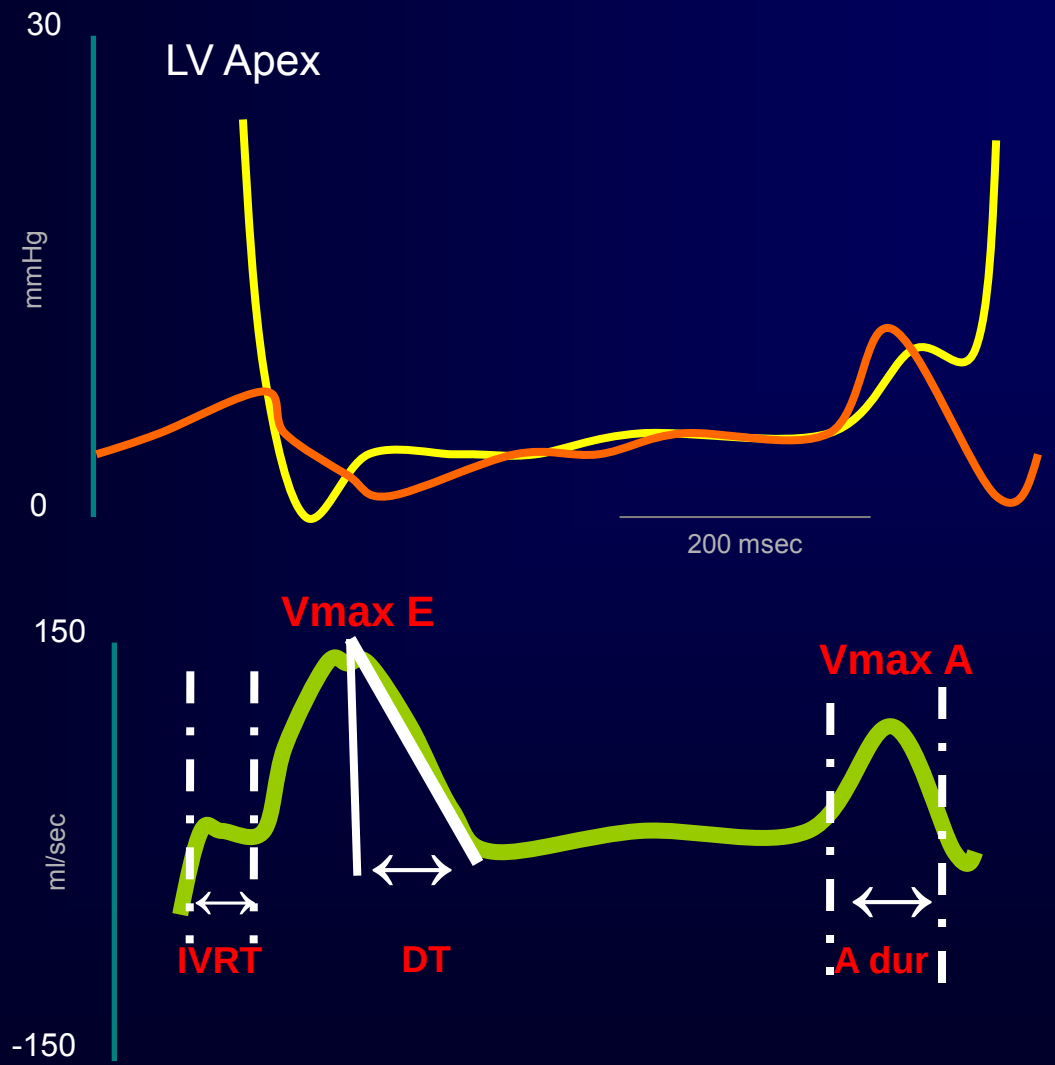
and

2D/M-mode parameters

Echocardiography in the LV Diastolic Dysfunction

- **Diagnosis of the LV diastolic dysfunction**
- Evaluation of LV filling pressure
- Diagnosis of HFNEF

Mitral inflow

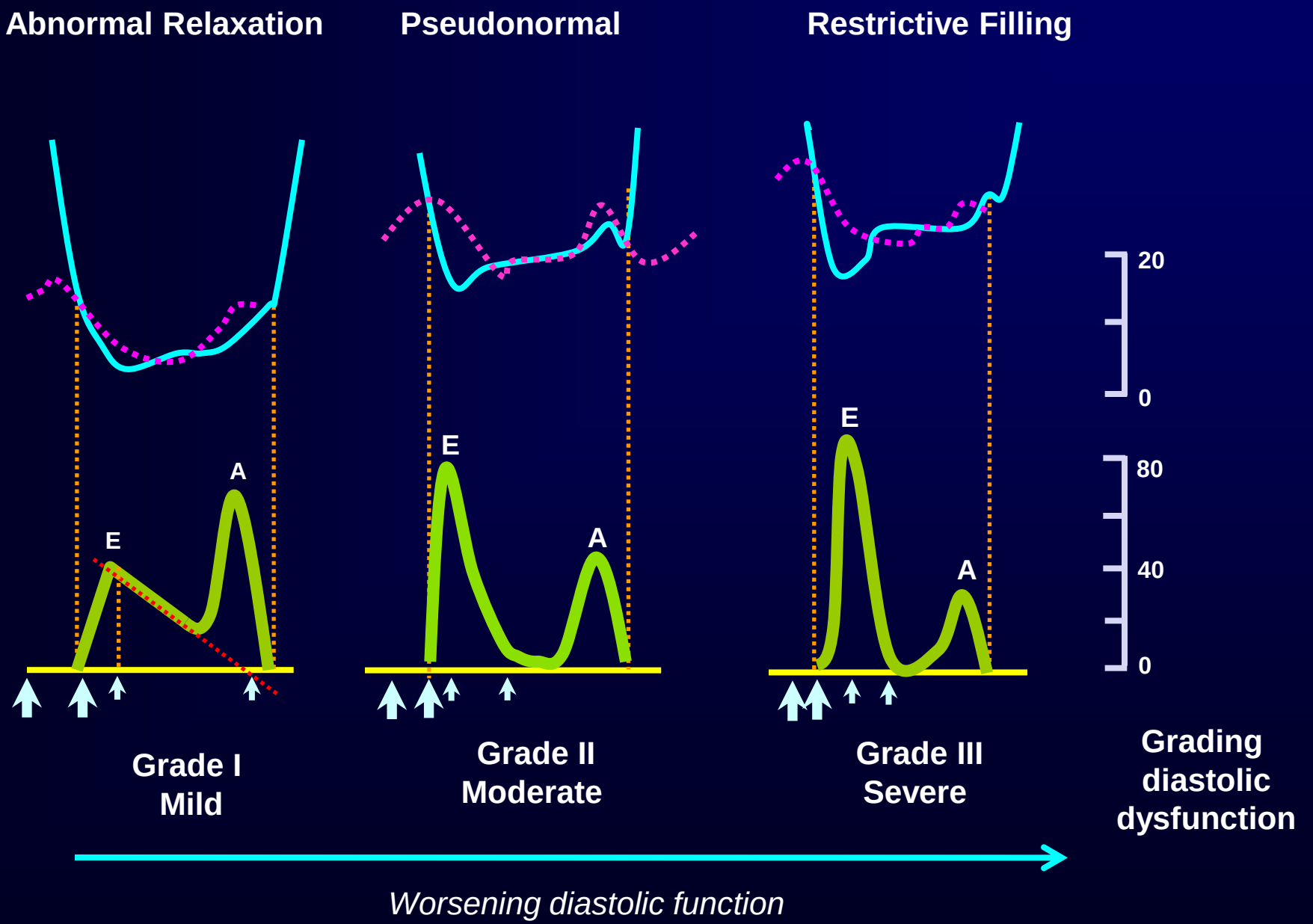


Normal values in adults:

E > A
DT 140 - 240
IVRT 70 - 90

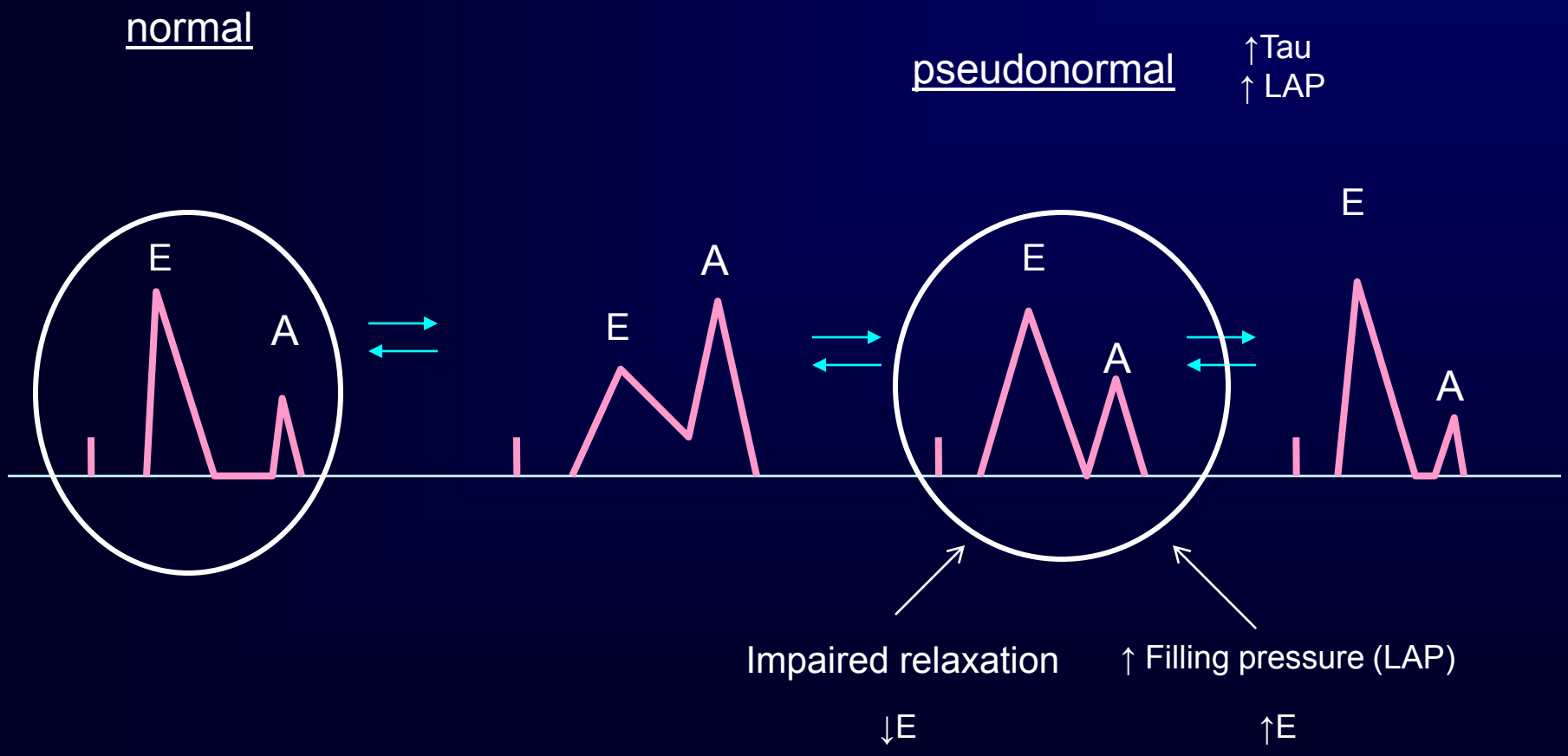
Normal values age-dependent

Mitral inflow - LV filling patterns

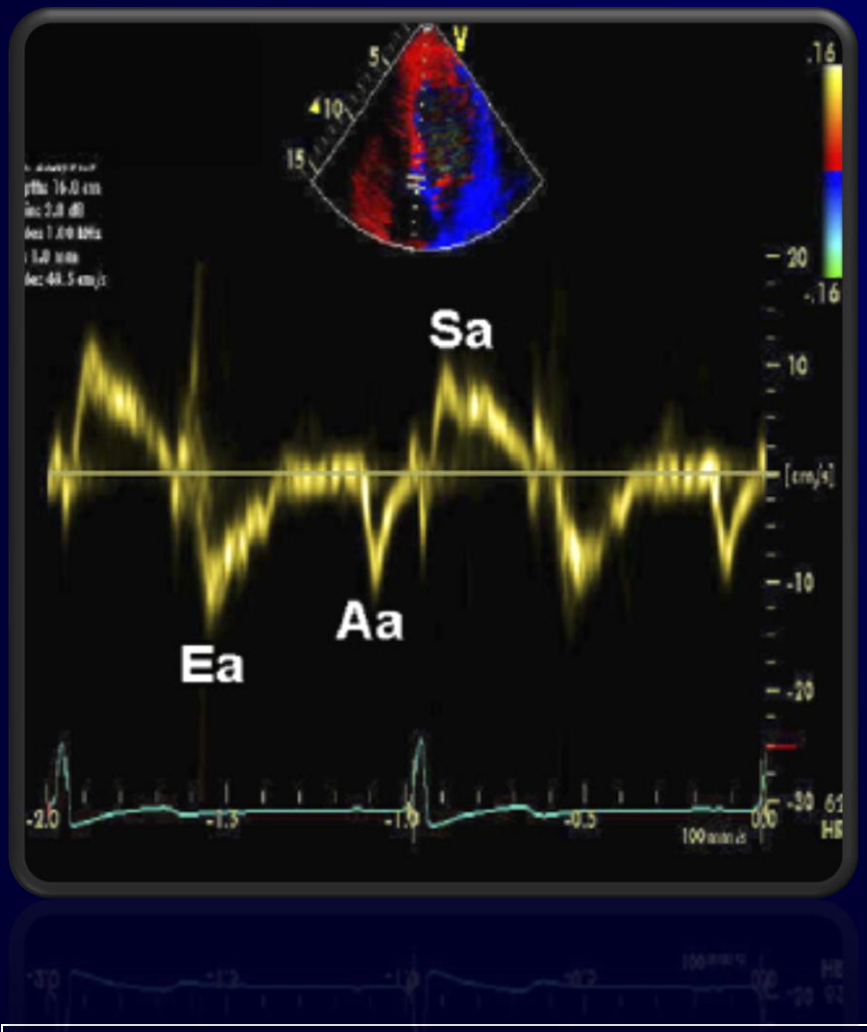


Mitral inflow - LV filling patterns

Mitral inflow is load dependent

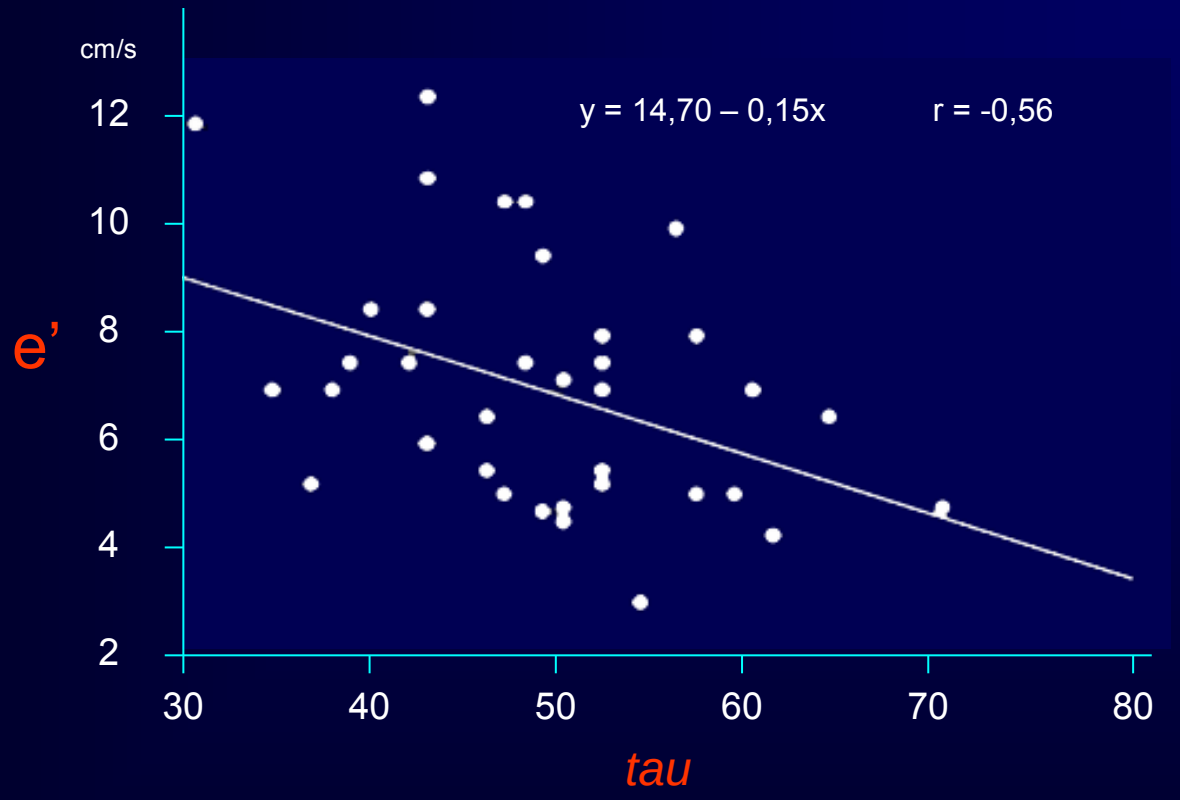


Mitral annulus velocities – TDI



Ea or e’ is significantly related with LV relaxation

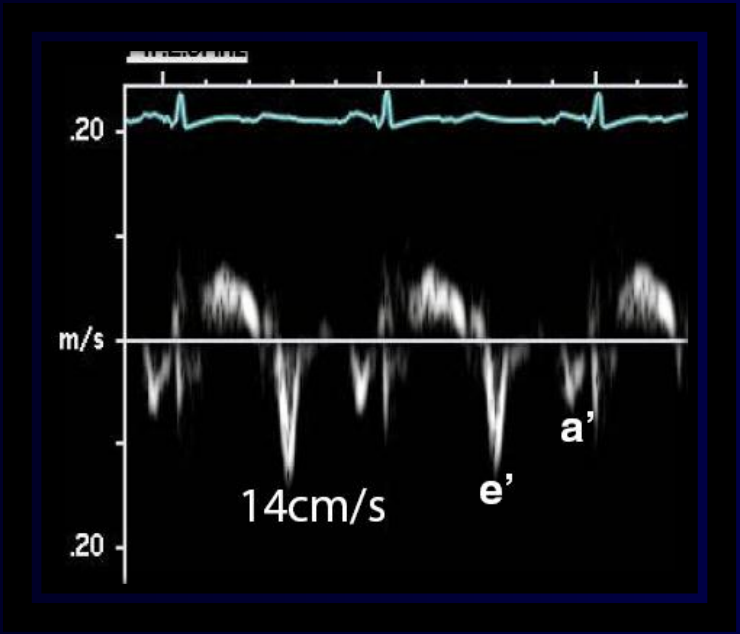
