Diastolic Function
What are we measuring?

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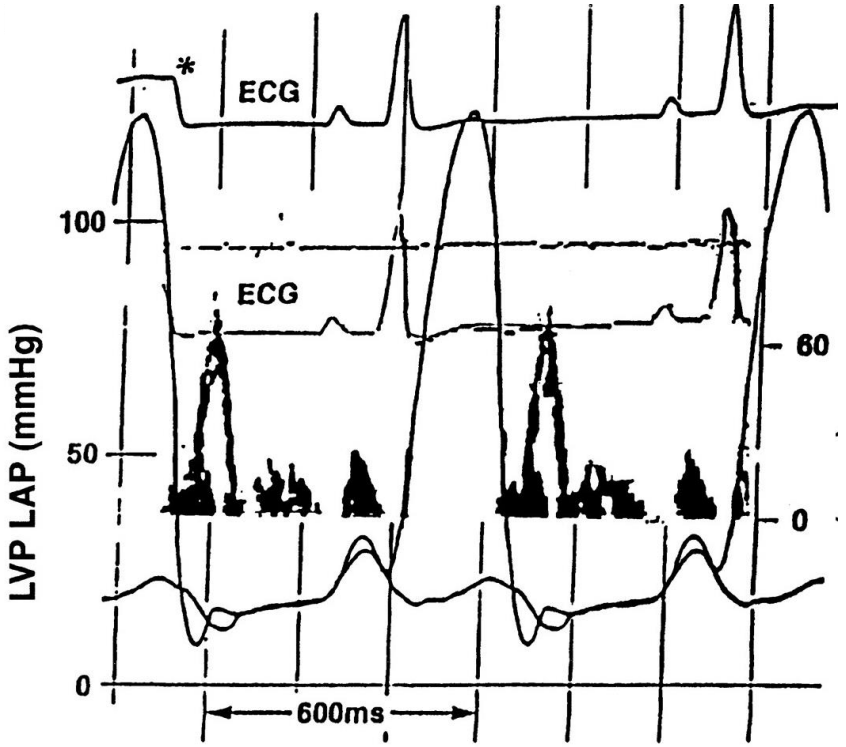
ECHO AUSTRALIA

17-19 March 2025

Focus of Diastology : LV filling pressure

Does the patient have heart failure?



Heart failure : elevated LVFP

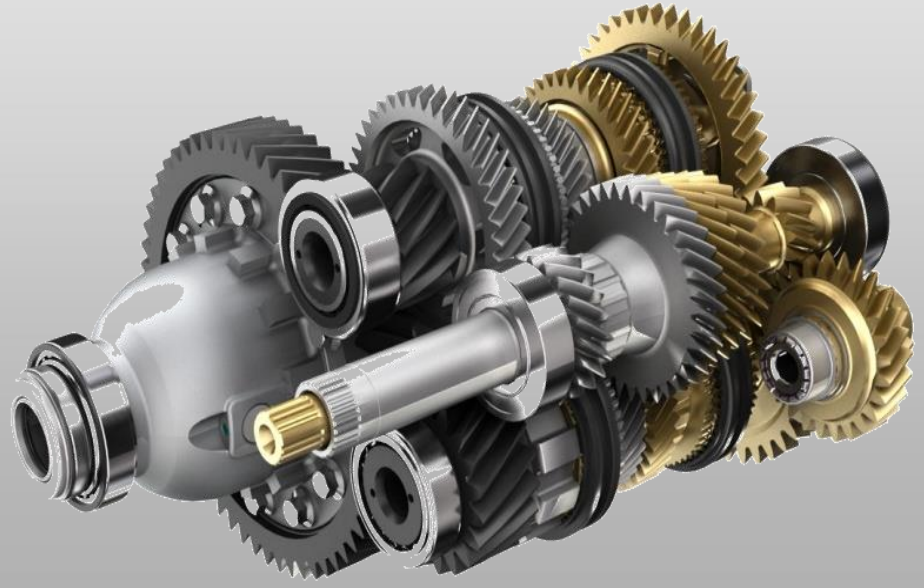
DIASTOLOGY

Intrinsic Myocardial Mechanical Properties

Cardiovascular Consequences

DIASTOLOGY

Diastolic Dysfunction



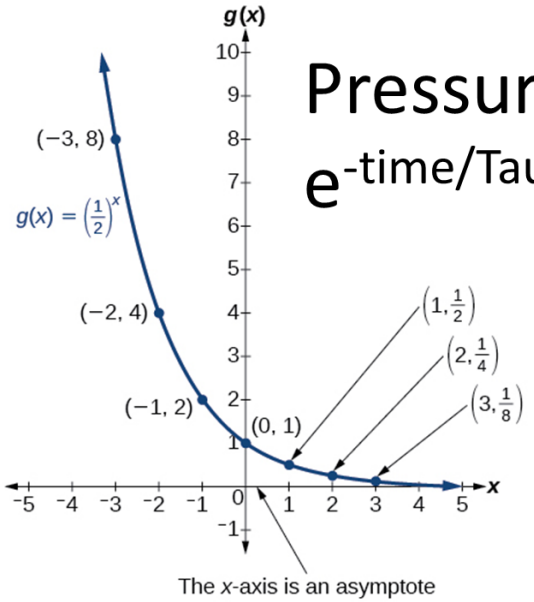
Increased filling pressures

As you get older, everything gets slower…

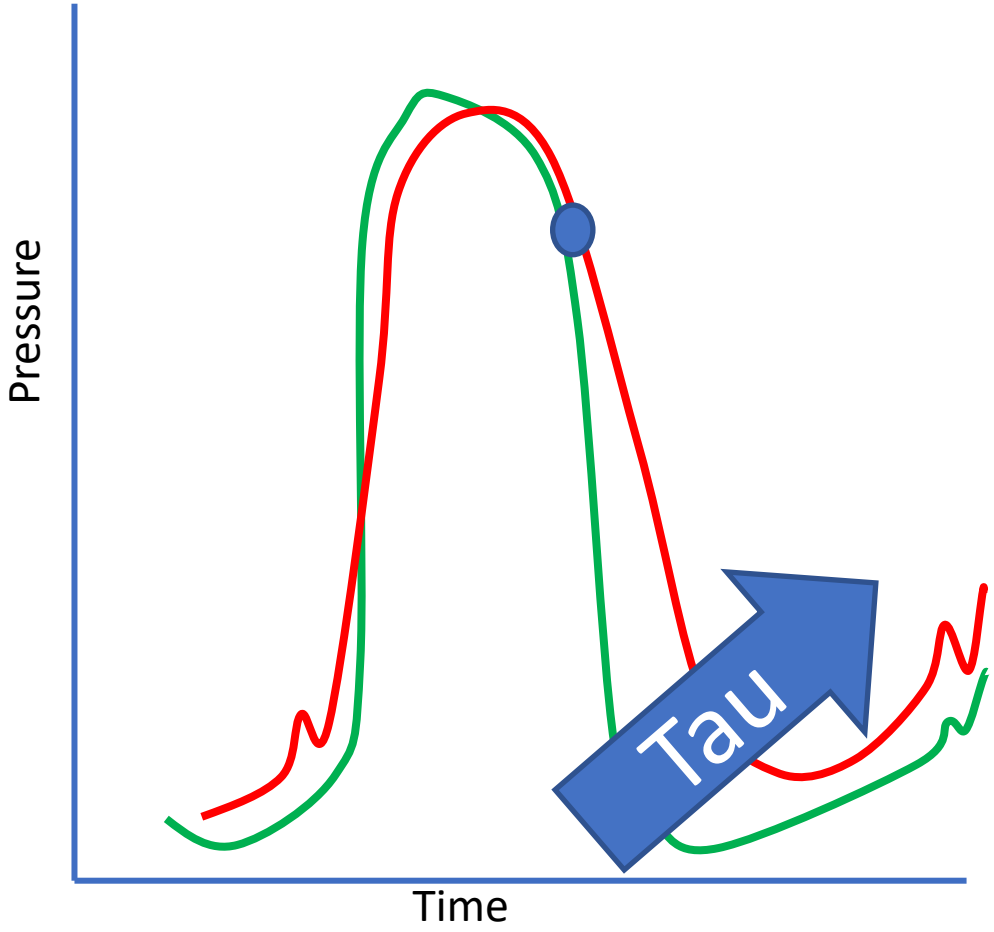
Intrinsic Myocardial Mechanical Properties

