Assessment of Diastolic LV Function
New ASE Guidelines 2016
Harald Becher, MD, PhD
2016 New Guidelines

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

Diastolic Function – who cares?

- Patients with dyspnea or history of heart failure but normal systolic function

- Patient with known heart disease and dyspnea

- High left atrial pressure related to dyspnea
LV Filling pressures translate into LA and lung vessels

Early diastole – 
Mean PCWP

Late diastole – 
LVEDP

Diast.Dysfunction grade = filling pressure (LAP or PCWP)=VmaxTR
Because better correlation for pulmonary pressures
Diastolic dysfunction – old grading

Normal

Abnormal Relaxation

Pseudo-normalization

Restriction (reversible)

Restriction (irreversible)

Mean LAP =

TAU =

NYHA

Grade diastolic dysfunction
Diastolic dysfunction – new grading

<table>
<thead>
<tr>
<th>Normal</th>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
</tr>
</thead>
</table>

**Mean LAP**

**TAU**

**NYHA**

**Grade diastolic dysfunction**

- Grade I
- Grade II
- Grade III

2016 ASE Recommendations Diastolic Function
<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LV relaxation</strong></td>
<td>Normal</td>
<td>Impaired</td>
<td>Impaired</td>
<td>Impaired</td>
</tr>
<tr>
<td><strong>LAP</strong></td>
<td>Normal</td>
<td>Low or normal</td>
<td>Elevated</td>
<td>Elevated</td>
</tr>
<tr>
<td><strong>Mitral E/A ratio</strong></td>
<td>$\geq 0.8$</td>
<td>$\leq 0.8$</td>
<td>$&gt;0.8$ to $&lt;2$</td>
<td>$&gt;2$</td>
</tr>
<tr>
<td><strong>Average E/e’ ratio</strong></td>
<td>$&lt;10$</td>
<td>$&lt;10$</td>
<td>$10$ to $14$</td>
<td>$&gt;14$</td>
</tr>
<tr>
<td><strong>Peak TR velocity</strong></td>
<td>$&lt;2.8$</td>
<td>$&lt;2.8$</td>
<td>$&gt;2.8$</td>
<td>$&gt;2.8$</td>
</tr>
<tr>
<td><strong>LA volume index</strong></td>
<td>Normal</td>
<td>Normal or increased</td>
<td>Increased</td>
<td>Increased</td>
</tr>
</tbody>
</table>
Conclusions on LV diastolic function should be included routinely in reports when feasible, particularly in patients referred with symptoms of dyspnea or diagnosis of heart failure.

- The report should comment on LV filling pressures and the grade of LV diastolic dysfunction.

- If available, comparison with previous studies is encouraged to detect and comment on changes in diastolic function grade over time.
Do not rely on only one measurement

Consistency between at least 2 measurements for assessing Diastolic Function

Algorithm for both screening and classification of diastolic dysfunction.

CW Doppler of Tricuspid Regurgitation for assessment of LVEDP
Key parameters

- Mitral inflow – PW Doppler
- Mitral ring tissue Doppler
- LA volume index
- Tricuspid regurgitation
First Questions when assessing diastolic function

- Is LV ejection fraction abnormal?
- Does the patients have known myocardial disease with normal EF?
  - CAD, regional wall motion abnormalities
  - LVH
  - Abnormal GLS
In patients with normal LV EF

1-Average E/e’ > 14
2-Septal e’ velocity < 7 cm/s or Lateral e’ velocity <10 cm/s
3-TR velocity > 2.8 m/s
4-LA volume index >34ml/m²

<50% positive
Normal Diastolic function

50% positive
Indeterminate

>50% positive
Diastolic Dysfunction
In patients with normal LV EF

1-Average E/e’ > 14
2-Septal e’ velocity < 7 cm/s or Lateral e’ velocity <10 cm/s
3-TR velocity > 2.8 m/s
4-LA volume index >34ml/m²