Early mitral annulus velocity – e’



e’ – can be used as non-invasive index of LV relaxation

Sohn DW, et al. J Am Coll Cardiol 1997

Mitral annulus velocities – TDI



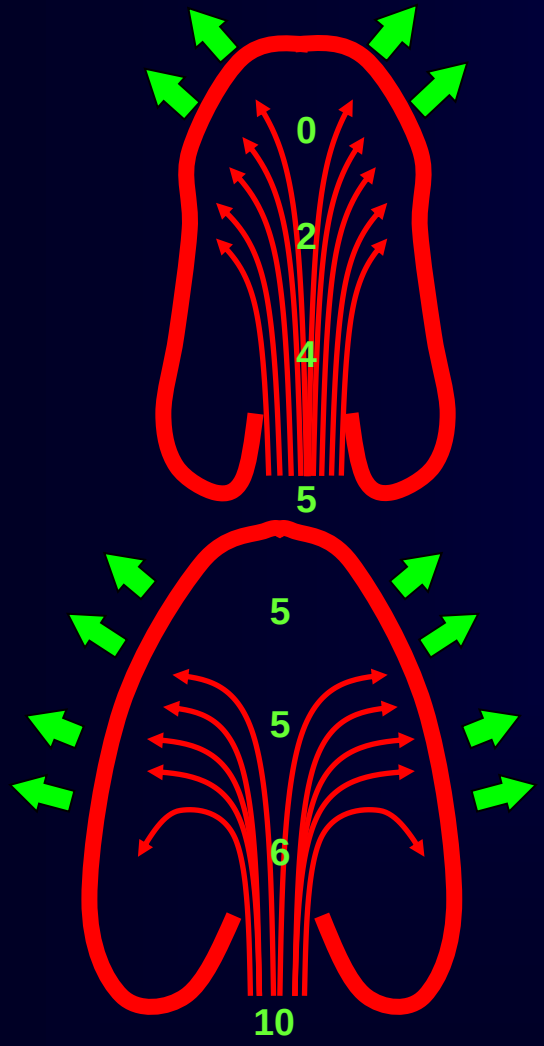
e´ lateral < 10 cm/sec
e´ septal < 8 cm/sec

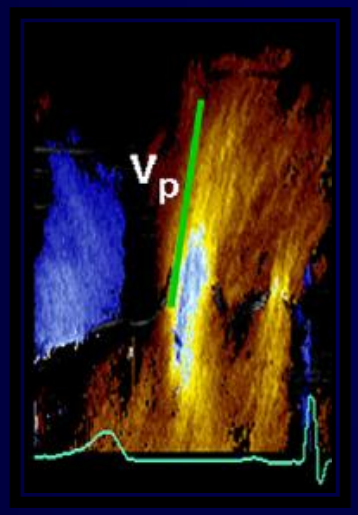
Limitations of e'

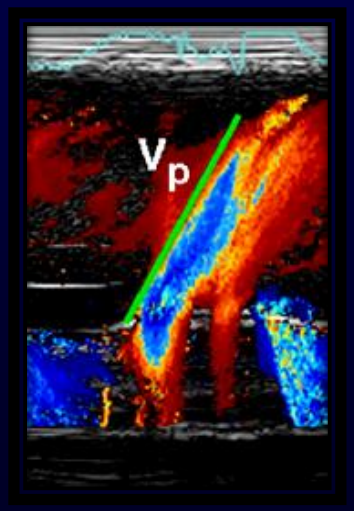
Heavy annular calcification
Prosthetic mitral valves

