LUST trial

Echocardiography

USER’S MANUAL

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Parameters required (1)

Aortic root (mm) ________________
End-diastolic interventricular septum thickness (mm) ________________
End-diastolic infero-lateral wall thickness (mm) ________________
End-diastolic LV diameter (mm) ________________
End-systolic LV diameter (mm) ________________
LVOT diameter (mm) ________________
End-diastolic LV volume (mL) ________________
End-systolic LV volume (mL) ________________
WMSI ________________
LA area (cm²) ________________
LA volume (mL) ________________
Aortic peak velocity (cm/sec) ________________
TVI LVOT (cm) ________________
E (cm/sec) ________________
A (cm/sec) ________________
DT (msec) ________________
IVRT (msec) ________________
TDI LV: S′(cm/sec) ________________ E′lateral (cm/sec) ________________ E′septal (cm/sec) ________________
RV basal diameter (mm) ________________
RA area (cm²) ________________
TVI RVOT (cm) ________________
TAPSE (mm) ________________
TDI RV: S′ (cm/sec) ________________ E′(cm/sec) ________________ A′ (cm/sec) ________________
IVC diameter (mm) ________________ IVC collapse >50% □ <50% □
Tricuspidal peak velocity (cm/sec) ________________
Pericardial effusion: yes □ no □ if present, maximum end-diastolic dimension ________________
Aortic root diameter measurement at sinuses of Valsava from 2-dimensional parasternal long-axis image. Inner edge-to-inner edge measurement in end-systole is advisable.
It is recommended that LV internal dimensions (LVIDd and LVIDs, respectively) and wall thicknesses be measured at the level of the LV minor axis, approximately at the mitral valve leaflet tips. These linear measurements can be made directly from 2D images or using 2D-targeted M-mode echocardiography.
Left ventricular outflow tract diameter is measured in the parasternal long-axis view in mid-systole from the white–black interface of the septal endocardium to the anterior mitral leaflet, parallel to the aortic valve plane and within 0.5–1.0 cm of the valve orifice.
Two-dimensional measurements for volume calculations using biplane method of disks (modified Simpson’s rule) in apical 4-chamber (A4C) and apical 2-chamber (A2C) views at end diastole (LV EDD) and at end systole (LV ESD). Papillary muscles should be excluded from the cavity in the tracing.
LV segmentation for WMSI

Figure 8
Segmental analysis of LV walls based on schematic views, in a parasternal short- and long-axis orientation, at 3 different levels. The "apex segments" are usually visualized from apical 4-chamber, apical 2 and 3-chamber views. The apical cap can only be appreciated on some contrast studies. A 16-segment model can be used, without the apical cap, as described in an ASE 1989 document.

Figure 9
Typical distributions of the right coronary artery (RCA), the left anterior descending (LAD), and the circumflex (CX) coronary arteries. The arterial distribution varies between patients. Some segments have variable coronary perfusion.
Measurement of left atrial (LA) volume from biplane method of disks (modified Simpson’s rule) using apical 4-chamber (A4C) and apical 2-chamber (A2C) views at ventricular end-systole (maximum LA size).
Aortic outflow can be displayed in the apical five-chamber view.

The V-shaped flow profile
Left ventricular outflow tract (LVOT) time-velocity integral is measured from the apical approach (5-chamber). Using pulsed-Doppler, the sample volume (SV), with a length (or gate) of 3–5 mm, is positioned on the LV side of the aortic valve, just proximal to the region of flow acceleration into the jet. An optimal signal shows a smooth velocity curve with a narrow velocity range at each time point. The VTI is measured by tracing the modal velocity (middle of the dense signal).
Mitral valve inflow

Pulsed-wave (PW) Doppler is performed in the apical 4-chamber view to obtain mitral inflow velocities to assess LV filling. A 1-mm to 3-mm sample volume is then placed between the mitral leaflet tips during diastole to record a crisp velocity profile.
Myocardial velocity recording obtained from apical window with tissue Doppler using PW mode. Diagram illustrates Doppler cursor with sample volume positioned at base of lateral wall. Recording shows systolic positive wave (S), early diastolic wave (E’), and atrial wave (a’). E’ should be assessed at both lateral and septal wall. S’ should also be the mean value of lateral and septal wall measurements.
RV basal diameter corresponds to RVD1
to it. Although a distended IVC usually denotes elevated RA pressures, in patients with otherwise normal exam results, reassessing the IVC size and collapsibility in the left lateral position may be useful to avoid the potentially erroneous inference of increased RA filling pressure. The IVC may also be dilated in normal young athletes, and in this population, it may not reflect elevated RA pressure.