Intrinsic Myocardial Mechanical Properties

As you get older, everything gets slower…

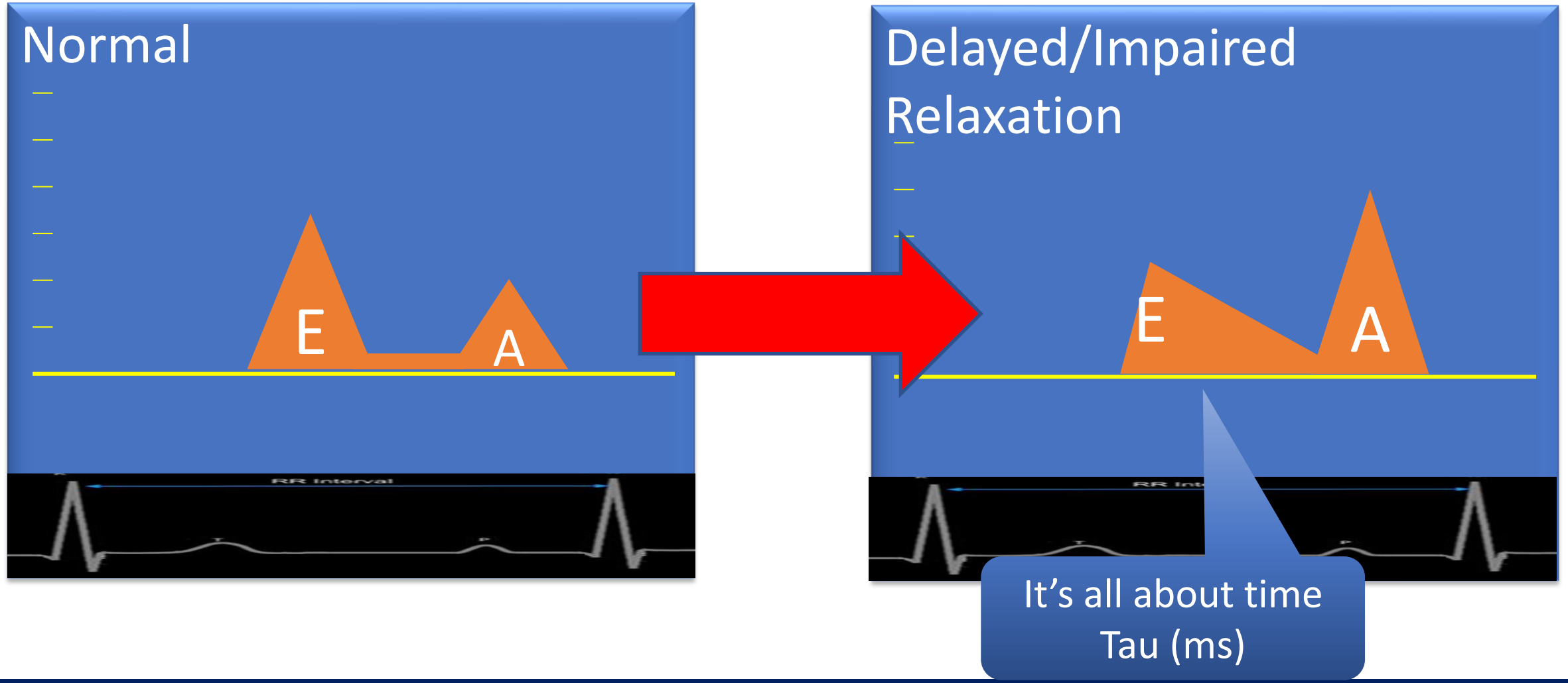


Pressure = $e^{-time/Tau}$

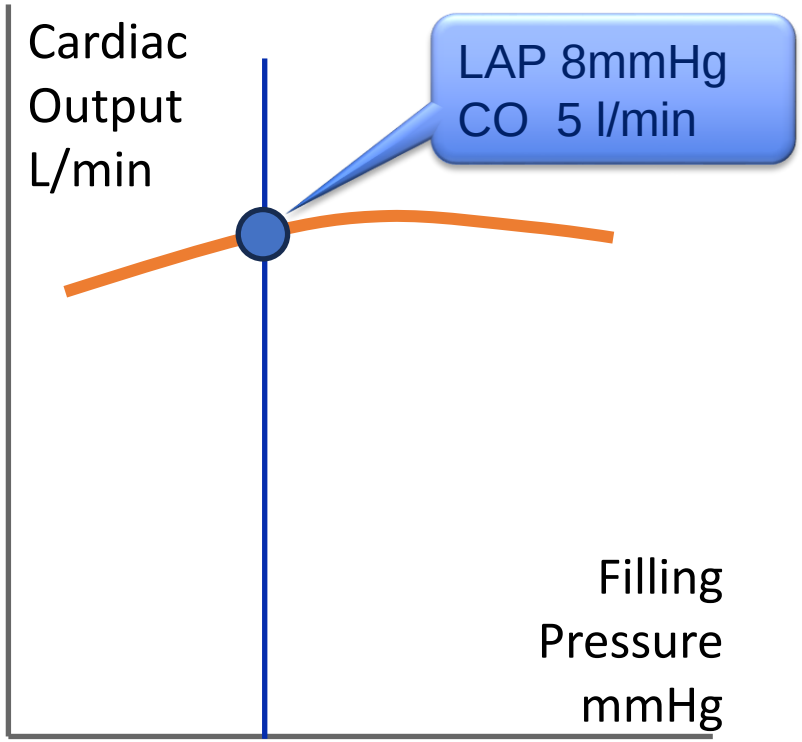


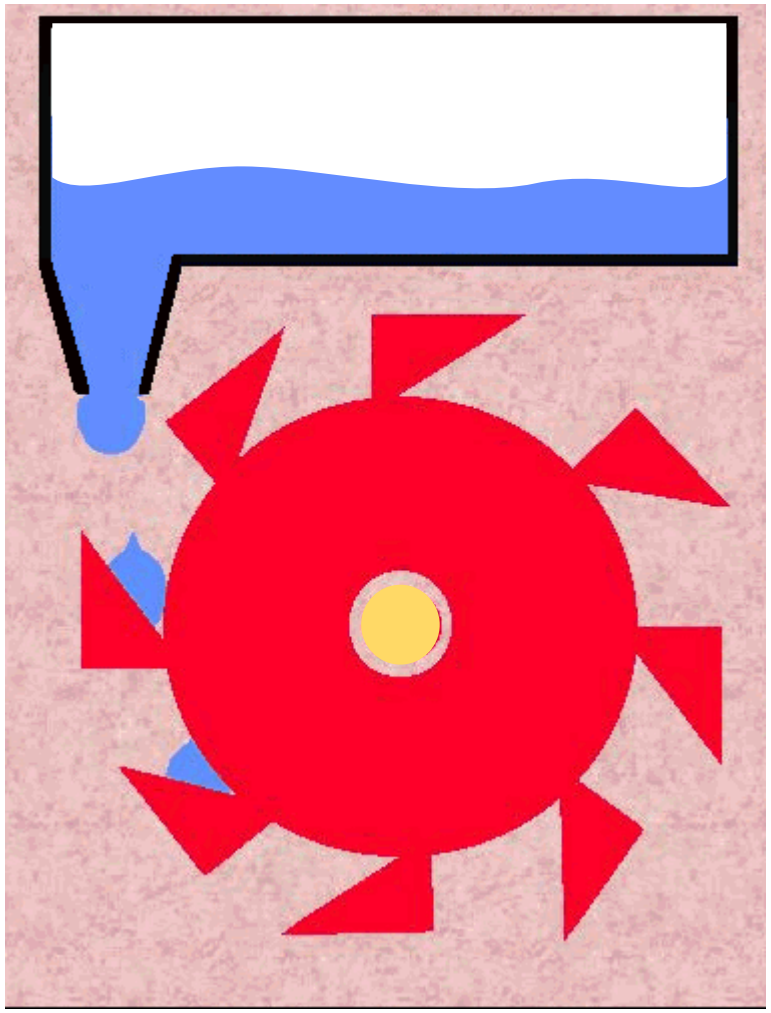
Tau

Early deterioration

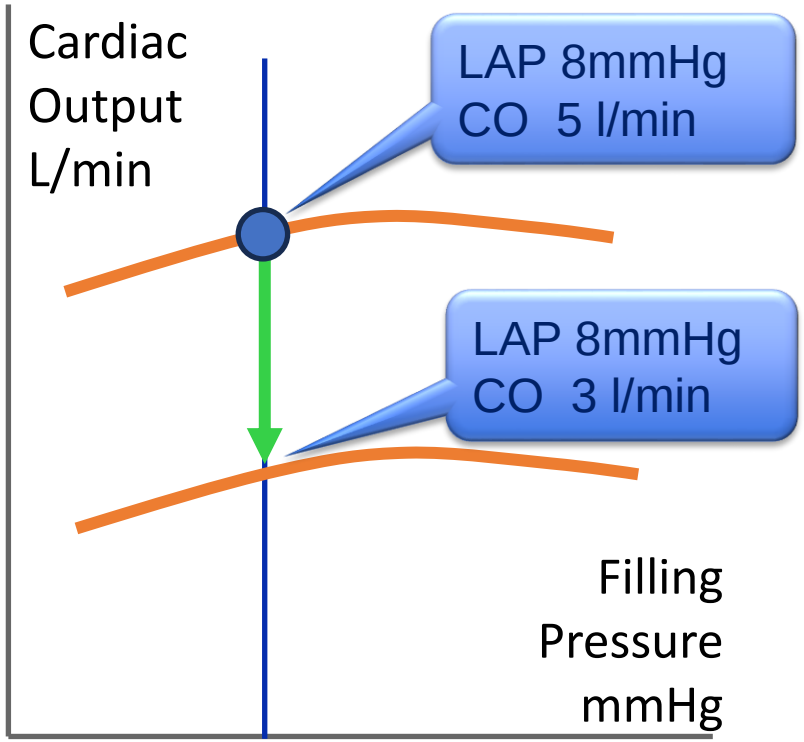


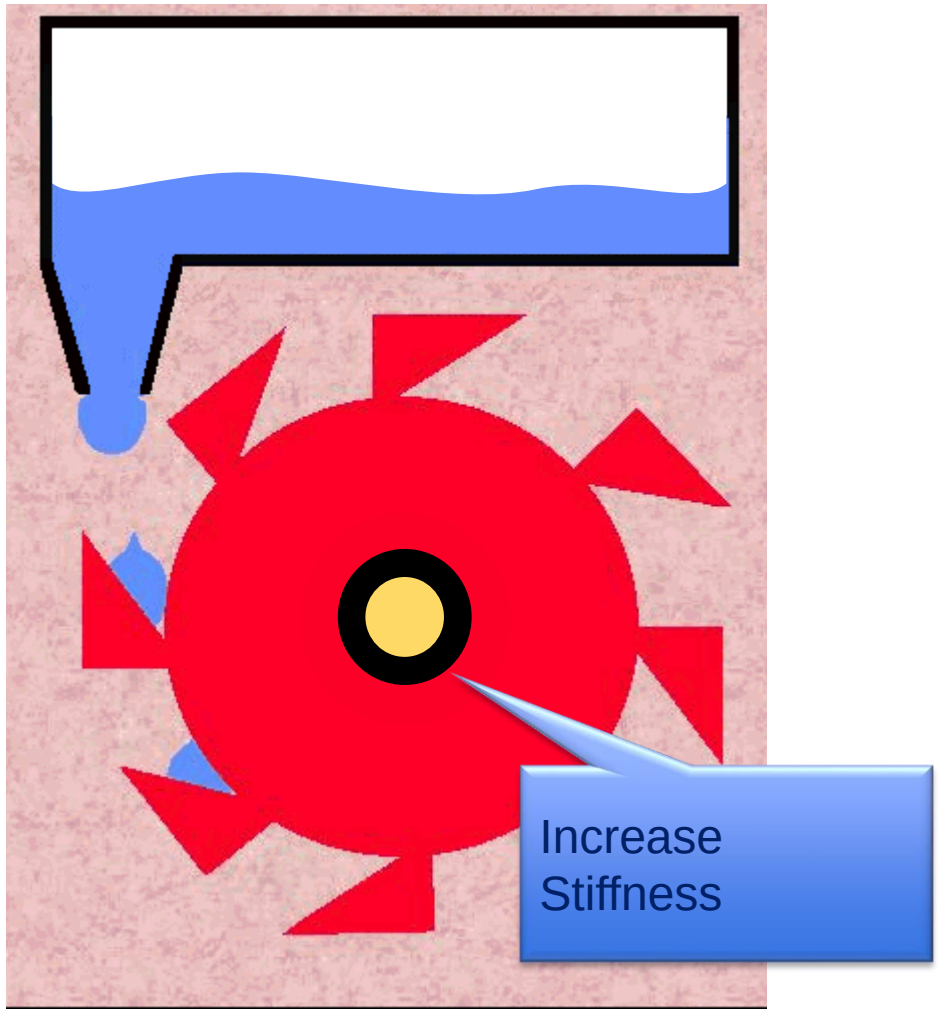
Hemodynamic effect