Mitral stenosis and regurgitation

Intraventricular colour M-mode flow propagation velocity in early diastole -Vp

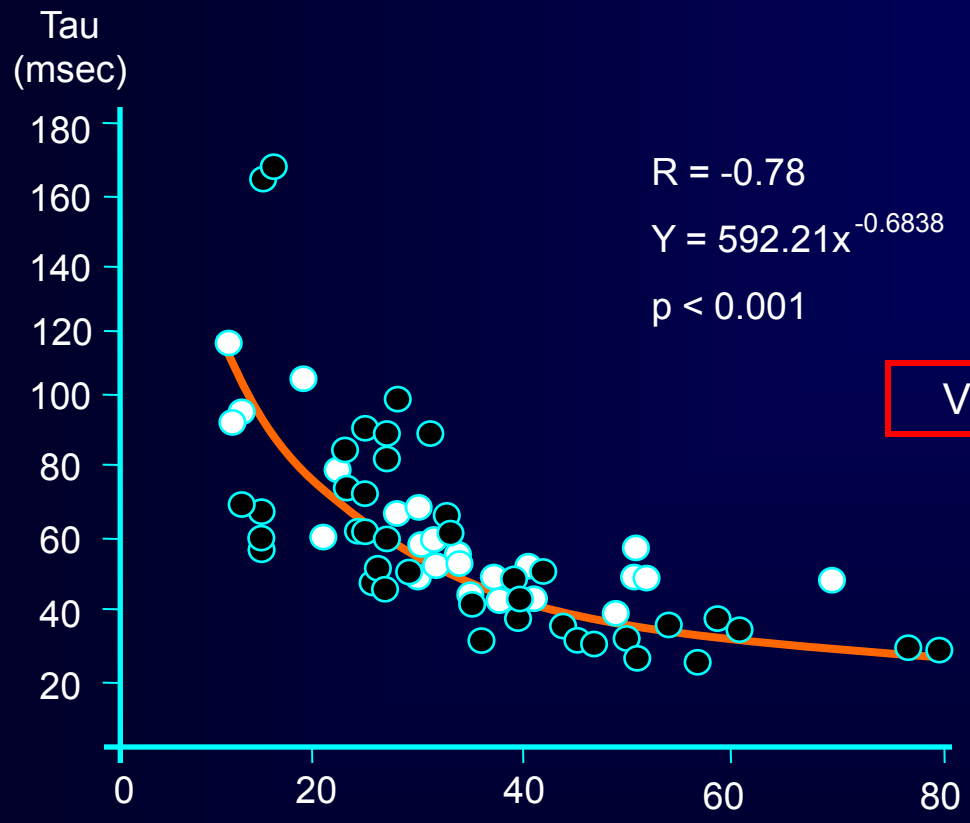






Colour M-mode-
High temporal and spatial resolution

Intraventricular colour M-mode flow propagation velocity - Vp



Vp < 50 cm/sec – impaired relaxation

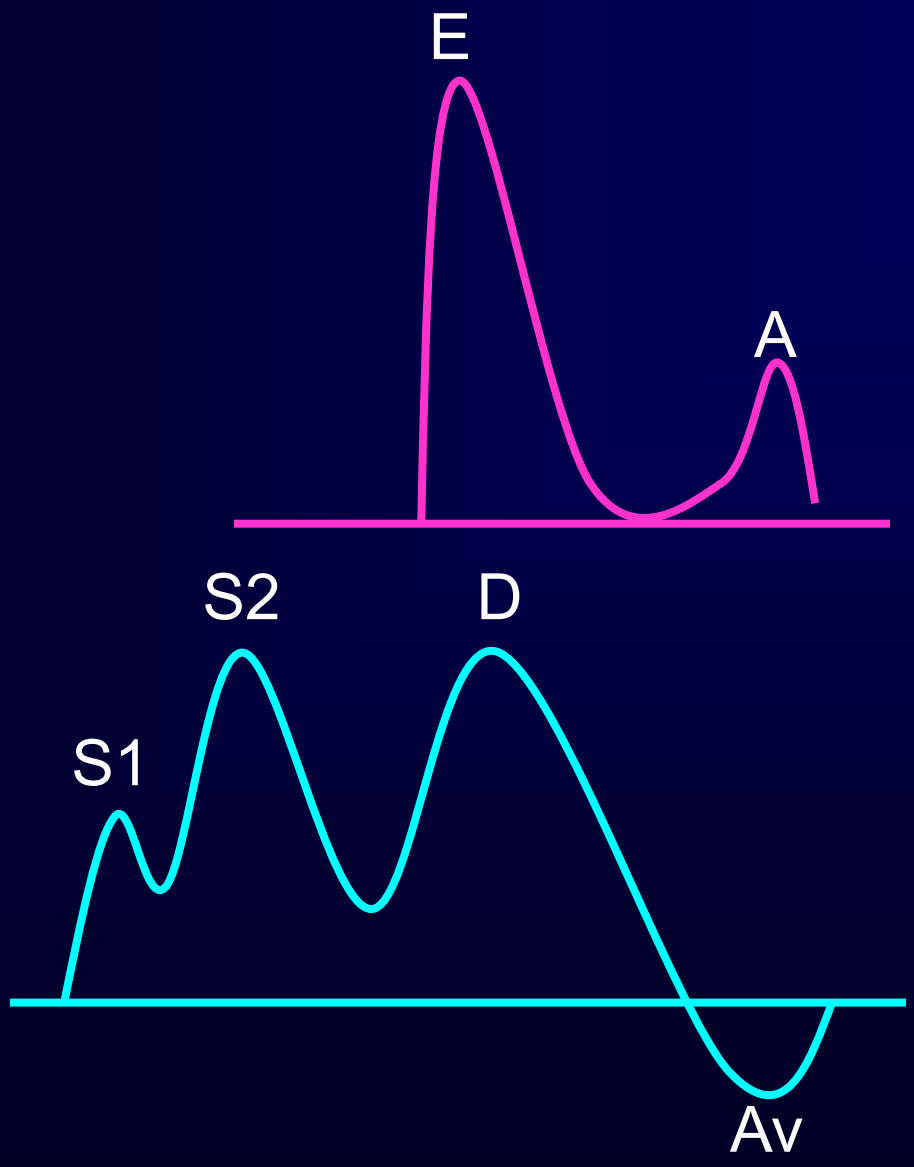
Limits:

small LV volumes / normal EF

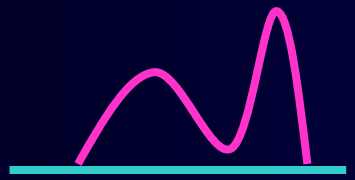
Interobserver variability

Garcia MJ, et al. J Am Coll Cardiol 2000

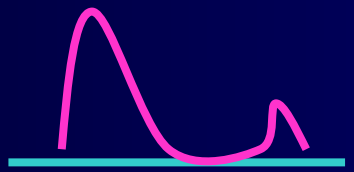
Pulmonary Venous Flow



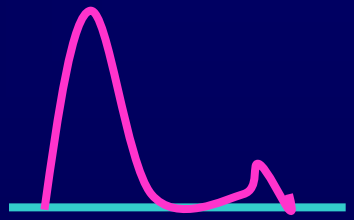
Pulmonary venous flow



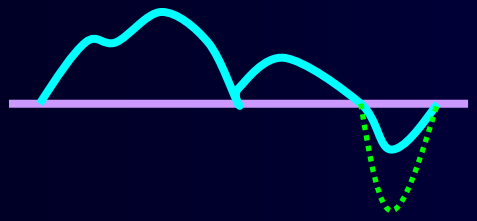
S > D



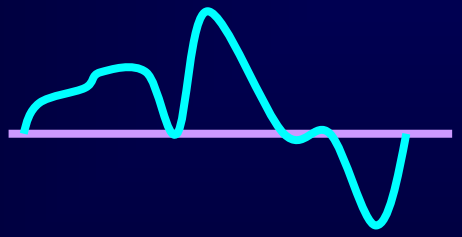
S < D and Ar > A



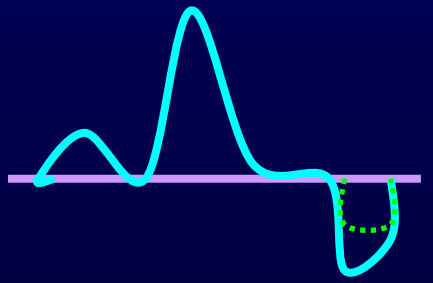
S< < D and Ar > A



Abnormal Relaxation



Pseudonormal pattern



Restrictive pattern

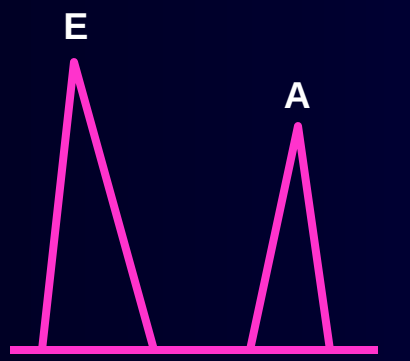
Limits: load dependent
cannot be obtained in all patients

Appleton CP et al, Heart Failure Clinics 2000

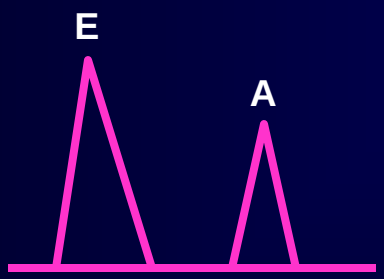
Preload reduction - Valsalva Maneuver

Normal filling pressure

Before



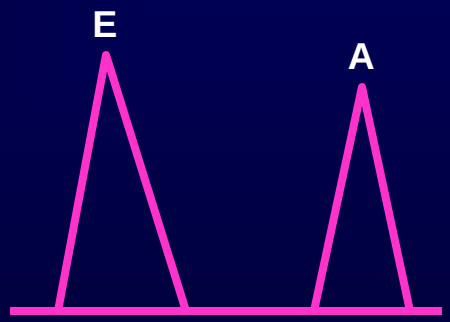
After



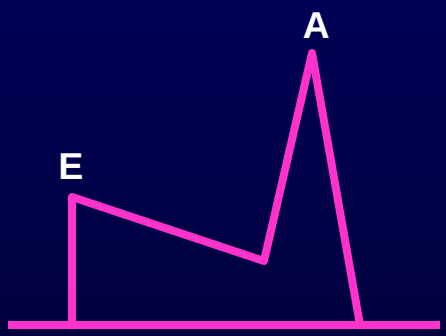
Δ E/A < 0.5

Delayed relaxation + ↑ LAP

Before



After

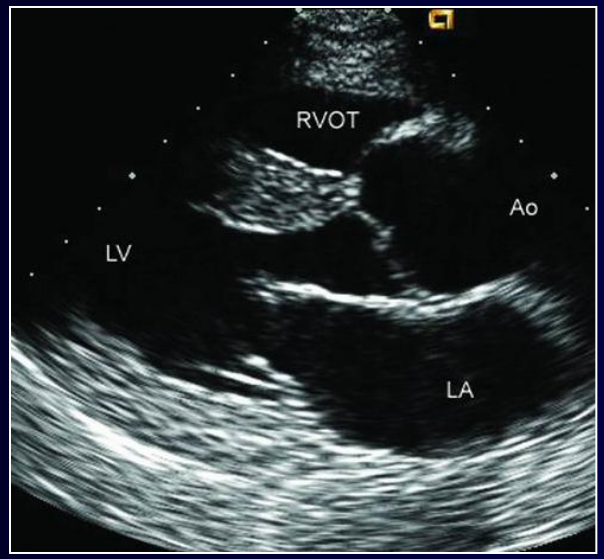


Δ E/A > 0.5

Limits : smaller magnitude of change ≠ normal LV diastolic function
difficult to obtain