Hepatic vein flow patterns provide complementary insights into RA pressure. At low or normal RA pressures, there is systolic predominance in hepatic vein flow, such that the velocity of the systolic wave (Vs) is greater than the velocity of the diastolic wave (Vd). At elevated RA pressures, this systolic predominance is lost, such that Vs is substantially decreased and Vs/Vd is <1. The hepatic vein systolic filling fraction is the ratio Vs/(Vs + Vd), and a value < 55% was found to be the most sensitive and specific sign of elevated RA pressure.

Importantly, hepatic vein flow velocities have been validated in mechanically ventilated patients, provided that the velocities are averaged over 5 consecutive beats and comprising 1 respiratory cycle.

Other 2D signs of increased RA pressure include a dilated right atrium and an interatrial septum that bulges into the left atrium throughout the cardiac cycle. These are qualitative and comparative, and do not allow the interpreter to assign an RA pressure but if present should prompt a more complete evaluation of RA pressure as well as a search for possible etiologies.

Advantages:
IVC dimensions are usually obtainable from the subcostal window.

Disadvantages:
IVC collapse does not accurately reflect RA pressure in ventilator-dependent patients. It is less reliable for intermediate values of RA pressure.

Recommendations: For simplicity and uniformity of reporting, specific values of RA pressure, rather than ranges, should be used in the determination of SPAP. IVC diameter ≥2.1 cm that collapses >50% with a sniff suggests a normal RA pressure of 3 mm Hg (range, 0-5 mm Hg), whereas an IVC diameter > 2.1 cm that collapses <50% with a sniff suggests a high RA pressure of 15 mm Hg (range, 10-20 mm Hg). In indeterminate cases in which the IVC diameter and collapse do not fit this paradigm, an intermediate value of 8 mm Hg (range, 5-10 mm Hg) may be used, or, preferably, secondary indices of elevated RA pressure should be integrated. These include restrictive right-sided diastolic filling pattern, tricuspid E/E0 ratio > 6, and diastolic flow predominance in the hepatic veins (which can be quantified as a systolic filling fraction < 55%). In indeterminate cases, if none of these secondary indices of elevated RA pressure are present, RA pressure may be downgraded to 3 mm Hg. If there is minimal IVC collapse with a sniff (<35%) and secondary indices of elevated RA pressure are present, RA pressure may be upgraded to 15 mm Hg. If uncertainty remains, RA pressure may be left at the intermediate value of 8 mm Hg. In patients who are unable to adequately perform a sniff, an IVC that collapses < 20% with quiet inspiration suggests elevated RA pressure. This method of assigning an RA pressure is preferable to assuming a fixed RA pressure value for all patients.

B. Right Ventricle

RV Wall Thickness. RV wall thickness is a useful measurement for RVH, usually the result of RVSP overload. Increased RV thickness can be seen in infiltrative and hypertrophic cardiomyopathies, as well as:

Figure 4
Inferior vena cava (IVC) view. Measurement of the IVC. The diameter (solid line) is measured perpendicular to the long axis of the IVC at end-expiration, just proximal to the junction of the hepatic veins that lie approximately 0.5 to 3.0 cm proximal to the ostium of the right atrium (RA).

Figure 3
Tracing of the right atrium (RA) is performed from the plane of the tricuspid annulus (TA), along the interatrial septum (IAS), superior and anterolateral walls of the RA. The right atrial major dimension is represented by the green line from the TA center to the superior right atrial wall, and the right atrial minor dimension is represented by the blue line from the anterolateral wall to the IAS.
The TVI at RVOT is obtained by placing a 1- to 2-mm pulsed wave Doppler sample volume in the proximal RVOT.
Measurement of tricuspid annular plane systolic excursion (TAPSE): the monodi-mensional cursor should be oriented to the junction of the tricuspid valve plane with the right ventricle free wall, using the 2-dimensional apical 4-chamber view. The tricuspid annular plane systolic excursion is measured as the total excursion of the tricuspid annulus from end-diastole to end-systole.
Tissue Doppler Imaging of the RV

Tissue Doppler of the tricuspid annulus: a sample is placed on the tricuspid annulus at the place of attachment of the anterior leaflet of the tricuspid valve. Peak systolic (S’), peak early (E’) and late (A’) diastolic annular velocities are recorded.
The diameter (solid line) is measured perpendicular to the long axis of the IVC at end-expiration, just proximal to the junction of the hepatic veins that lie approximately 0.5 to 3.0 cm proximal to the ostium of the right atrium (RA). M-mode can be used to assess the percentage of diameter variation during inspiration.
Tricuspidal peak velocity

Spectral continuous-wave Doppler signal of tricuspid regurgitation corresponding to the right ventricular (RV)—right atrial (RA) pressure gradient.