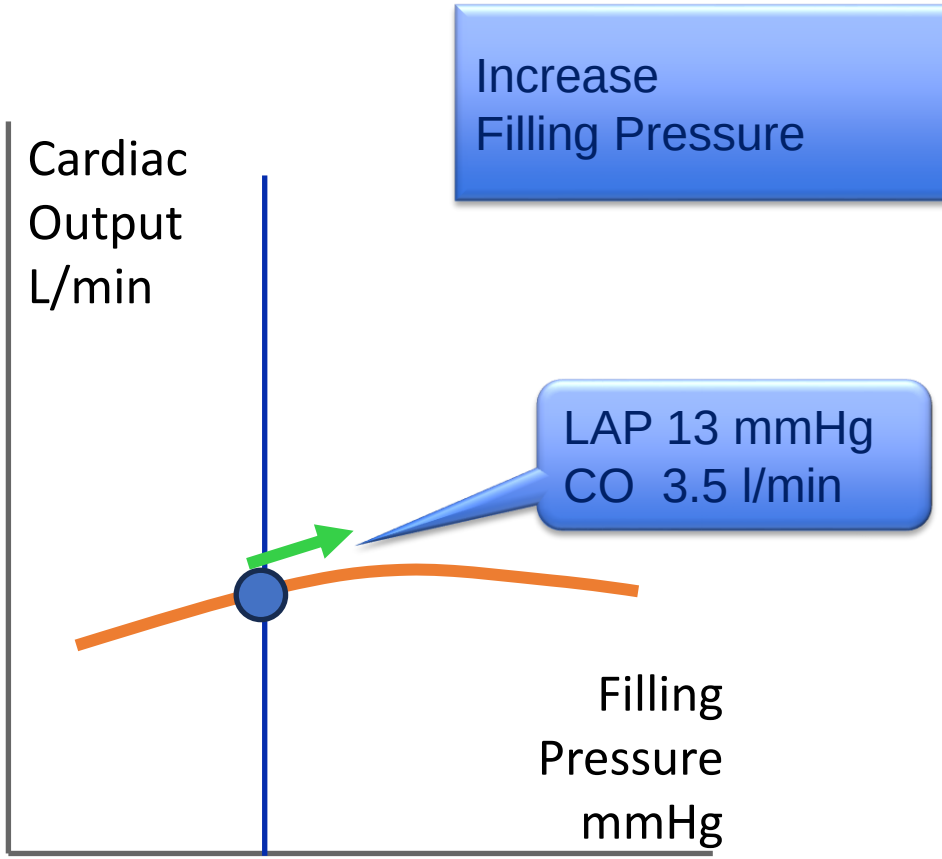


Hemodynamic effect



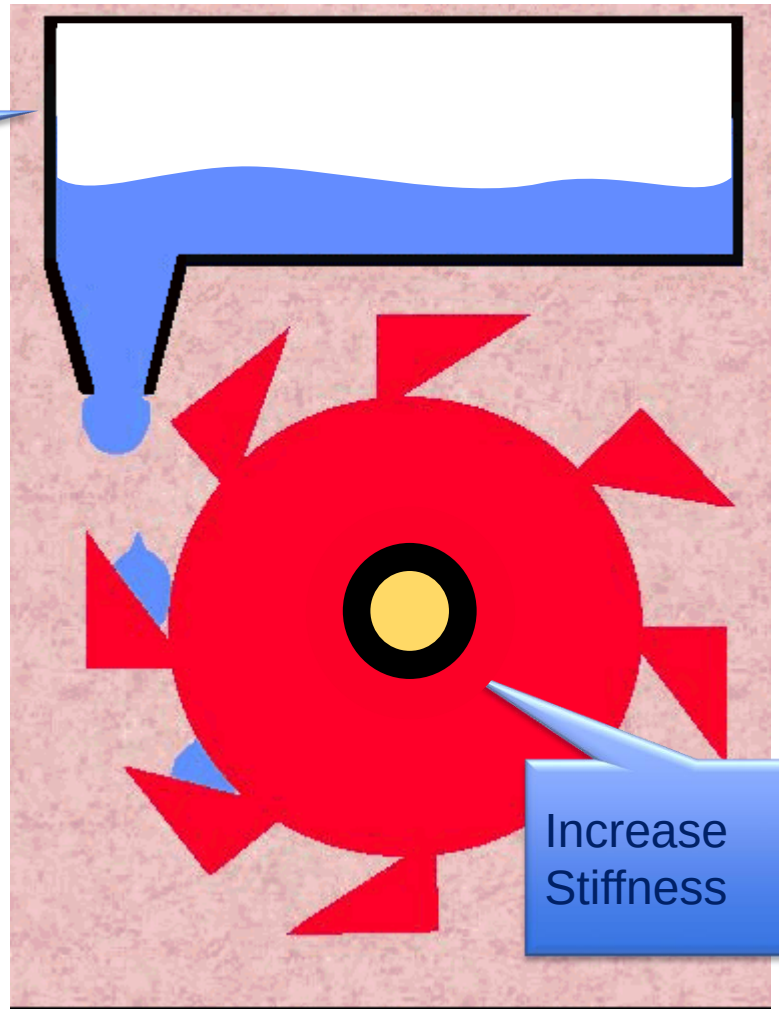


Hemodynamic Response to Diastolic Dysfunction



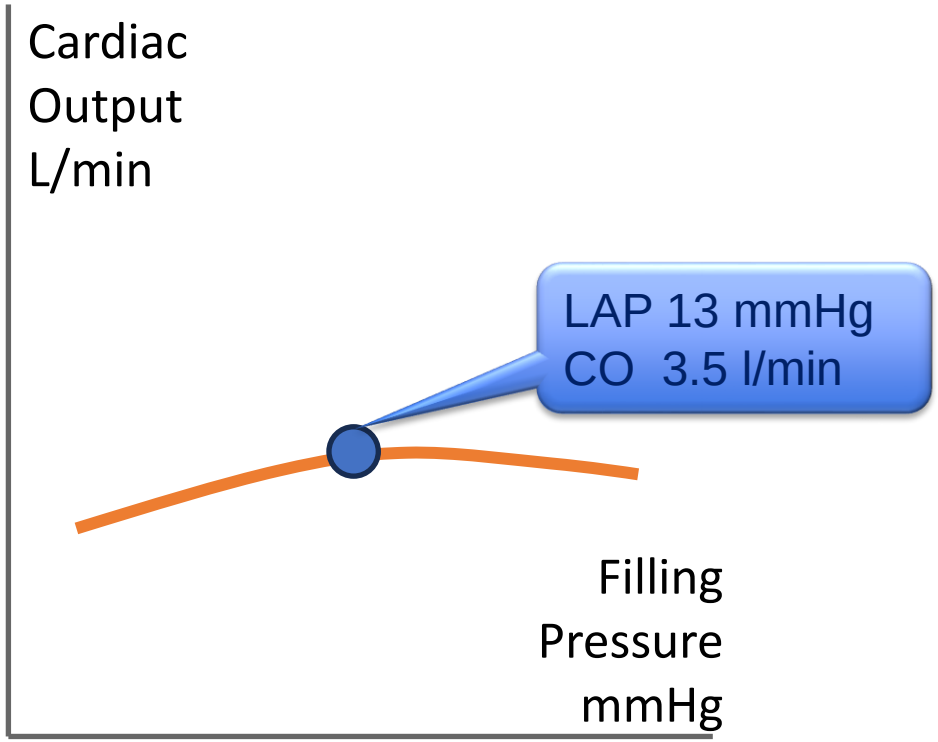
Increase
Filling Pressure

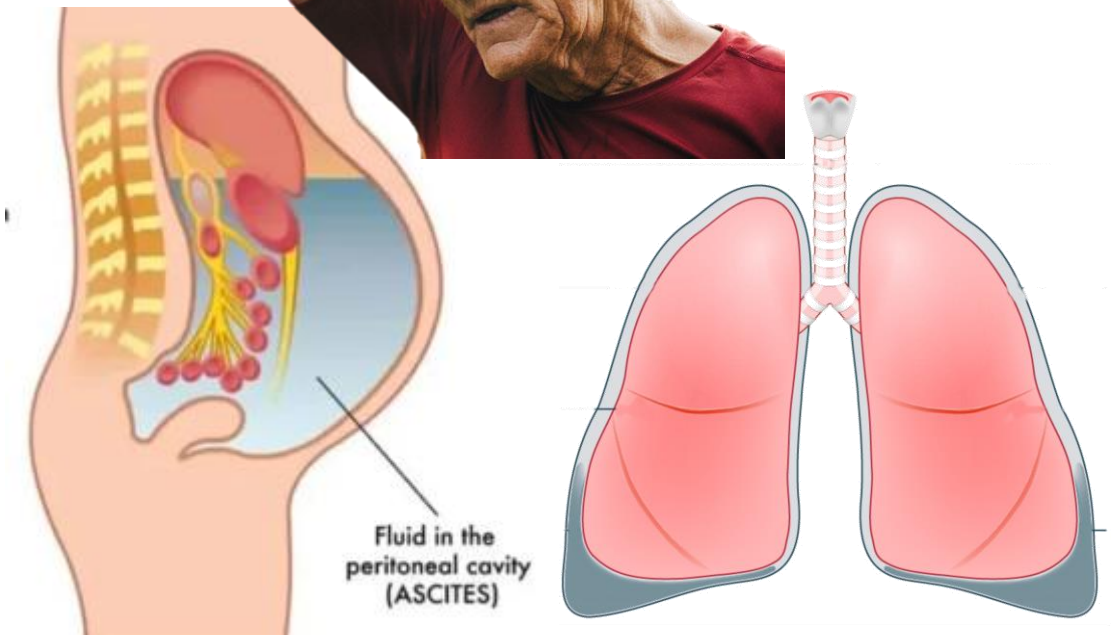
LAP 13 mmHg
CO 3.5 l/min



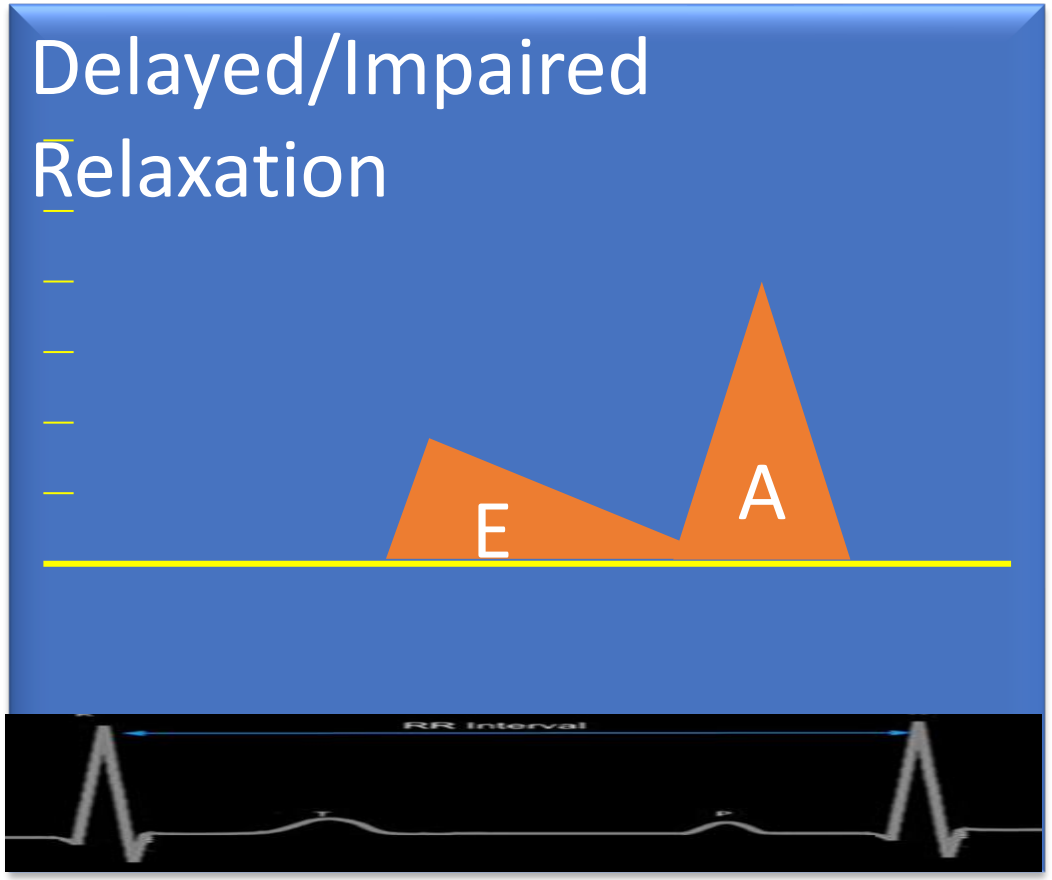
Increase
Stiffness

Consequence