HurrellD et al., J Am Coll Cardiol 1997

Left Ventricular and Left Atrial Remodelling



LV Hypertrophy

LA volume index > 34 ml/mp

<u>Dilated LA in the absence of diastolic dysfunction</u>

Mitral valve disease
Atrial fibrilation
Anemia/high output states

LV Diastolic Dysfunction

- Diagnosis of the LV diastolic dysfunction
- **Evaluation of LV filling pressure**
- Diagnosis of HFNEF
- Challenging situations

Evaluation of LV filling pressure

Combined indices

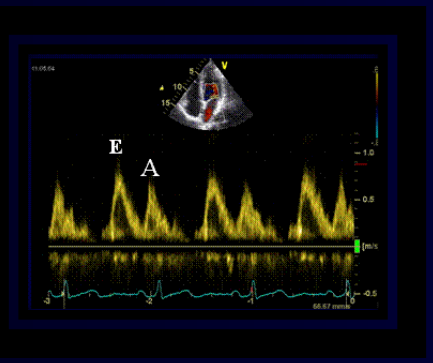
E/e‘

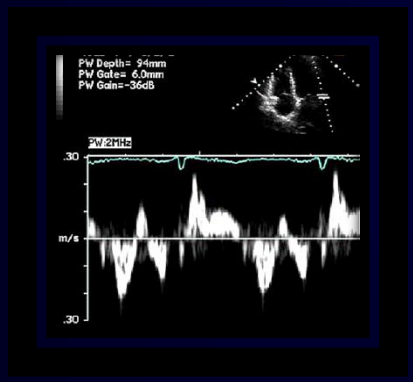
E/Vp

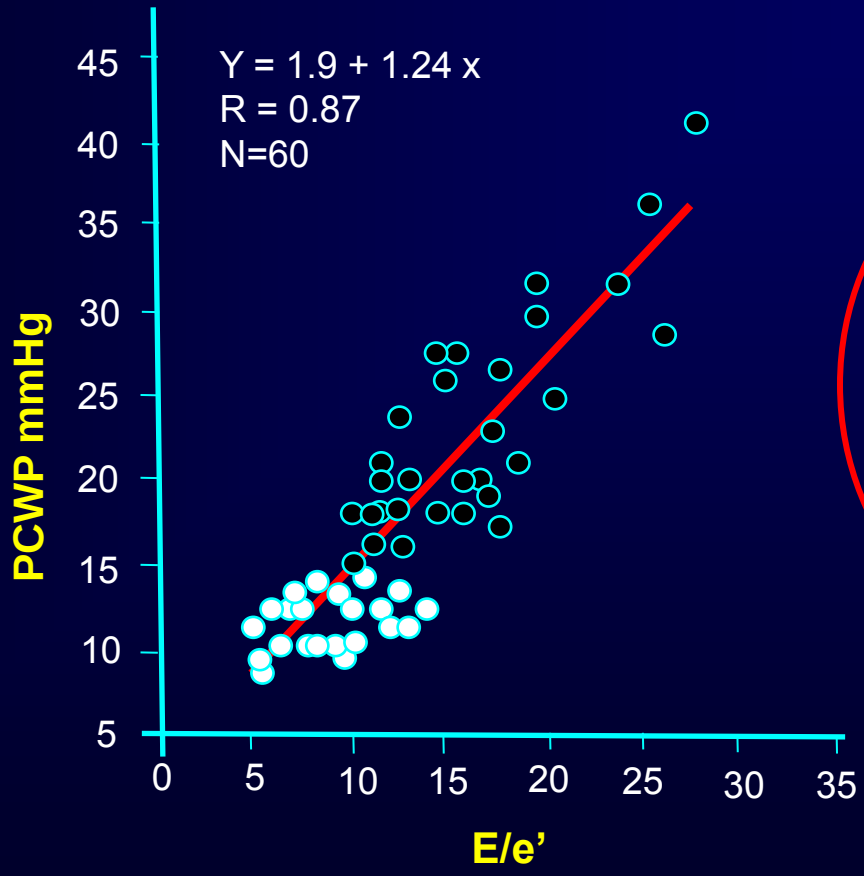
Ar - A

E/e' and PWCP

E/e’ ratio = most important combined indice to estimate LV filling pressure







Independent of EF

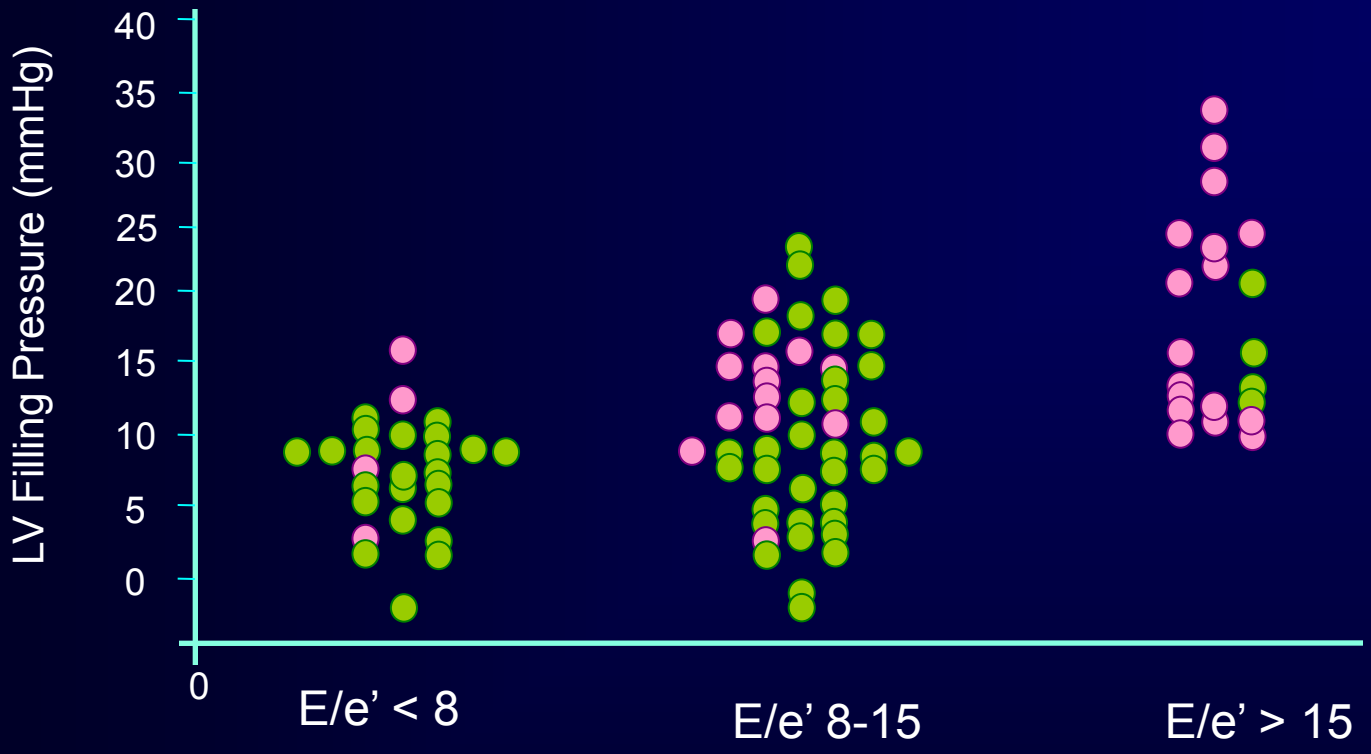
Sinus tachycardia

Atrial fibrilation

HOCM

Nagueh SF et al. J Am Coll Cardiol 1997

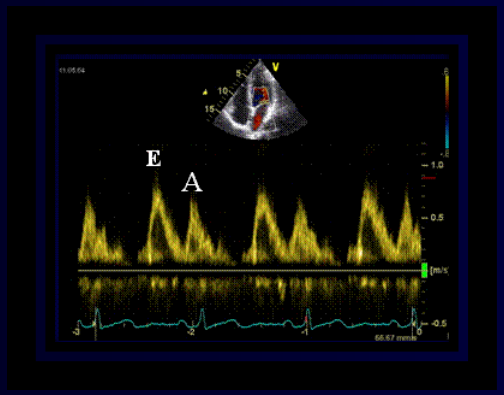
E/e' and PWCP

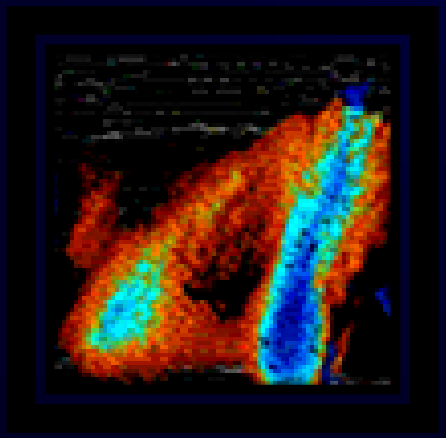


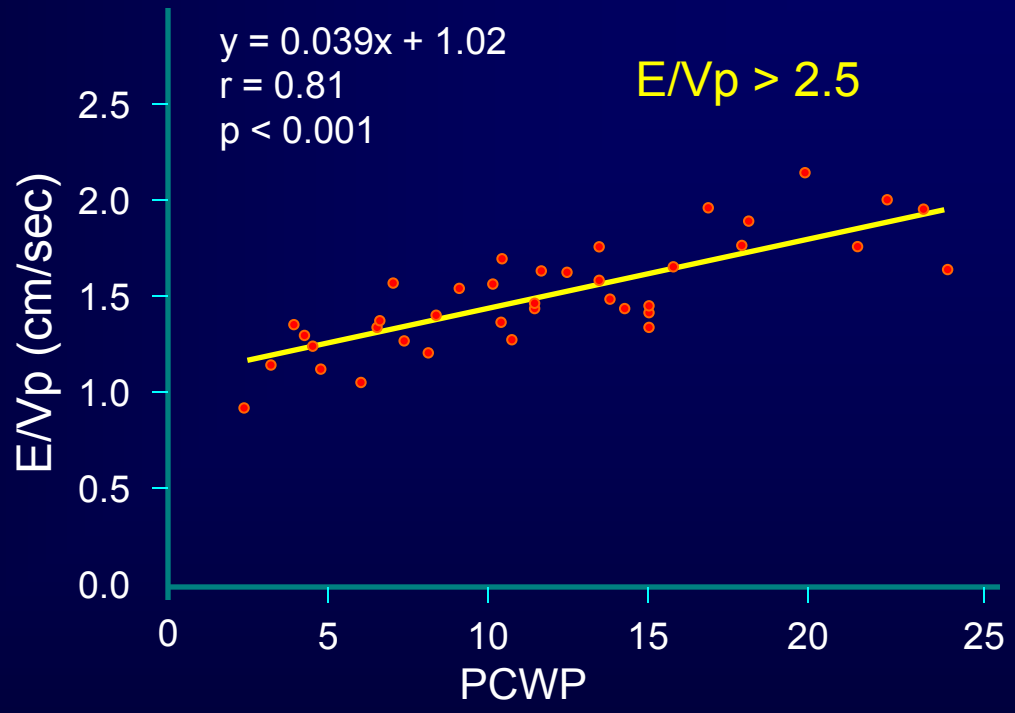
The majority of patients with elevated filling pressure and normal EF were in the group of E/e' between 8-15