- <50% positive
  - Normal Diastolic function

- 50% positive
  - Indeterminate

- >50% positive
  - Diastolic Dysfunction

= myocardial disease

Continue like in Pts with reduced EF

LA size, GLS S’

2016 ASE Recommendations Diastolic Function
Diastolic Function in patients with reduced EF

- The main reason to assess diastolic function in patients with reduced EF is to estimate LV filling pressure or left atrial pressure.
Diastolic Function in patients with reduced EF

- The main reason to assess diastolic function in patients with reduced EF is to estimate LV filling pressure or left atrial pressure.

- Assessment of mitral inflow + three other key parameters (not necessary in all patients).
Assessing Diastolic LV Function in Patients with reduced EF: 
**Mitral Inflow first!**

- $E/A \leq 0.8$ and $E \leq 50$ cm/s
- $E/A > 2$
- Every other $E/A$ and $E > 50$ cm/s
Assessing Diastolic LV Function in Patients with reduced EF: Mitral Inflow first!

- E/A ≤ 0.8 and E ≤ 50 cm/s
- E/A > 2
- Every other E/A and E > 50 cm/s
If E/A > 2 no further measurements needed
In particular no deceleration time
Assessing Diastolic LV Function in Patients with reduced EF: Mitral Inflow first!

- $E/A \leq 0.8$ and $E \leq 50 \text{ cm/s}$
  
  Normal LAP, Grade 1 Diast.Dysfunction

- $E/A > 2$
  
  Every other $E/A$ and $E > 50 \text{ cm/s}$
Assessing Diastolic LV Function in Patients with reduced EF: Mitral Inflow first!

- **E/A ≤ 0.8 and E ≤ 50 cm/s**
  - Normal LAP, Grade 1 Diast.Dysfunction

- **E/A > 2**
  - High LAP, Grade 3 Diast.Dysfunction

- **Every other E/A and E > 50 cm/s**
Patients with reduced EF

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

3 criteria to be evaluated*

1- Average E/e' > 14
2- TR velocity > 2.8 m/s
3- LA Vol. index > 34 ml/m²
Patients with reduced EF

3 criteria to be evaluated*

1. Average E/e’ > 14
2. TR > 2.8 m/s
3. LA Vol > 34 ml/m²

When only 2 criteria are available

2 negative 1 positive and 1 negative 2 positive

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic

Consider CAD, or proceed to diastolic stress test

Cannot determine LAP and Diastolic Dysfunction Grade*

↑ LAP
Grade II Diastolic Dysfunction
<table>
<thead>
<tr>
<th>LA index:</th>
<th>E/e’ (average):</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 34 cm³/m²</td>
<td>&gt; 14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TR max. velocity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 2.8 cm/s</td>
</tr>
<tr>
<td>LA index:</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>&gt;34 cm³/m²</td>
</tr>
<tr>
<td>31 cm³/m²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TR max.velocity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2.8 cm/s</td>
</tr>
<tr>
<td>2.6 cm/s</td>
</tr>
<tr>
<td>LA index:</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>&gt;34 cm³/m²</td>
</tr>
<tr>
<td>31 cm³/m²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TR max. velocity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2.8 cm/s</td>
</tr>
<tr>
<td>No CW Signal</td>
</tr>
</tbody>
</table>
PW Doppler - RUPV
<table>
<thead>
<tr>
<th>LA index:</th>
<th>E/e’ (average):</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;34 cm³/m²</td>
<td>&gt;14</td>
</tr>
<tr>
<td>31 cm³/m²</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulmonary Vein S/D ratio</th>
<th>TR max.velocity:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>&gt;2.8 cm/s</td>
</tr>
<tr>
<td></td>
<td>No CW Signal</td>
</tr>
</tbody>
</table>
Patients with reduced EF or myocardial disease with normal EF