It is recommended to gather TR signals from several windows and to use the signal with the highest velocity.

Technically adequate signals with well-defined borders can be obtained in the majority of patients.
Parameters required (2)

Valvulopathy:
AORTIC:
- moderate stenosis □
- severe stenosis □
- continuity equation valve area* (cm²) _____________
- moderate regurgitation □
- severe regurgitation □
- vena contracta* (mm) _____________
- PHT* (msec) _____________

MITRAL:
- moderate stenosis □
- severe stenosis □
- mean gradient* (mmHg) ________
- planimetric valve area* (cm²) ________
- PHT* (msec) ________
- moderate regurgitation □
- severe regurgitation □
- vena contracta* (mm) _____________
- regurgitant volume (PISA method)* (mL) _____________

TRICUSPIDAL
- moderate stenosis □
- severe stenosis □
- mean gradient* (mmHg) _____________
- moderate regurgitation □
- severe regurgitation □
- vena contracta* (mm) _____________

PULMONARY
- moderate stenosis □
- severe stenosis □
- peak gradient* (mmHg) _____________
- moderate regurgitation □
- severe regurgitation □

* to be assessed only if at least a moderate valvular abnormality seems to be present at Color Doppler
Aortic stenosis: continuity equation

Aortic valve area is calculated based on the continuity-equation, according to the following formula:

\[
AVA = \frac{\text{Area}_{\text{LVOT}} \times VTI_{\text{LVOT}}}{VTI_{AV}}
\]

which results in:

\[
AVA = 0.785 \times (\text{diameter}_{\text{LVOT}})^2 \times VTI_{\text{LVOT}}
\]

Calculation of continuity-equation valve area requires three measurements:
1) aortic valve TVI by CW Doppler in 5-chamber apical view;
2) LVOT TVI by PW Doppler in 5-chamber apical view;
3) LVOT diameter from parasternal long axis view (zoomed image).
Aortic stenosis: grading severity

### Table 3  Recommendations for classification of AS severity

<table>
<thead>
<tr>
<th></th>
<th>Aortic sclerosis</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic jet velocity (m/s)</td>
<td>≤2.5 m/s</td>
<td>2.6–2.9</td>
<td>3.0–4.0</td>
<td>&gt;4.0</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td>—</td>
<td>&lt;20 (&lt;30&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>20–40&lt;sup&gt;b&lt;/sup&gt; (30–50&lt;sup&gt;a&lt;/sup&gt;)</td>
<td>&gt;40&lt;sup&gt;b&lt;/sup&gt; (&gt;50&lt;sup&gt;a&lt;/sup&gt;)</td>
</tr>
<tr>
<td>AVA (cm²)</td>
<td>—</td>
<td>&gt;1.5</td>
<td>1.0–1.5</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Indexed AVA (cm²/m²)</td>
<td>—</td>
<td>&gt;0.85</td>
<td>0.60–0.85</td>
<td>&lt;0.6</td>
</tr>
<tr>
<td>Velocity ratio</td>
<td>—</td>
<td>&gt;0.50</td>
<td>0.25–0.50</td>
<td>&lt;0.25</td>
</tr>
</tbody>
</table>

<sup>a</sup>ESC Guidelines.