Ommen SR et al, Circ 2000

E/Vp and PCWP



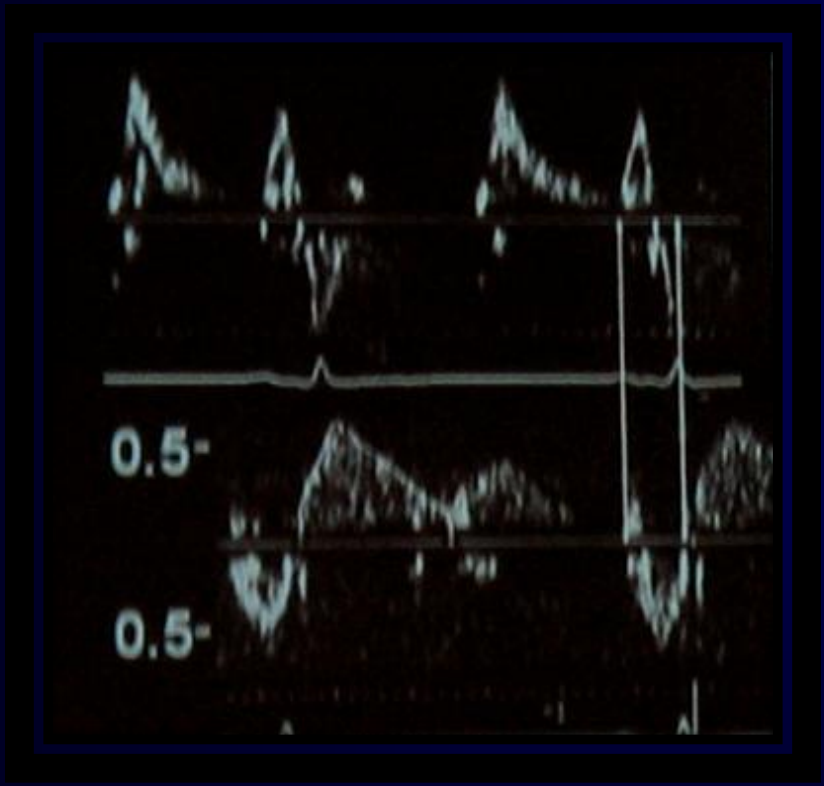


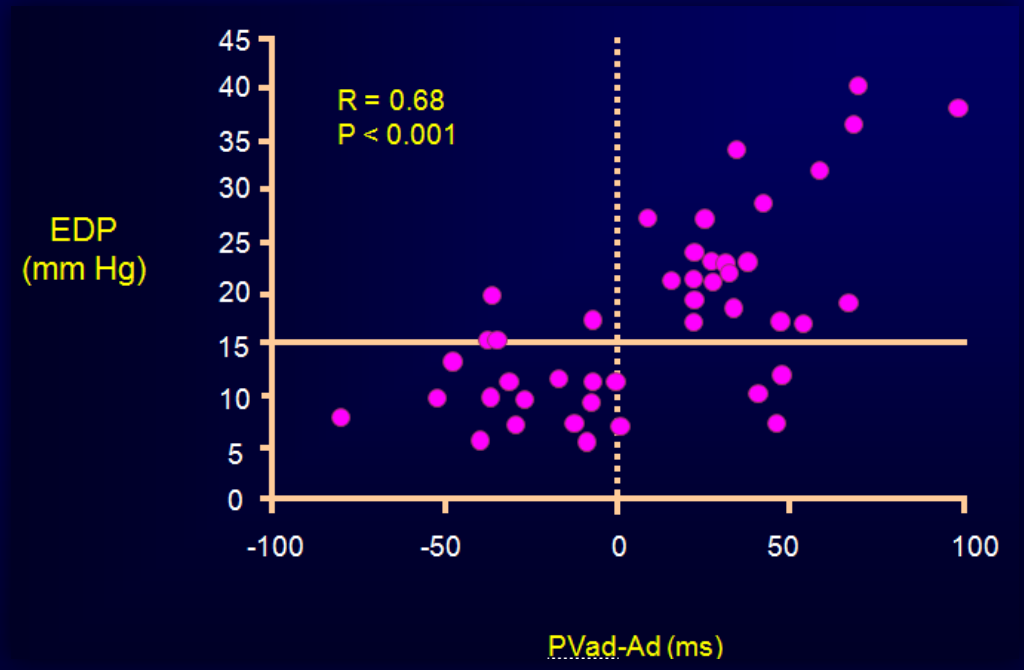


Lower accuracy in normal EF / small LV

Garcia J Am Coll Cardiol 1997, Rivas-Gotz C, Am J Cardiol 2003

Δ Time Ar - A and LVEDP





A r – A > 30 msec

↑ LVEDP > 15 mmHg

Duration of Ar – difficult to measure

Independent of EF and age

Rossvoll, Hatle, J Am Coll Cardiol 1993

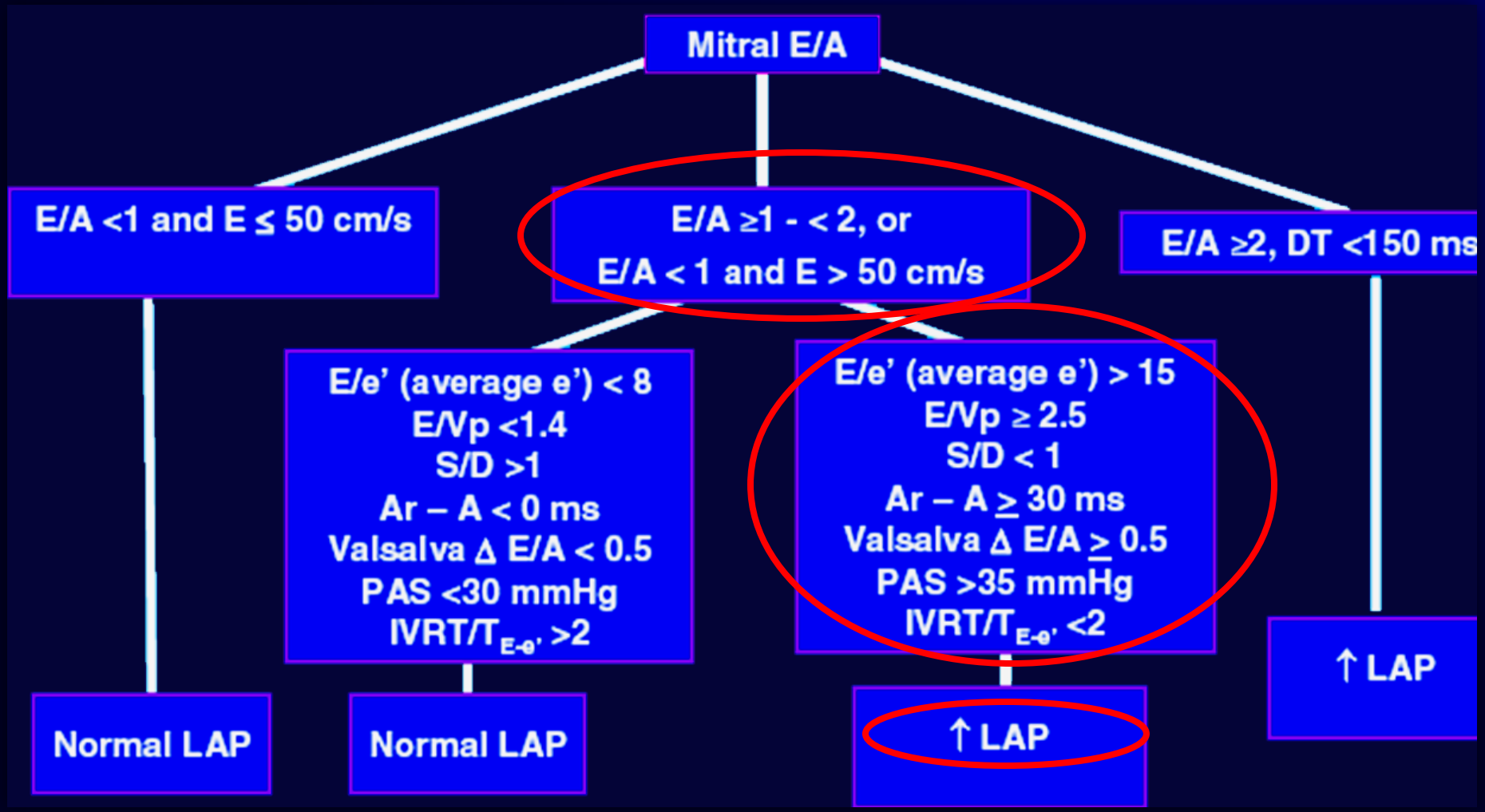
GUIDELINES AND STANDARDS

Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography