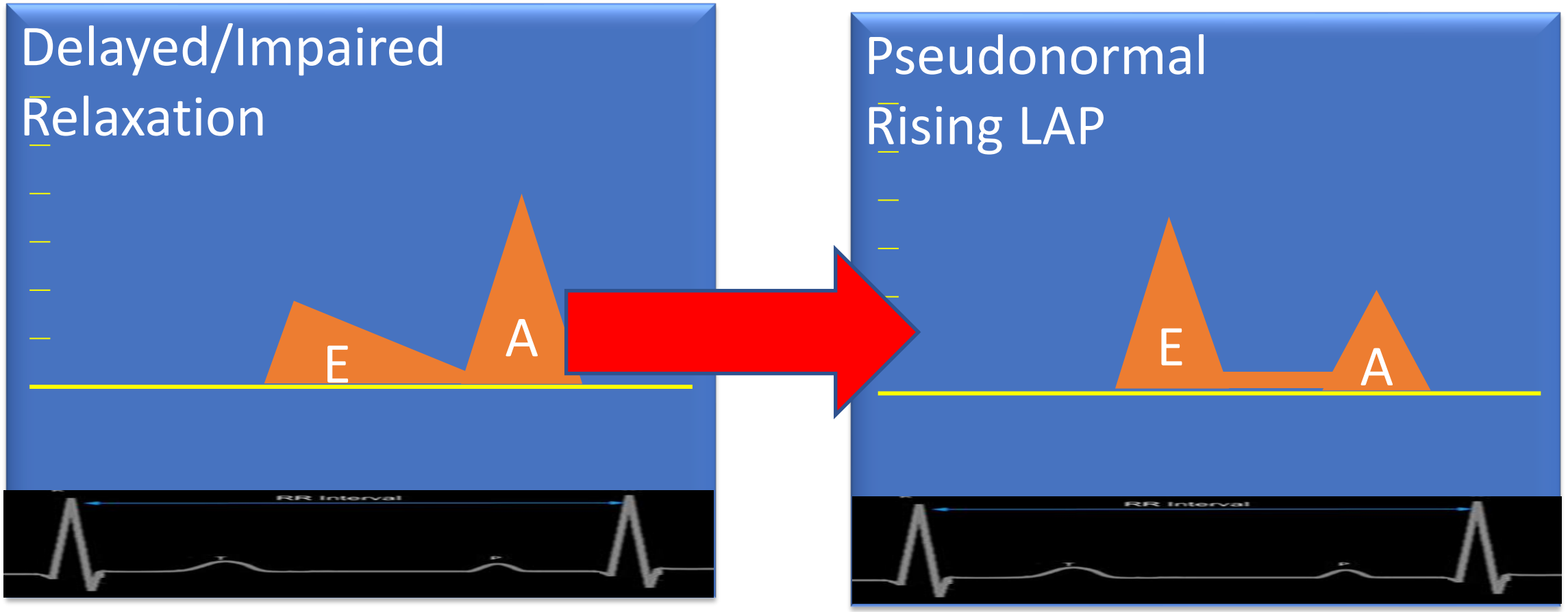




Further deterioration

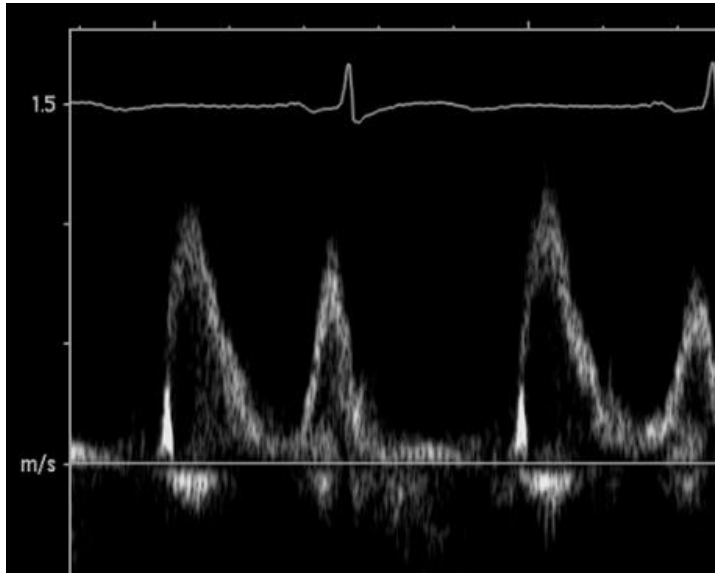


Progressive rise LAP - Pseudonormal



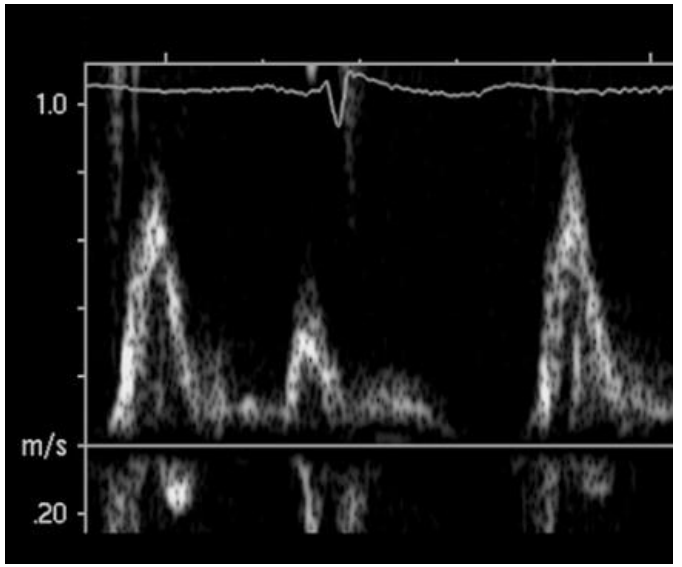
U-Shaped Curve

Healthier



E/A ratio
MV Inflow

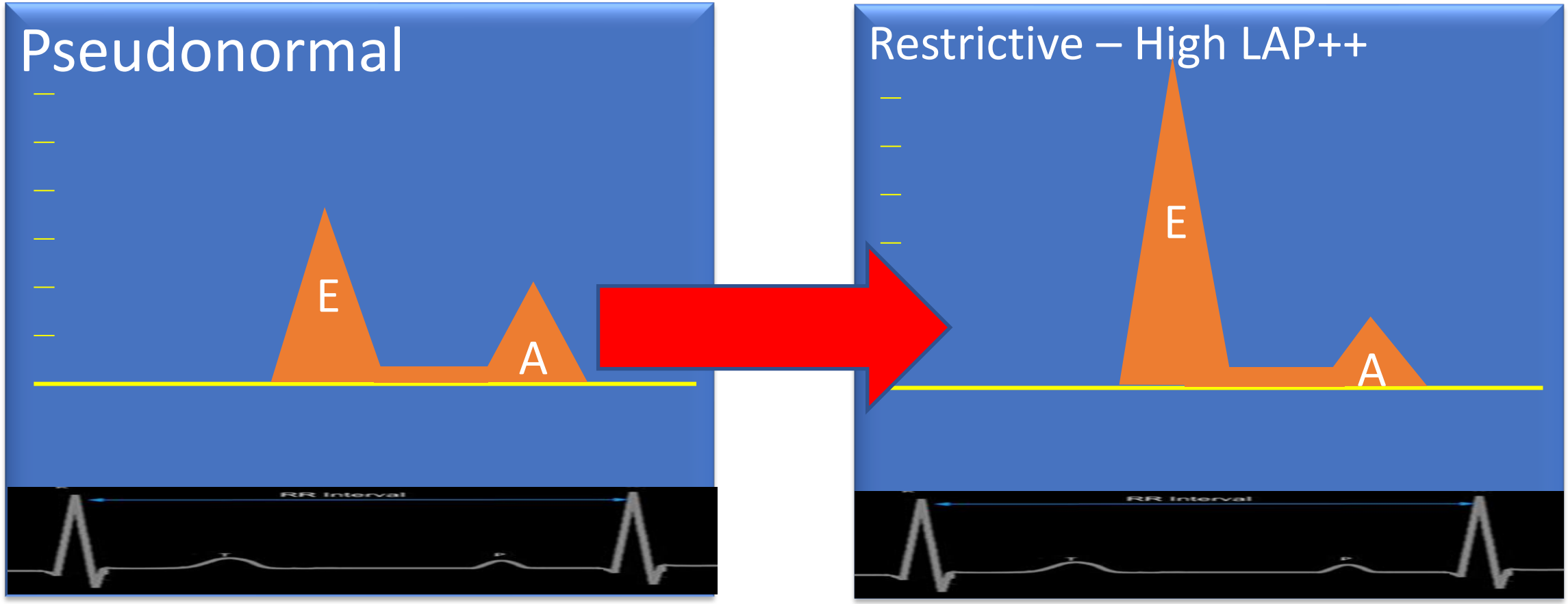
Sicker



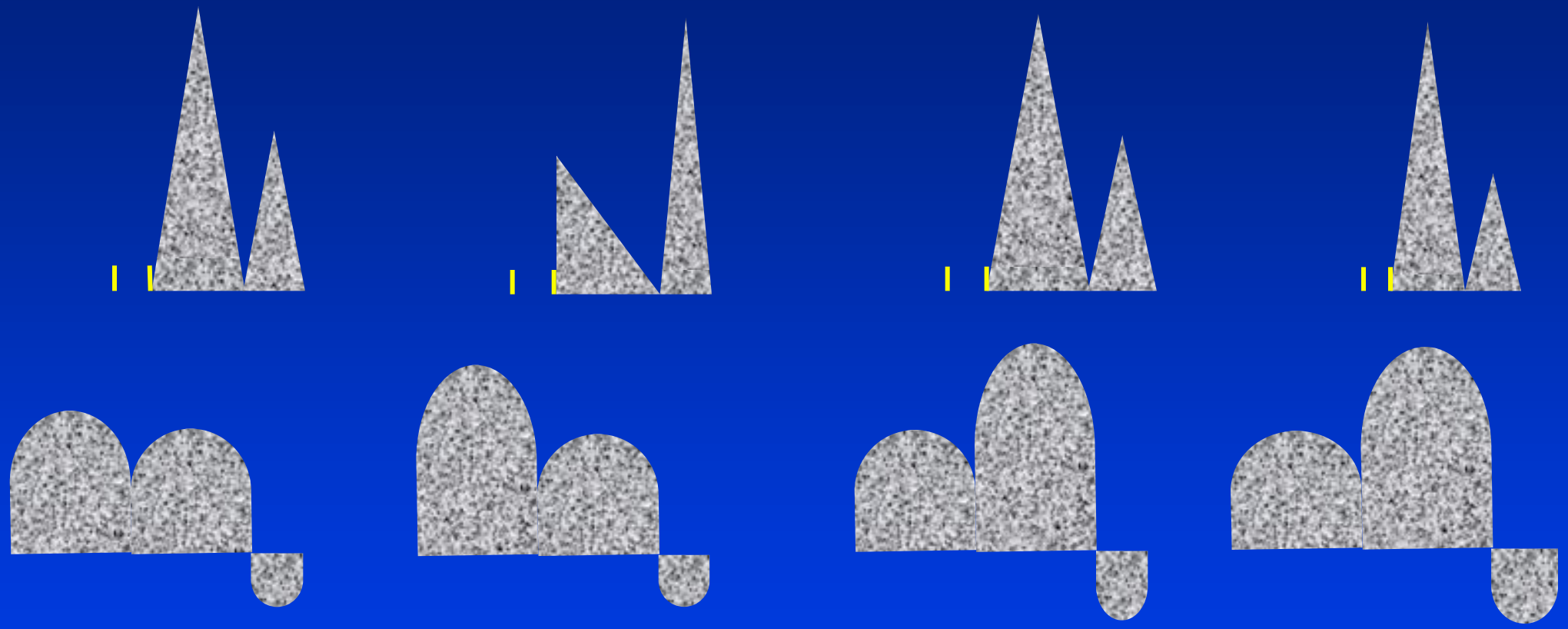
Rapid LA relaxation
Normal LV compliance