<sup>b</sup>AHA/ACC Guidelines.
Aortic regurgitation: vena contracta

Regurgitant jet. Parasternal long-axis view. The position for measuring the height of the colour flow map as a percentage of the outflow tract height is at (a). The vena contracta or neck is at (b).
Aortic regurgitation: PHT

CW Doppler tracing of aortic regurgitation velocity illustrating method for determining pressure half time.
Aortic regurgitation: grading severity

Table 2  Grading the severity of AR

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic valve morphology</td>
<td>Normal/Abnormal</td>
<td>Normal/Abnormal</td>
<td>Abnormal/flail/large coaptation defect</td>
</tr>
<tr>
<td>Colour flow AR jet width</td>
<td>Small in central jets</td>
<td>Intermediate</td>
<td>Large in central jet, variable in eccentric jets</td>
</tr>
<tr>
<td>CW signal of AR jet</td>
<td>Incomplete/faint</td>
<td>Dense</td>
<td>Dense</td>
</tr>
<tr>
<td>Diastolic flow reversal in descending aorta</td>
<td>Brief, protodiastolic flow reversal</td>
<td>Intermediate</td>
<td>Holodiastolic flow reversal (end-diastolic velocity ≥20 cm/s)</td>
</tr>
<tr>
<td>Semi-quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC width (mm)</td>
<td>&lt;3</td>
<td>Intermediate</td>
<td>&gt;6</td>
</tr>
<tr>
<td>Pressure half-time (ms)</td>
<td>&gt;500</td>
<td>Intermediate</td>
<td>&lt;200</td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (mm²)</td>
<td>&lt;10</td>
<td>10–19; 20–29°</td>
<td>≥30</td>
</tr>
<tr>
<td>R Vol (mL)</td>
<td>&lt;30</td>
<td>30–44; 45–59°</td>
<td>≥60</td>
</tr>
<tr>
<td>+LV size</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AR, aortic regurgitation; CW, continuous-wave; LA, left atrium; EROA, effective regurgitant orifice area; LV, left ventricle; R Vol, regurgitant volume; VC, vena contracta.

aAt a Nyquist limit of 50–60 cm/s.

bPHT is shortened with increasing LV diastolic pressure, vasodilator therapy, and in patients with a dilated compliant aorta or lengthened in chronic AR.

cGrading of the severity of AR classifies regurgitation as mild, moderate or severe and subclassifies the moderate regurgitation group into ‘mild-to-moderate’ (EROA of 10–19 mm² or an R Vol of 30–44 mL) and ‘moderate-to-severe’ (EROA of 20–29 mm² or an R Vol of 45–59 mL).

dUnless for other reasons, the LV size is usually normal in patients with mild AR. In acute severe AR, the LV size is often normal. In chronic severe AR, the LV is classically dilated. Accepted cut-off values for non-significant LV enlargement: LV end-diastolic diameter <56 mm, LV end-diastolic volume <82 mL/m², LV end-systolic diameter <40 mm, LV end-systolic volume <30 mL/m².
Mitral stenosis: PHT

CW Doppler tracing taken from a patient with mitral stenosis, illustrating measurement of pressure half time.

Determination of Doppler pressure half-time (T1/2) with a bimodal, non-linear decreasing slope of the E-wave. The deceleration slope should not be traced from the early part (left), but using the extrapolation of the linear mid-portion of the mitral velocity profile (right).
Doppler gradient is assessed using the apical window in most cases, as it allows for parallel alignment of the ultrasound beam and mitral inflow. The ultrasound Doppler beam should be oriented to minimize the intercept angle with mitral flow to avoid underestimation of velocities.

In the figure: determination of mean mitral gradient from Doppler diastolic mitral flow in a patient with severe mitral stenosis in atrial fibrillation. Mean gradient varies according to the length of diastole: it is 8 mmHg during a short diastole (A) and 6 mmHg during a longer diastole (B).
Mitral stenosis: valve area

Planimetry measurement is obtained by direct tracing of the mitral orifice, including opened commissures, if applicable, on a parasternal short-axis view.
Mitral stenosis: grading severity

Table 9  Recommendations for classification of mitral stenosis severity

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specific findings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve area (cm²)</td>
<td>&gt;1.5</td>
<td>1.0–1.5</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td><strong>Supportive findings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean gradient (mmHg)²</td>
<td>&lt;5</td>
<td>5–10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Pulmonary artery pressure (mmHg)</td>
<td>&lt;30</td>
<td>30–50</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

²At heart rates between 60 and 80 bpm and in sinus rhythm.
The vena contracta is the area of the jet as it leaves the regurgitant orifice. The vena contracta is typically imaged in a view perpendicular to the commissural line (e.g. the parasternal long-axis or the apical four-chamber view) using a careful probe angulation to optimize the flow image, an adapted Nyquist limit (colour Doppler scale) (40–70 cm/s) to perfectly identify the neck or narrowest portion of the jet and the narrowest Doppler colour sector scan coupled with the zoom mode to improve resolution and measurement accuracy.
Mitral regurgitation: PISA method
Mitral regurgitation: grading severity