Sherif F. Nagueh, MD, Chair,† Christopher P. Appleton, MD,† Thierry C. Gillebert, MD,*
Paolo N. Marino, MD,* Jae K. Oh, MD,† Otto A. Smiseth, MD, PhD,*
Alan D. Waggoner, MHS,† Frank A. Flachskampf, MD, Co-Chair,*
Patricia A. Pellikka, MD,† and Arturo Evangelista, MD,* *Houston, Texas; Phoenix, Arizona; Ghent, Belgium; Novara, Italy; Rochester, Minnesota; Oslo, Norway; St. Louis, Missouri; Erlangen, Germany; Barcelona, Spain*

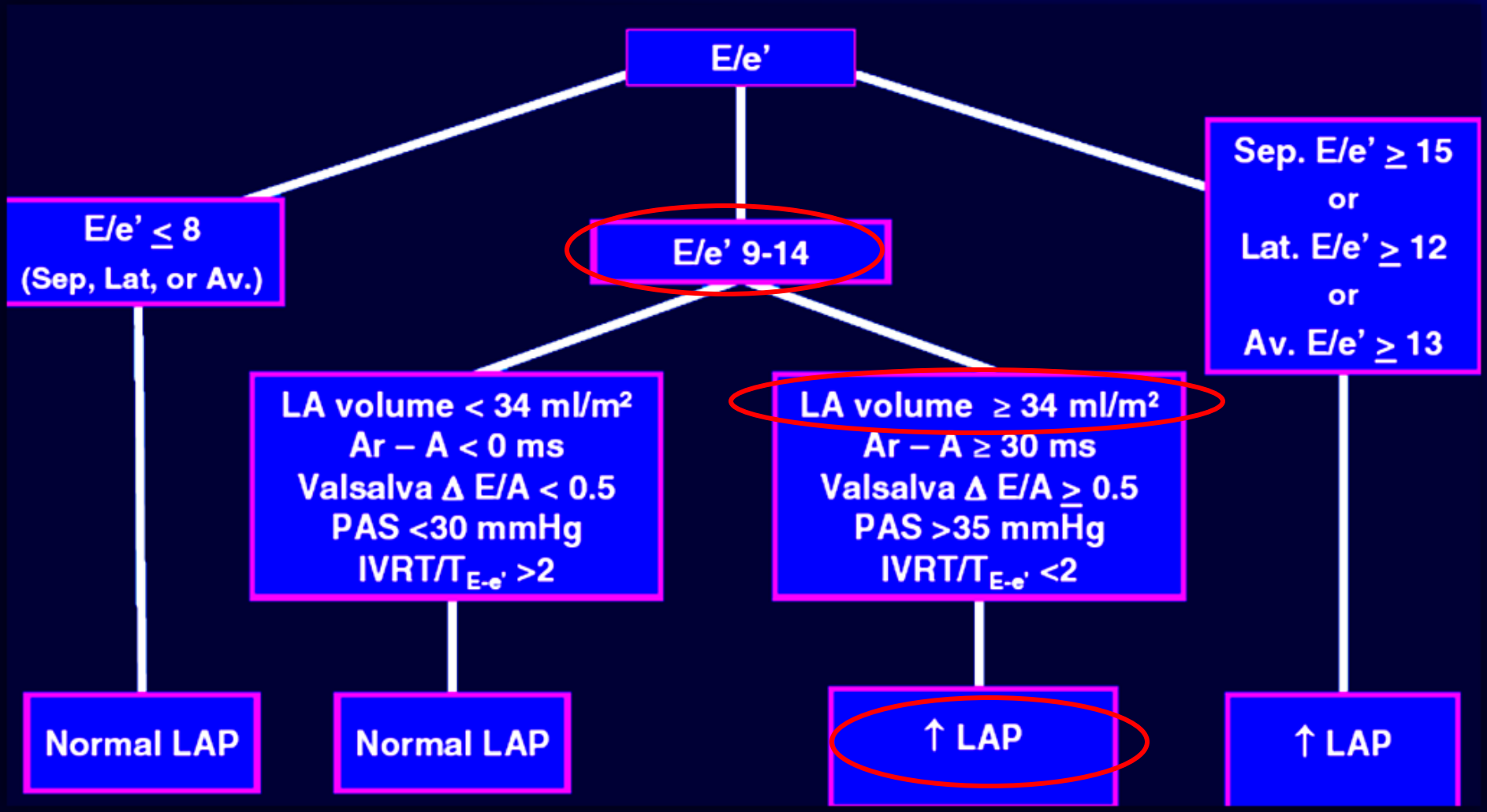
J Am Soc Echo 2009, 22 107-133
Eur Jl Echocard 2009 10: 165-193