High LA pressure
Poor LV compliance

Very sick – very high LAP



Standard Doppler Diastolic Function Patterns



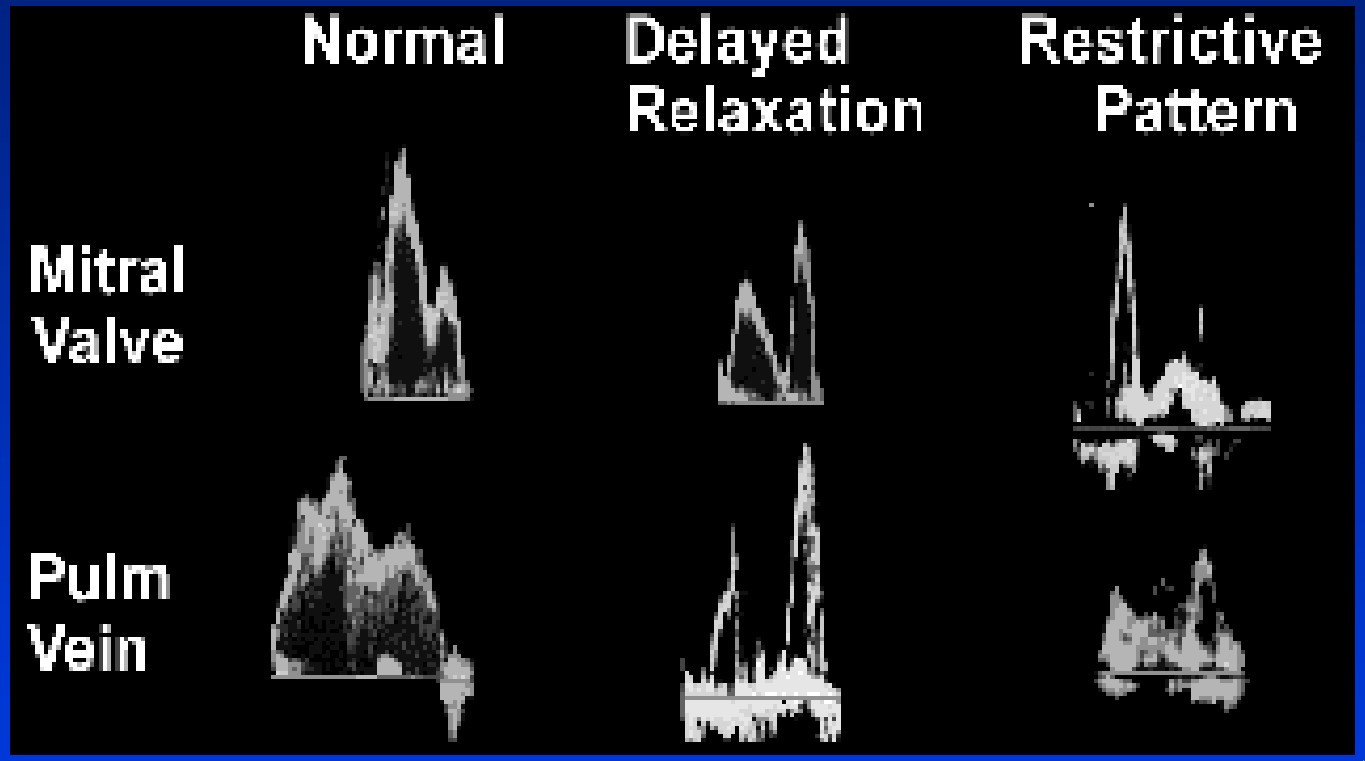
Normal

Abnormal Relaxation

Pseudo-normal

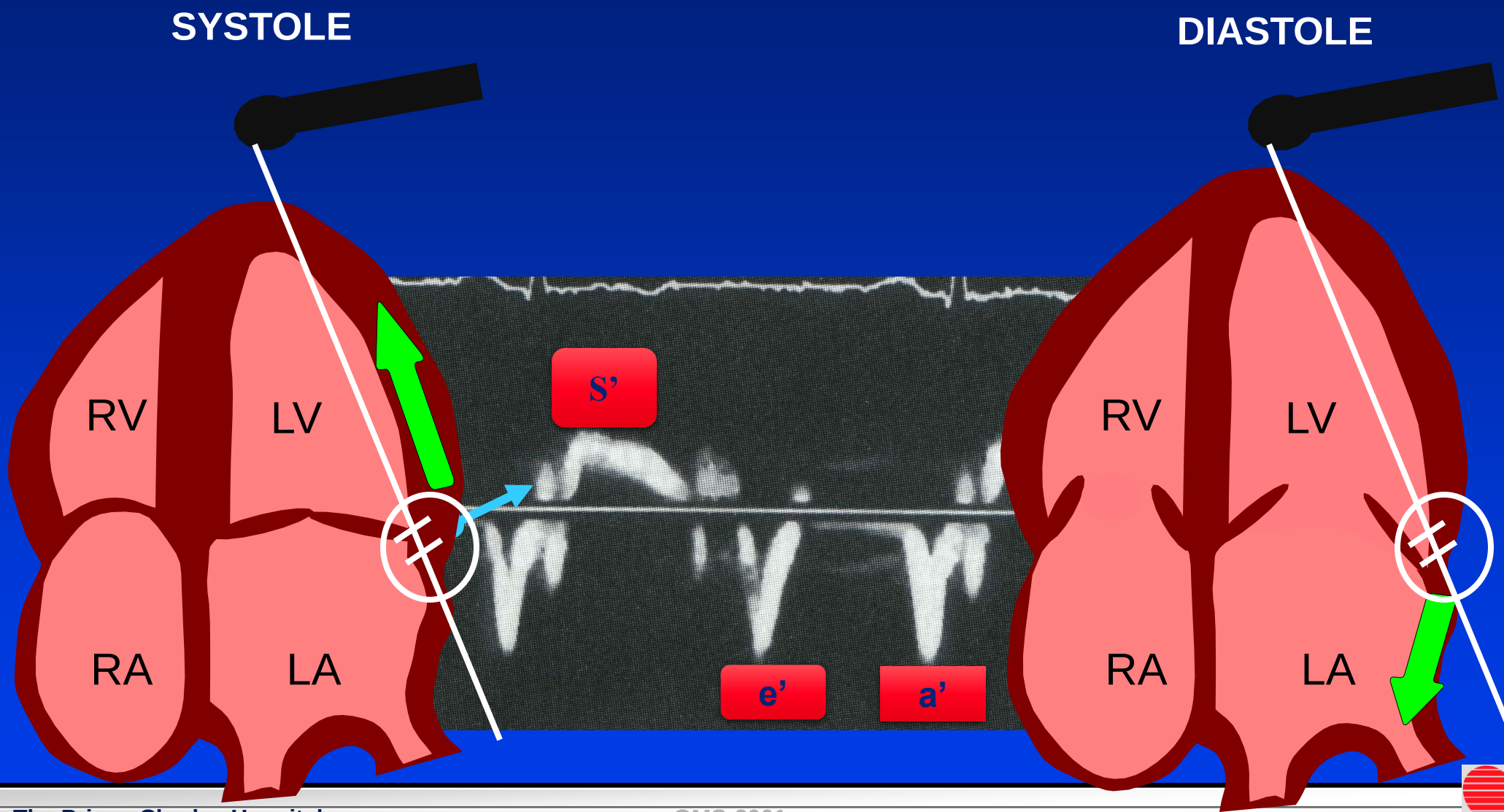
Restrictive

Background - Doppler Patterns

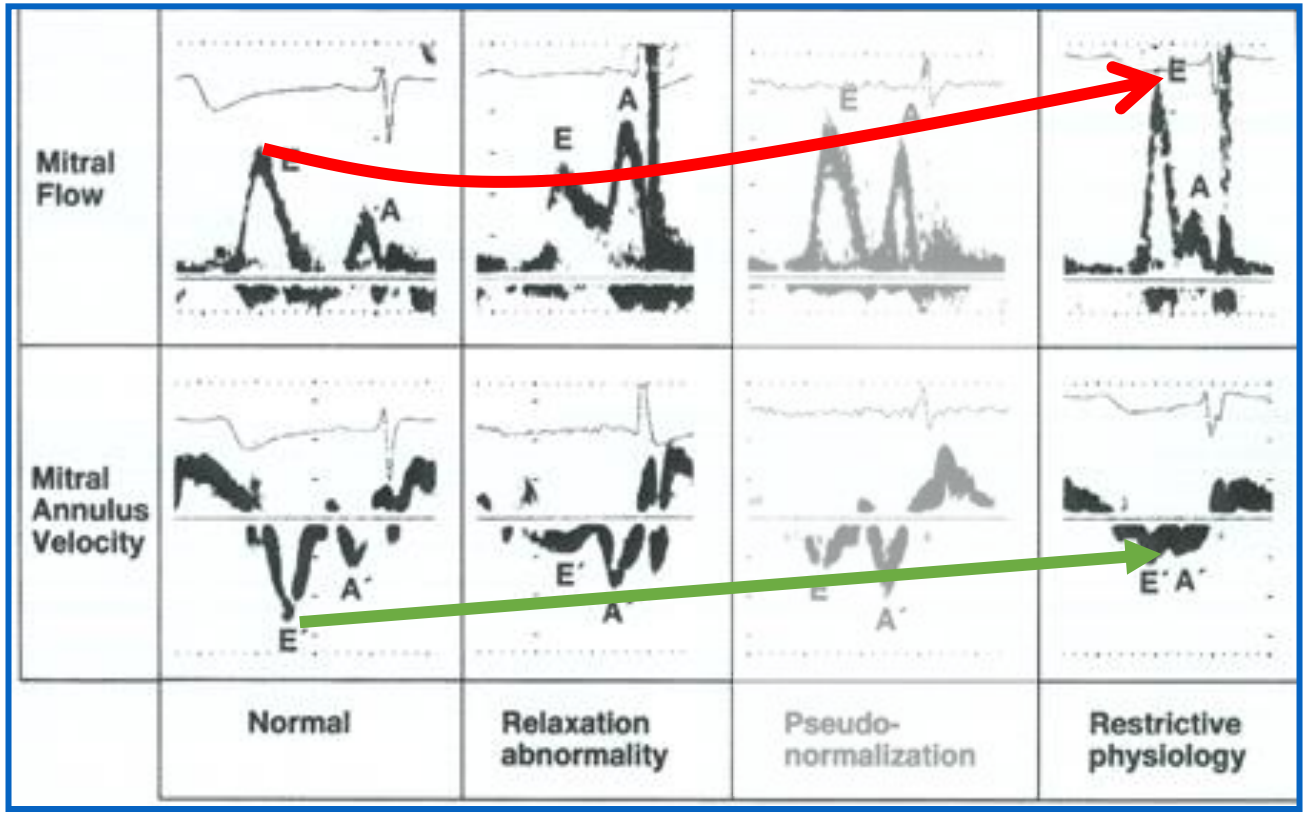


Lower **LA PRESSURE** Higher

Pulsed Doppler DTI

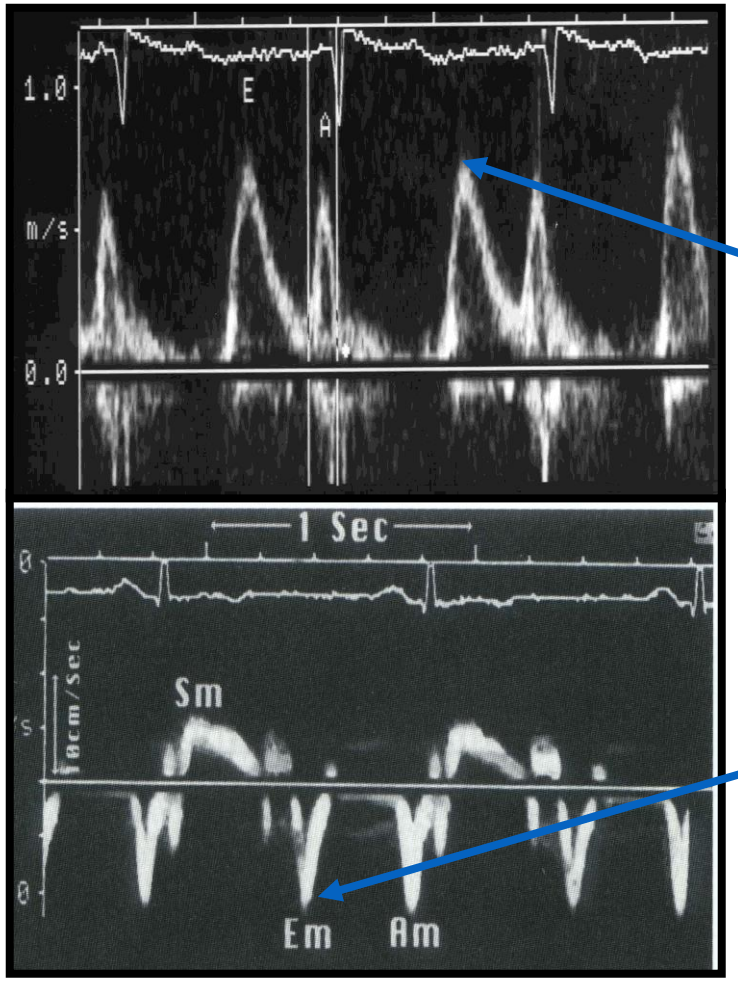


Pulsed Doppler DTI



Farias et al J Am Soc Echocardiogr 1999;12:609-617

Pulsed Doppler DTI



E

e’

E/e’ < 8 predicts normal mean LAP

E/e’ > 15 predicts elevated mean LAP >15mmHg

particularly useful in patients with markedly abnormal relaxation

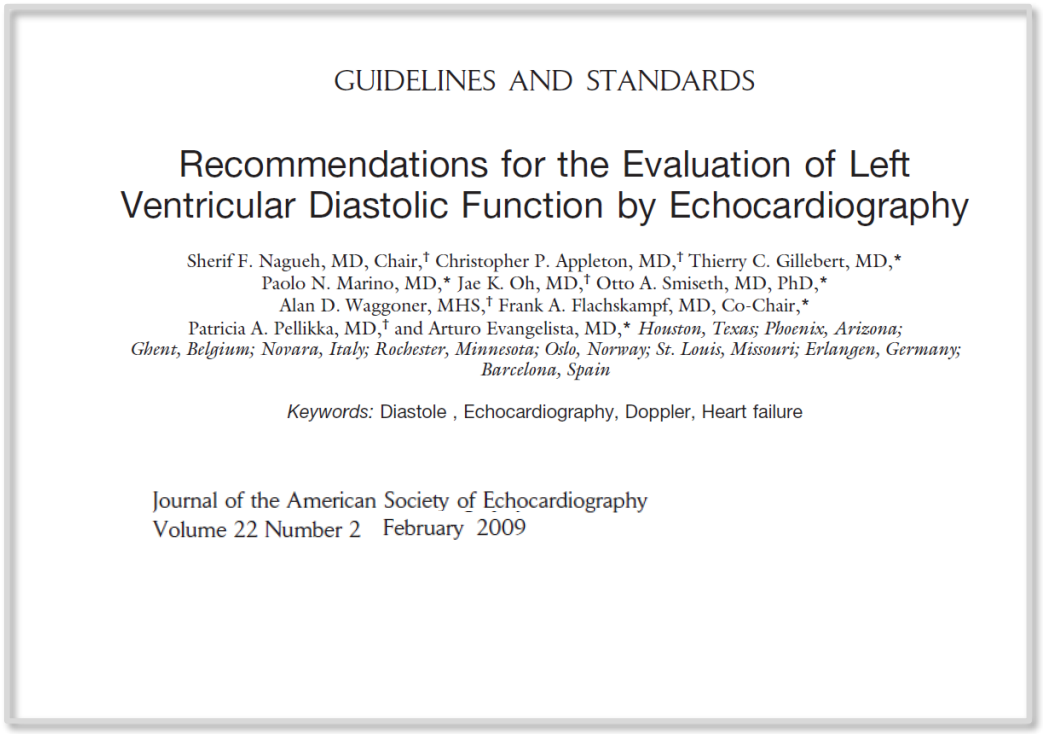
Ommen et al J Am Coll Cardiol Feb 2000

Markers of Diastolic Dysfunction

Elevated LV filling Pressures?