Mitral Inflow

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

E/A ≥ 2

3 criteria to be evaluated*

1. Average E/e’ > 14
2. TR velocity > 2.8 m/s
3. LA Vol. index > 34ml/m²

2 of 3 or 3 of 3
Negative

2 of 3 or 3 of 3
Positive

When only 2 criteria are available

2 negative

1 positive and 1 negative

2 positive

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic
Consider CAD, or proceed to diastolic stress test

Cannot determine LAP and Diastolic Dysfunction
Grade*

↑ LAP
Grade II Diastolic Dysfunction

↑ LAP
Grade III Diastolic Dysfunction
When you cannot use the flowcharts

- Atrial fibrillation – use different rules
- More than moderate mitral regurgitation
- Severe mitral ring calcification
- Mitral valve repair or prosthesis
- LBBB, paced ventricular rhythm
- LV assist devices
Change in Reporting Diastolic Function

- Normal diastolic function and filling pressure
- Grade 1 (impaired relaxation with low to normal filling pressure)
- Grade 2 (moderate increase in filling pressure)
- Grade 3 (marked elevation in filling pressure)
2016 ASE Recommendations for Assessment of Diastolic Function

- Simplified screening in patients with normal EF or unknown heart disease – do not use E/A!

- In patients with reduced EF assessing mitral inflow is the first step followed by using 3 key parameters
2016 ASE Recommendations for Assessment of Diastolic Function

- Simplified screening in patients with normal EF or unknown heart disease – do not E/A
  4 key parameters

- In patients with reduced EF assessing mitral inflow is the first step followed by using 3 key parameters 4 key parameters
Warning

The guidelines are not necessarily applicable in children or in the perioperative setting.
<table>
<thead>
<tr>
<th>Disease</th>
<th>Echocardiographic measurements and cutoff values</th>
</tr>
</thead>
</table>
| AF<sup>43,94-99</sup> | Peak acceleration rate of mitral E velocity (≥1,900 cm/sec²)  
IVRT (≤65 msec)  
DT of pulmonary venous diastolic velocity (≤220 msec)  
E/Vp ratio (≥1.4)  
Septal E/e’ ratio (≥11) |
| Sinus tachycardia<sup>41,44</sup> | Mitral inflow pattern with predominant early LV filling in patients with EFs <50%  
IVRT ≤70 msec is specific (79%)  
Pulmonary vein systolic filling fraction ≤40% is specific (88%)  
Average E/e’ >14 (this cutoff has highest specificity but low sensitivity)  
When E and A velocities are partially or completely fused, the presence of a compensatory period after premature beats often leads to separation of E and A velocities which can be used for assessment of diastolic function |
| HCM<sup>100-106</sup> | Average E/e’ (>14)  
Ar-A (≥30 msec)  
TR peak velocity (>2.8 m/sec)  
LA volume (>34 mL/m²). |
| Restrictive cardiomyopathy<sup>13,107-109</sup> | DT (<140 msec)  
Mitral E/A (>2.5)  
IVRT (<50 msec has high specificity)  
Average E/e’ (>14) |
| Noncardiac pulmonary hypertension<sup>32</sup> | Lateral E/e’ can be applied to determine whether a cardiac etiology is the underlying reason for the increased pulmonary artery pressures  
When cardiac etiology is present, lateral E/e’ is >13, whereas in patients with pulmonary hypertension due to a noncardiac etiology, lateral E/e’ is <8 |
| Mitral stenosis<sup>110</sup> | IVRT (<60 msec has high specificity)  
IVRT/T<sub>E-e’</sub> (<4.2)  
Mitral A velocity (>1.5 m/sec) |
| MR<sup>110-112</sup> | Ar-A (≥30 msec)  
IVRT (<60 msec has high specificity)  
IVRT/T<sub>E-e’</sub> (<5.6) may be applied for the prediction of LV filling pressures in patients with MR and normal EFs  
Average E/e’ (>14) may be considered only in patients with depressed EFs |