Estimation of filling pressures in patients with depressed EF



Nagueh SF et al , JASE and Eur JL Echocard 2009

Estimation of filling pressures in patients with normal EF

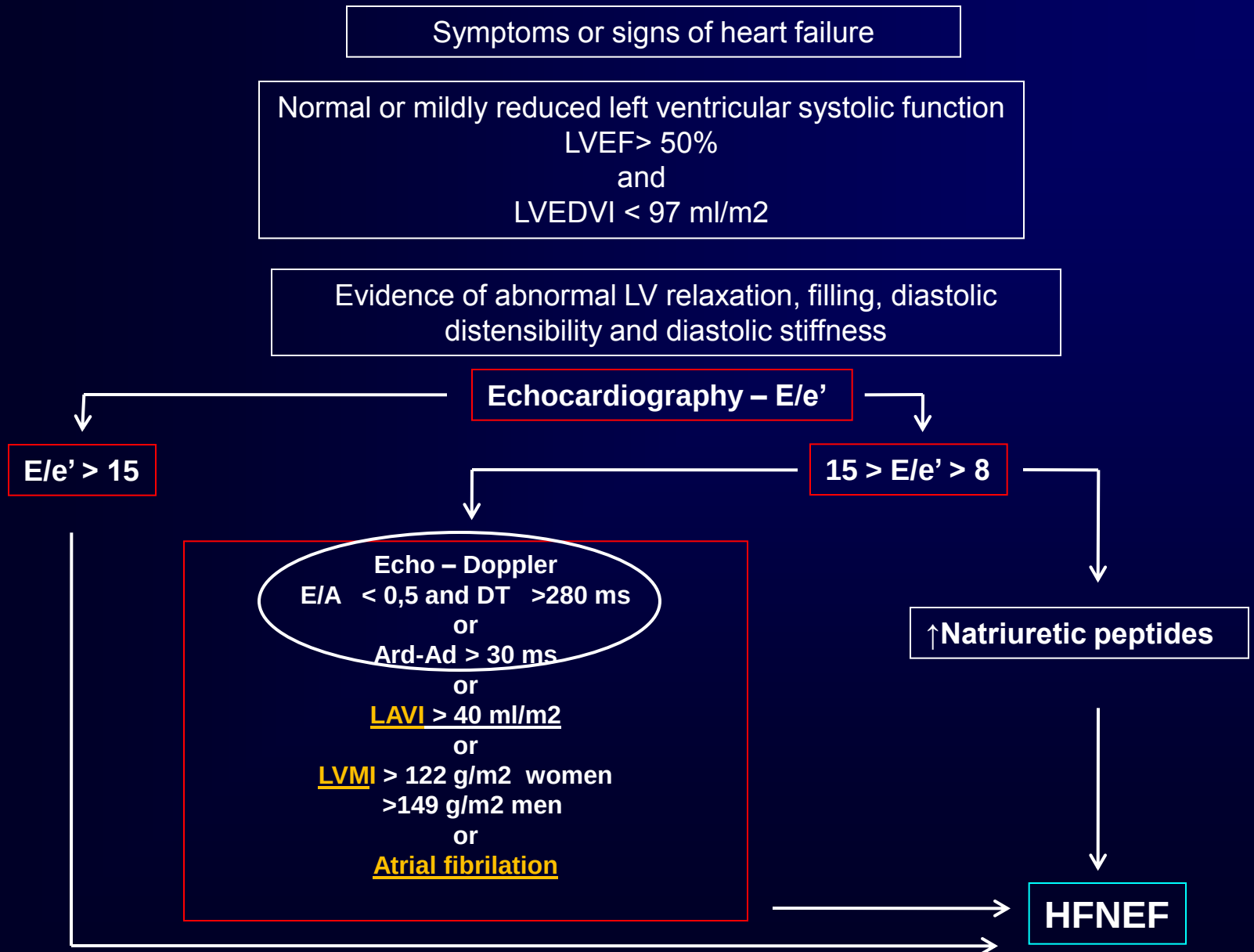


Nagueh SF et al , JASE and Eur JL Echocard 2009

LV Diastolic Dysfunction

- Diagnosis of the LV diastolic dysfunction
- Evaluation of LV filling pressure
- **Diagnosis of HFNEF**

Diagnosis of Heart Failure with Normal EF

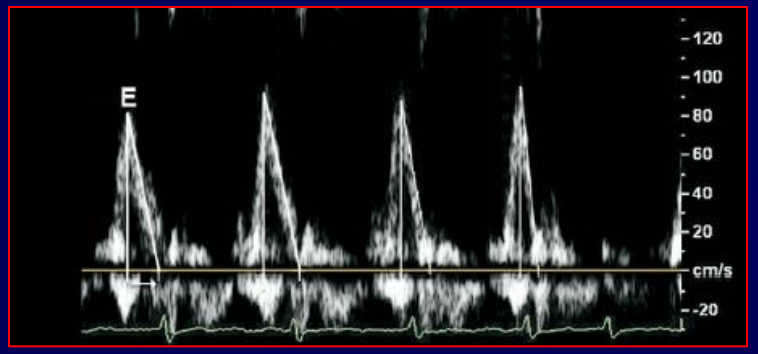


Adapted from Paulus WJ, Eur H J 2007

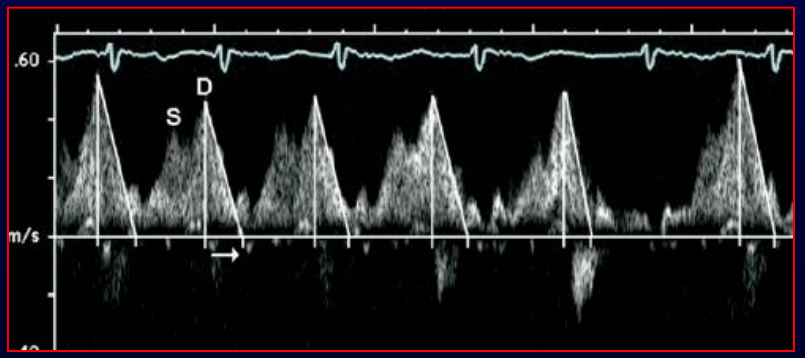
Atrial Fibrillation and Diastolic Dysfunction

E/e´ > 11

E/Vp > 1.4



Mitral inflow
DT <150 ms
IVRT < 65 msec



PVF
DT < 220 msec

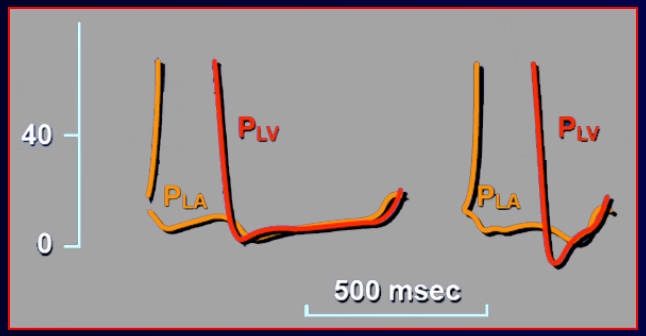
Diastolic stress test

Normal

Exertional dyspnea
and
Impaired relaxation/ normal filling pressures

rest stress

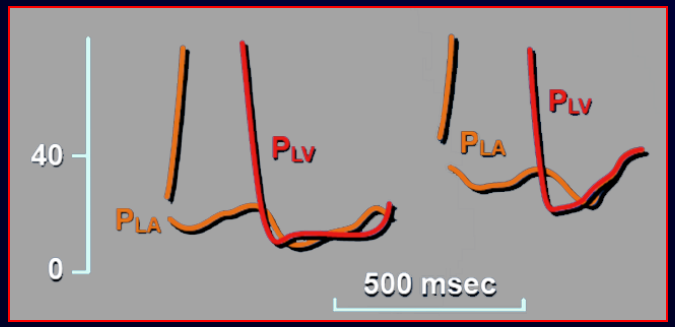
mm Hg



E **e´** **E / e´**

Heart failure

mm Hg



Conclusions

Comprehensive evaluation of LV diastolic dysfunction consists of the assessment of LV filling and filling pressure together with the left atrial and left ventricular size, morphology and function .

The diagnosis of HFNEF remain challenging and the LV diastolic function can be assessed during exercise stress.

The emerging techniques assessing myocardial deformation and ventricular-arterial coupling will add new insights into the left ventricular and left atrial function .