- **Mitral E/A – what if everyone is “sick”?**
- **E/e’ – LAP today**
- **PV S/D ratio – easier for blood to go backwards**
- **LA volume – LAP everyday**
- **Elevated RVSP (PHT) – back pressure**

ASE/EACVI Diastology Guidelines



GUIDELINES AND STANDARDS

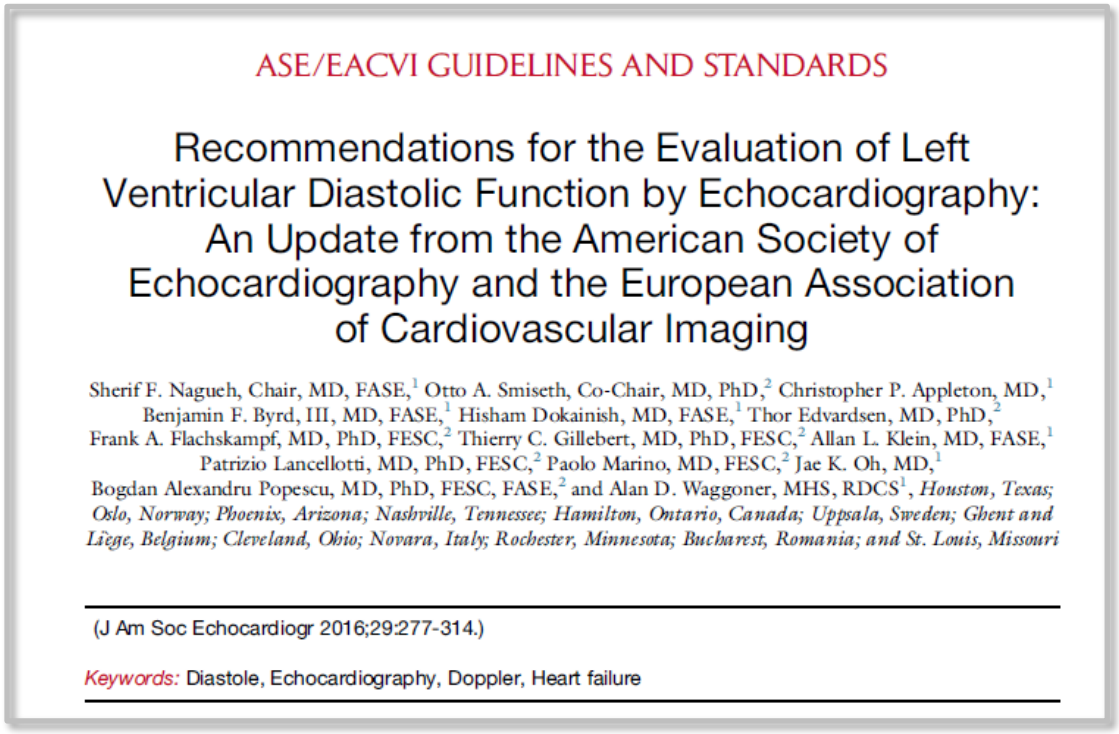
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography

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*

Keywords: Diastole , Echocardiography, Doppler, Heart failure

Journal of the American Society of Echocardiography
Volume 22 Number 2 February 2009

9 variables
3 algorithms
2009



ASE/EACVI GUIDELINES AND STANDARDS

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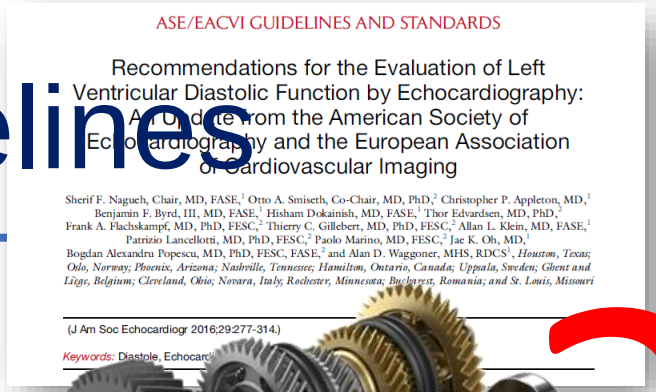
Sherif F. Nagueh, Chair, MD, FASE,[1] Otto A. Smiseth, Co-Chair, MD, PhD,[2] Christopher P. Appleton, MD,[1] Benjamin F. Byrd, III, MD, FASE,[1] Hisham Dokainish, MD, FASE,[1] Thor Edvardsen, MD, PhD,[2] Frank A. Flachskampf, MD, PhD, FESC,[2] Thierry C. Gillebert, MD, PhD, FESC,[2] Allan L. Klein, MD, 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.)

Keywords: Diastole, Echocardiography, Doppler, Heart failure

5 variables
2 algorithms
2016

General principles of 2016 Guidelines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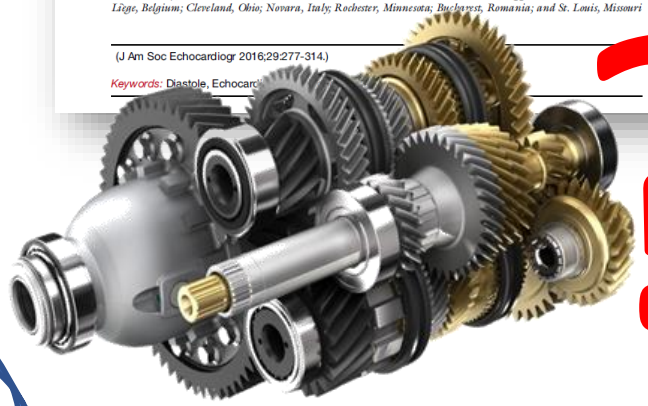
Keywords: Diastole, Echocard

'Screening' algorithm

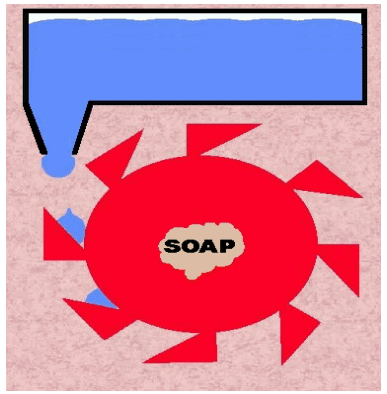
Normal LVEF and no clear myocardial disease - ??DD



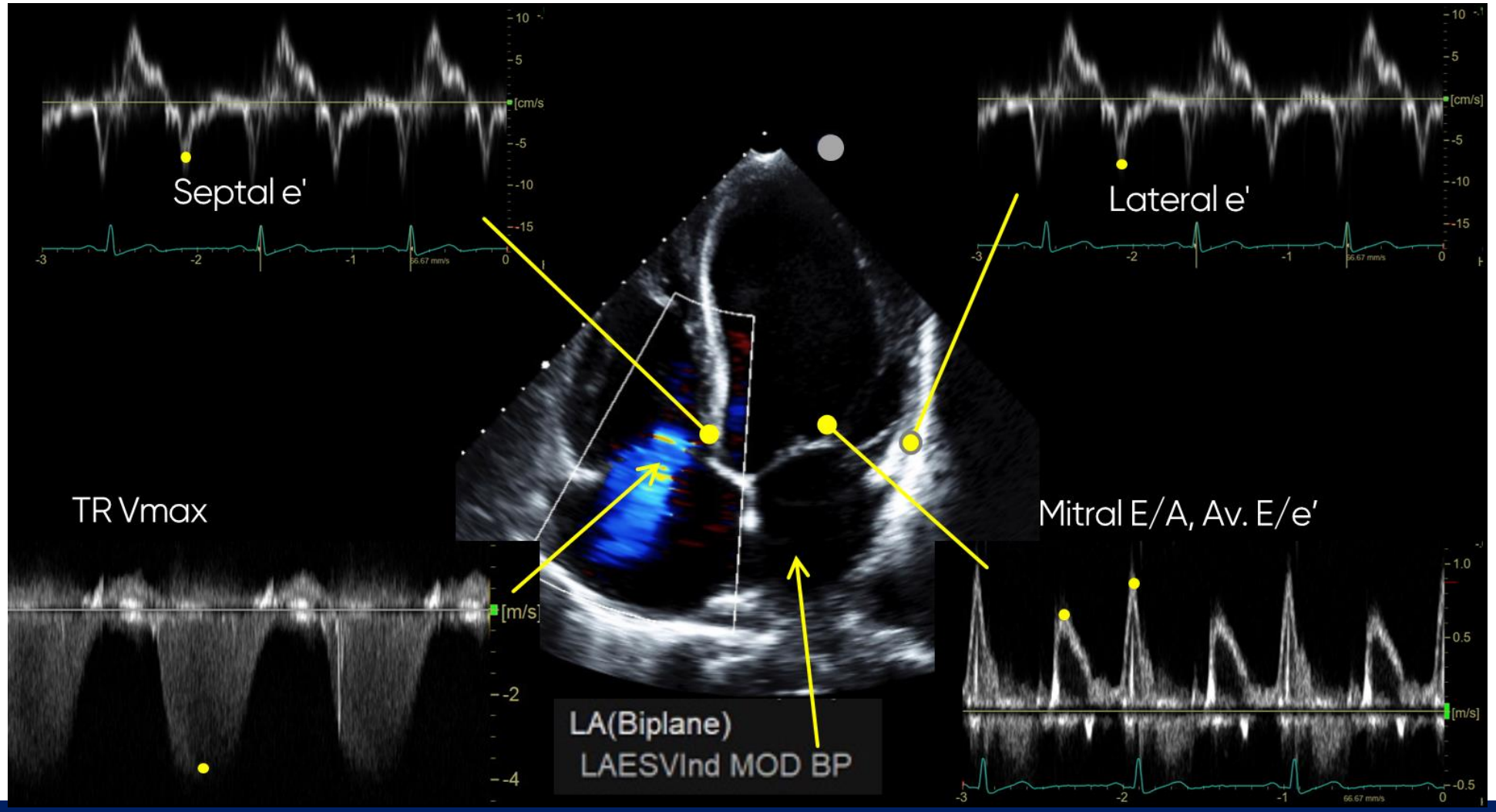
"Main" algorithm

Reduced EF or normal EF and DD

??High filling pressures



5 standard parameters 2016 guidelines



Screening Algorithm

Starting point in Patients with normal LVEF [and no clear myocardial disease]

None of these

Evidence of myocardial disease

- Known CV disease as CAD
- Pathologic LVH
- Hypertensive CV Disease (HTN+ LVH and/or LA enlargement)
- LV systolic dysfunction as noted by depressed LV EF
- Established clinical diagnosis of HFpEF
- Abnormal LV GLS or MAPSE or mitral s' velocity

(Modified from Nagueh et al J Am Soc Echocardiogr 2016;29:277-314.)

Screening Algorithm

Starting point in Patients with normal LVEF [and no clear myocardial disease]

1. Average E/e' >14
2. Septal e' <7 cm/s or Lateral e' <10cm/s
3. TR velocity > 2.8m/s
4. LA volume index >34mls/m^2

None of these

<50% positive	50% positive	>50% positive
1		3-4
Normal Diastolic function	Indeterminate	Diastolic Dysfunction

Evidence of myocardial disease

- Known CV disease as CAD
- Pathologic LVH
- Hypertensive CV Disease (HTN+ LVH and/or LA enlargement)
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ECHO AUSTRALIA

Main Algorithm

Mitral Inflow

E/A ≤ 0.8 + E ≤ 50cm/s

Normal LAP
Grade 1 DD

E/A ≤ 0.8 + E > 50cm/s
or
E/A > 0.8 to <2

3 criteria to be evaluated*

*in absence of one major criteria, PV S/D ratio <1 can be substituted

3 of 3 NEGATIVE	1. Average E/e' >14 2. TR velocity >2.8m/s 3. LAV index > 34mls/m^2	3 of 3 POSITIVE
2 NEGATIVE	When only 2 criteria are available	2 POSITIVE

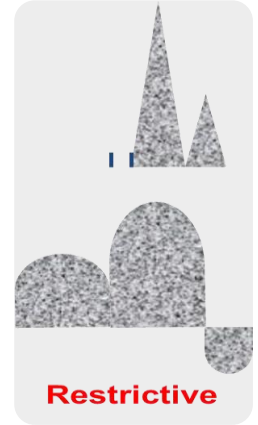
1 POSITIVE and 1 NEGATIVE

Indeterminate

If symptomatic, Diastolic stress test

Elevated LAP
Grade 2 DD

E/A ≥ 2



High LAP
Grade 3 DD

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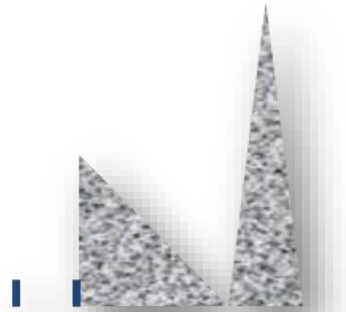
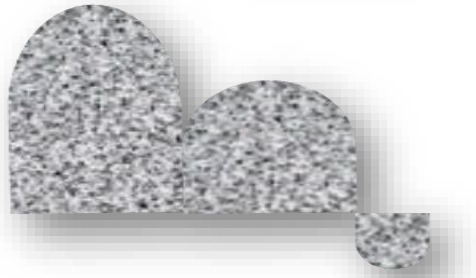
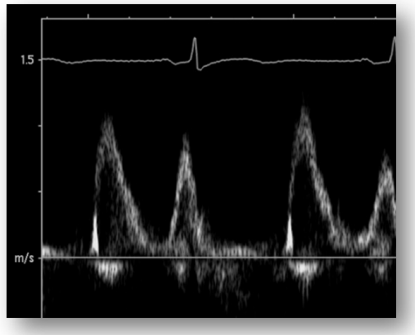




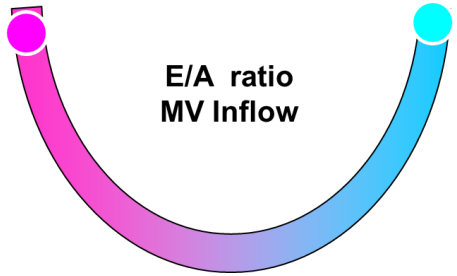
Abnormal Relaxation

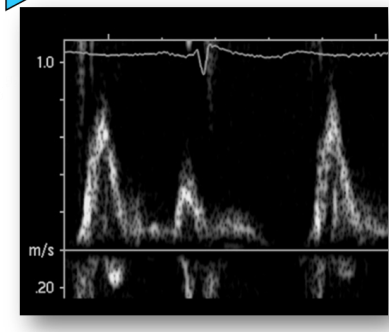
L O W L A P

Healthier → **Sicker**



Rapid LA relaxation
Normal LV compliance





High LA pressure
Poor LV compliance

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Grade 1 DD

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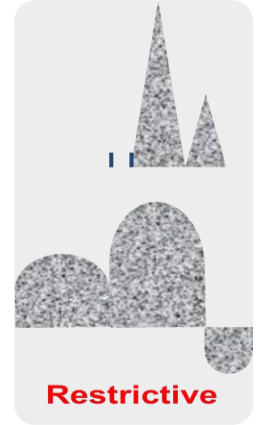
Indeterminate

If symptomatic, Diastolic stress test

Elevated LAP
Grade 2 DD

E/A ≥ 2



High LAP
Grade 3 DD

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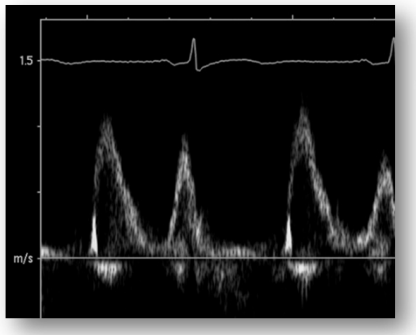
ECHO AUSTRALIA

Main Algorithm

Mitral Inflow

HIGH LAP

Healthier → Sicker



Rapid LA relaxation
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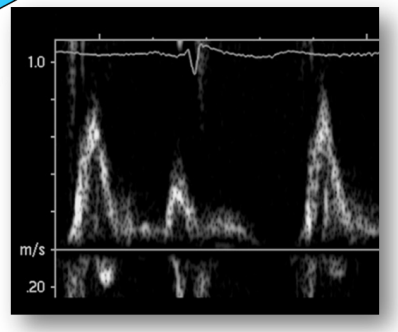
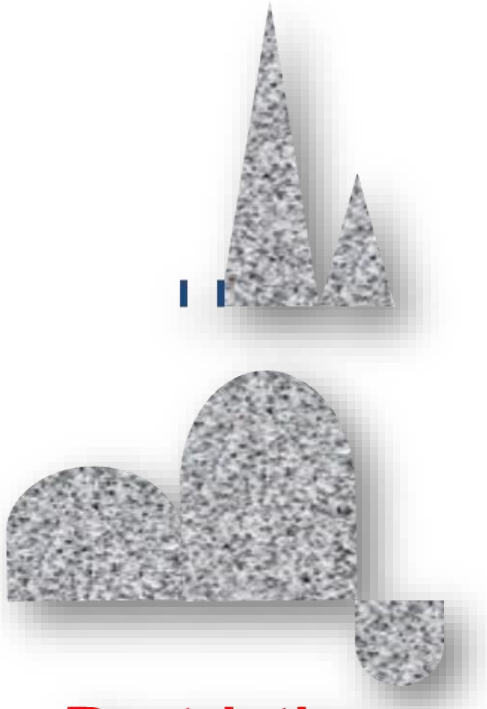
E/A ratio
MV Inflow



High LA pressure
Poor LV compliance



Restrictive

E/A ≥ 2

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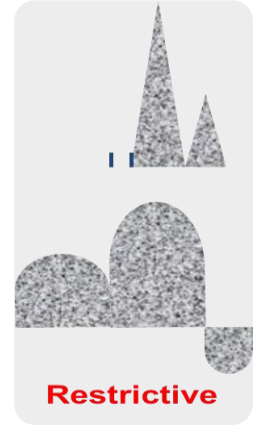

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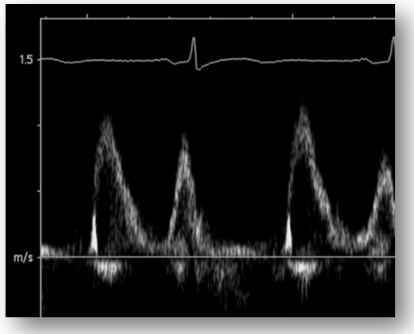
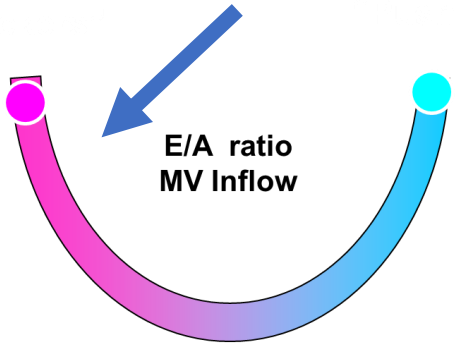
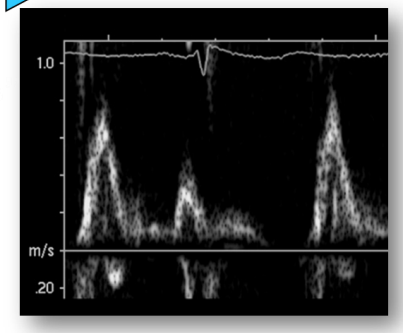
Grade 2 DD

Healthier → **Sicker**



Rapid LA relaxation
Normal LV compliance





High LA pressure
Poor LV compliance

(Modified from Nagueh et al J Am Soc Echocardiogr 2016;29:277-314.)

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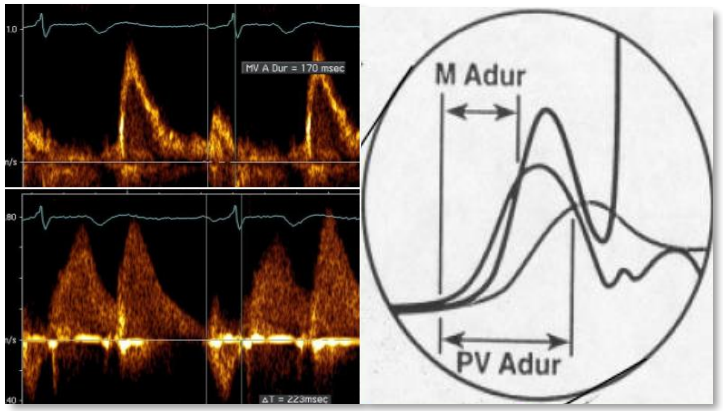
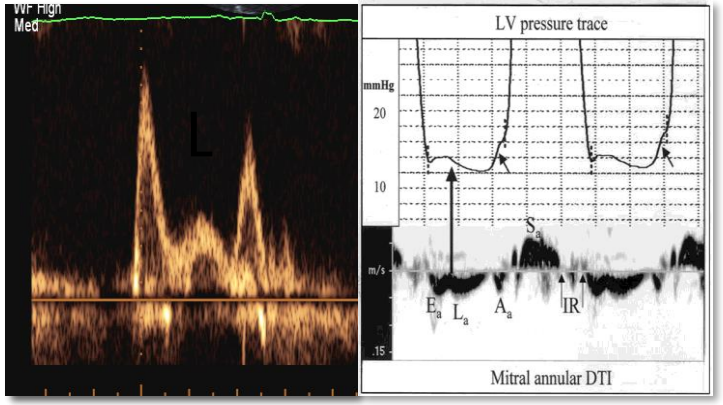
What do you do for indeterminate studies?
Role of supplementary parameters

- **Pulm Venous flow**
  - S/D ratio
  - AR_d – Mitral A_d > 30ms
- **Positive Valsalva manoeuvre**
- **L wave in Mitral inflow**
- **Diastolic stress test**

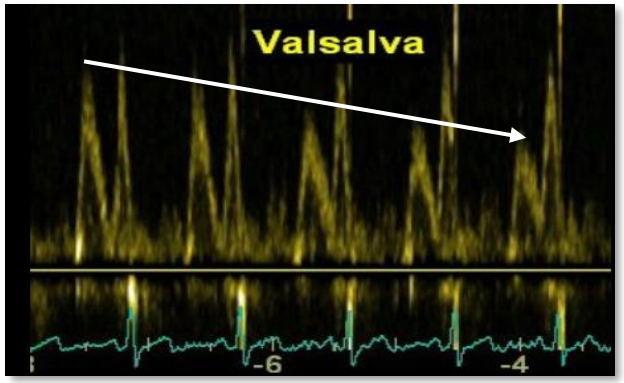


S/D <1 : raised LVFP
Ar_d-A_d >30ms : raised LVEDP



L wave : advanced DD with raised LVFP

Frommelt et al J Am Soc Echo 16: 176, 2003



+ve Valsalva : raised LVFP
Defined as a reduction in E/A >0.5

neda
national echo database australia

Principal Investigator
Professor David Playford

1.8 million echos

Principal Investigator
Professor Geoff Strange

Professor David Celermajer
Professor Greg Scalia
Professor Tom Marwick
A/Professor David Prior
Dr Majo Joseph
Dr Marcus Ilton
Professor Simon Stewart
Professor Jim Codde

NEDA Diastolic function 2021

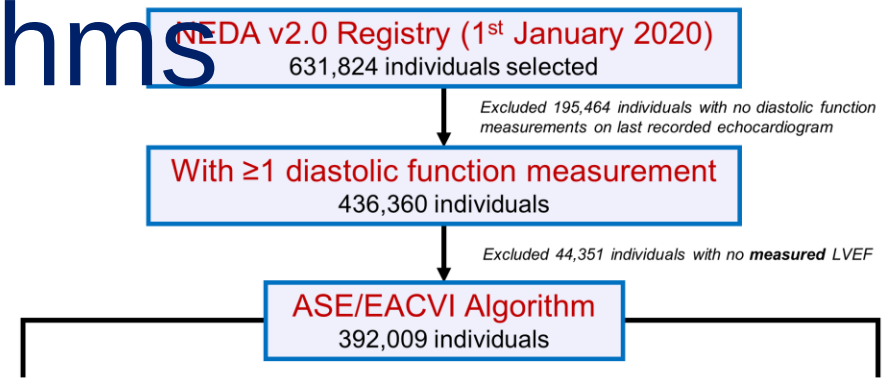
ESC European Society of Cardiology

European Heart Journal - Cardiovascular Imaging (2021) **22**, 505–515
doi:10.1093/ehjci/jeaa253

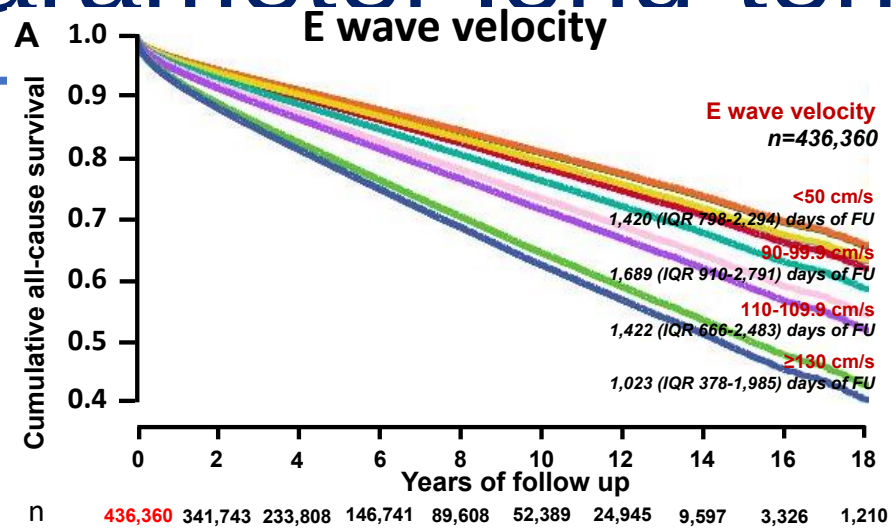
Diastolic dysfunction and mortality in 436 360 men and women: the National Echo Database Australia (NEDA)

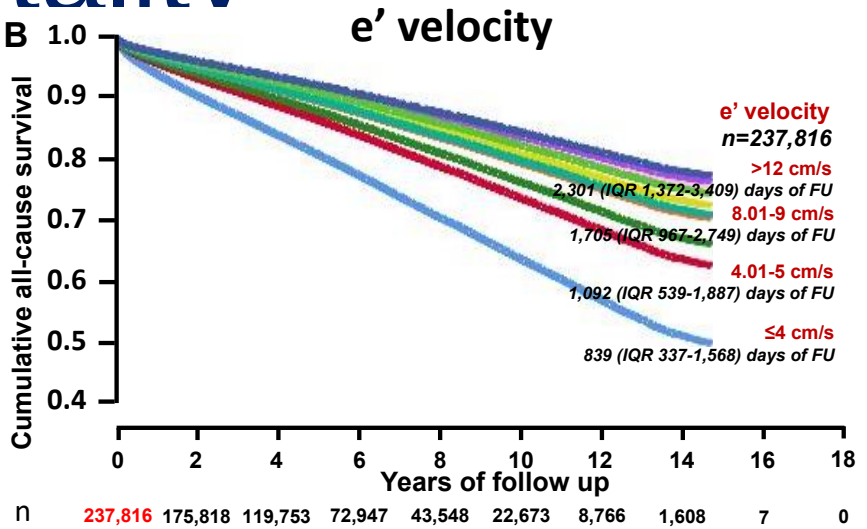
David Playford [1]*, Geoff Strange [1], David S. Celermajer [2], Geoffrey Evans [3], Gregory M. Scalia [4], Simon Stewart [5,6], and David Prior [7,8]; On behalf of the NEDA Investigators

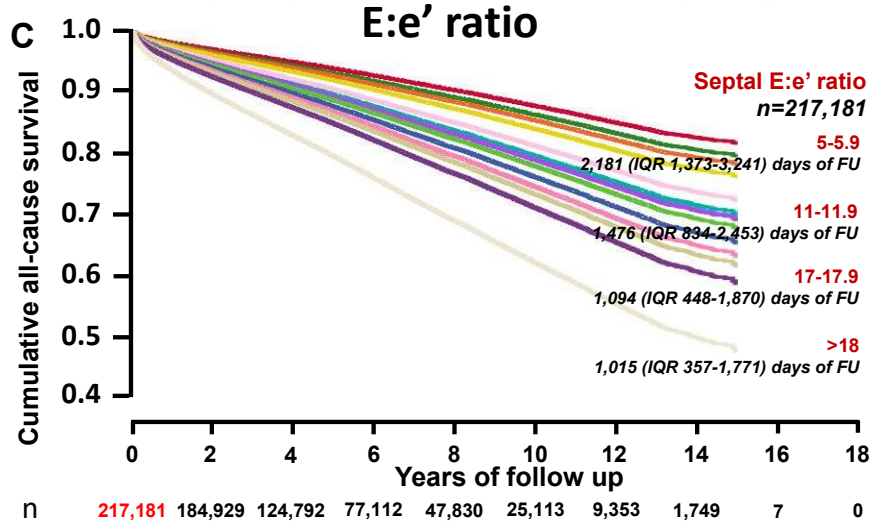
2016 ASE Algorithms

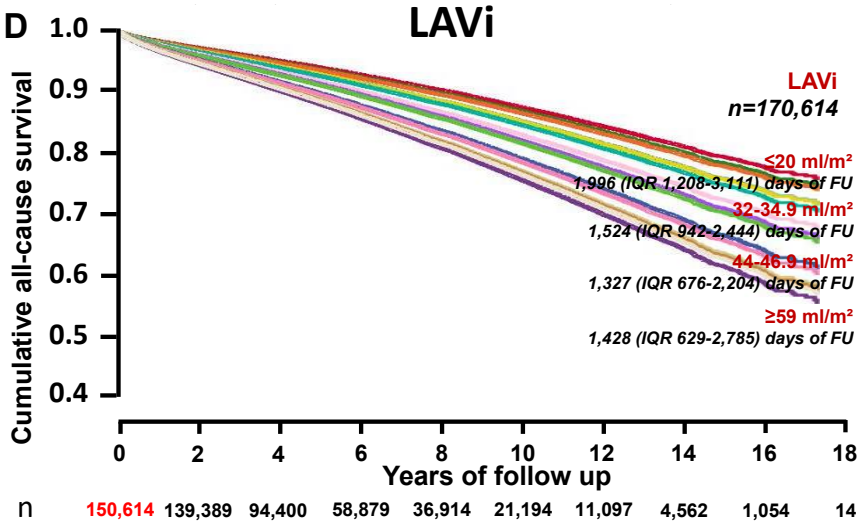


Parameter long-term mortality

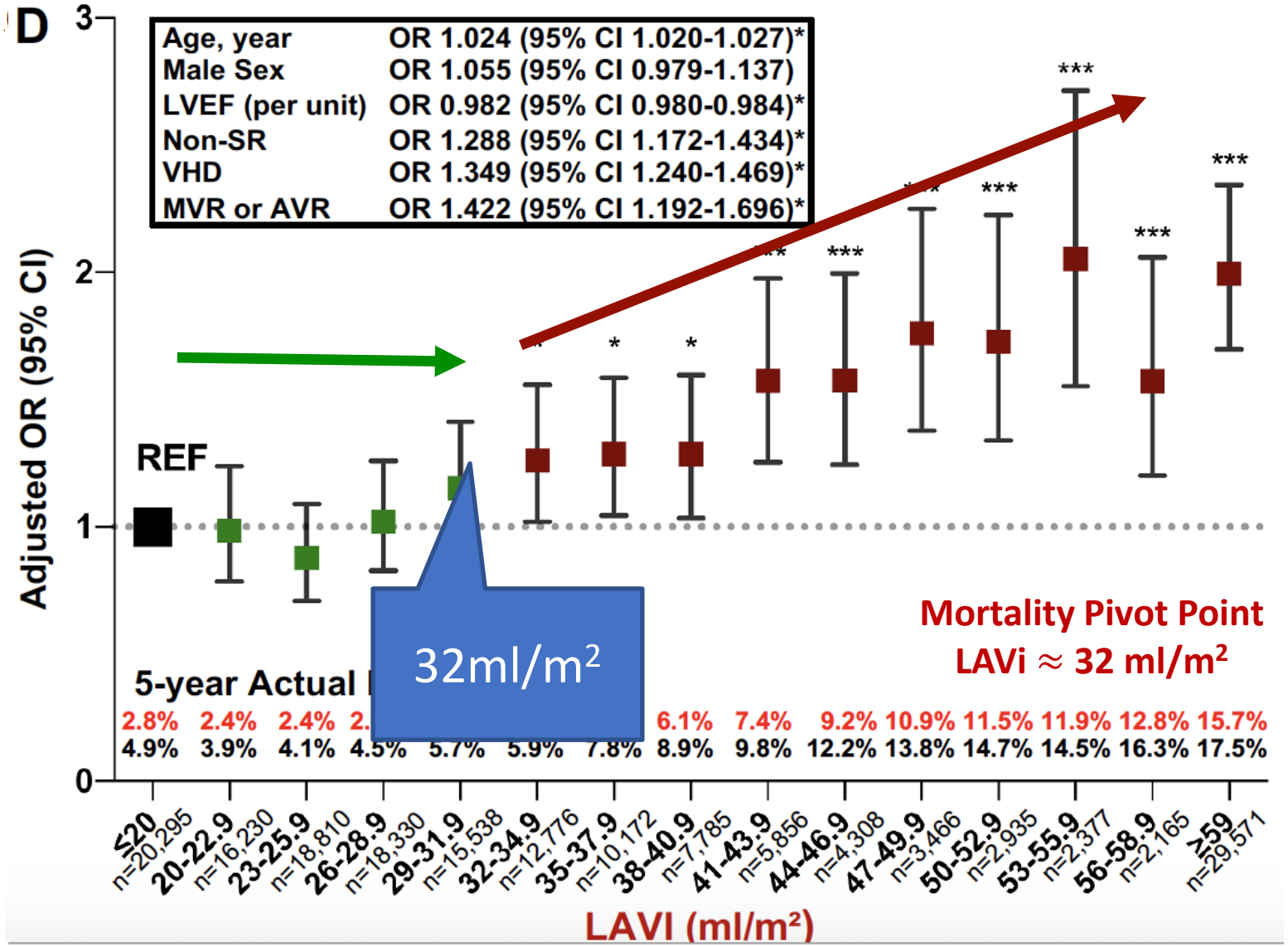








Indexed Left Atrial Volume



Diastology – 2024+…….

- Determine of there are intrinsic relaxation and stiffness issues with LV
- Determine degree of filling pressure response - this is where the symptoms come from…
- Use the parametric algorithms to determine DD and LAP
- Think of new parameters like LA strain….watch this space.
- Big data may be resetting cut-points of “normality”
- Await Diastology guidelines 2025!

Diastolic Function
What are we measuring?

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17-19 March 2025