Table 3  Grading the severity of organic mitral regurgitation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MV morphology</td>
<td>Normal/Abnormal</td>
<td>Normal/Abnormal</td>
<td>Flail leaflet/Ruptured PMs</td>
</tr>
<tr>
<td>Colour flow MR jet</td>
<td>Small, central</td>
<td>Intermediate</td>
<td>Very large central jet or eccentric jet adhering, swirling and reaching the posterior wall of the LA</td>
</tr>
<tr>
<td>Flow convergence zone(^a)</td>
<td>No or small</td>
<td>Intermediate</td>
<td>Large</td>
</tr>
<tr>
<td>CW signal of MR jet</td>
<td>Faint/Parabolic</td>
<td>Dense/Parabolic</td>
<td>Dense/Triangular</td>
</tr>
<tr>
<td>Semi-quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC width (mm)</td>
<td>&lt; 3</td>
<td>Intermediate</td>
<td>≥ 7 (&gt; 8 for biplane)(^b)</td>
</tr>
<tr>
<td>Pulmonary vein flow</td>
<td>Systolic dominance</td>
<td>Systolic blunting</td>
<td>Systolic flow reversal(^c)</td>
</tr>
<tr>
<td>Mitral inflow</td>
<td>A wave dominant(^d)</td>
<td>Variable</td>
<td>E wave dominant (&gt; 1.5 cm/s)(^e)</td>
</tr>
<tr>
<td>TVI mit /TVI Ao</td>
<td>&lt; 1</td>
<td>Intermediate</td>
<td>&gt; 1.4</td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (mm(^2))</td>
<td>&lt; 20</td>
<td>20–29; 30–39(^f)</td>
<td>≥ 40</td>
</tr>
<tr>
<td>R Vol (mL)</td>
<td>&lt; 30</td>
<td>30–44; 45–59(^f)</td>
<td>≥ 60</td>
</tr>
<tr>
<td>+ LV and LA size and the systolic pulmonary pressure(^g)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)At a Nyquist limit of 50–60 cm/s

\(^b\)For average between apical four- and two-chamber views.

\(^c\)Unless other reasons of systolic blunting (atrial fibrillation, elevated LA pressure).

\(^d\)Usually after 50 years of age;

\(^e\)in the absence of other causes of elevated LA pressure and of mitral stenosis.

\(^f\)Grading of severity of organic MR classifies regurgitation as mild, moderate or severe, and sub-classifies the moderate regurgitation group into ‘mild-to-moderate’ (EROA of 20–29 mm or a R Vol of 30–44 mL) and ‘moderate-to-severe’ (EROA of 30–39 mm\(^2\) or a R Vol of 45–59 mL).

\(^g\)Unless for other reasons, the LA and LV size and the pulmonary pressure are usually normal in patients with mild MR. In acute severe MR, the pulmonary pressures are usually elevated while the LV size is still often normal. In chronic severe MR, the LV is classically dilated. Accepted cut-off values for non significant left-sided chambers enlargement: LA volume < 36 mL/m\(^2\), LV end-diastolic diameter < 56 mm, LV end-diastolic volume < 82 mL/m\(^2\), LV end-systolic diameter < 40 mm, LV end-systolic volume < 30 mL/m\(^2\), LA diameter < 39 mm, LA volume < 29 mL/m\(^2\).
Tricuspidal stenosis

The evaluation of stenosis severity is primarily done using the haemodynamic information provided by CWD. The tricuspid inflow velocity is best recorded from either a low parasternal right ventricular inflow view or from the apical four-chamber view.

TVI = 60 cm; mean grad = 9 mmHg
P1/2T = 173 ms
Tricuspidal regurgitation

Figure 29 Semi-quantitative assessment of tricuspid regurgitation severity using the vena contracta width (VC). The three components of the regurgitant jet (flow convergence zone, vena contracta, jet turbulence) are obtained. CV, chamber view.
Tricuspidal regurgitation: grading severity

Table 5  Grading the severity of TR

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tricuspid valve morphology</td>
<td>Normal/abnormal</td>
<td>Normal/abnormal</td>
<td>Abnormal/flail/large coaptation defect</td>
</tr>
<tr>
<td>Colour flow TR jet</td>
<td>Small, central</td>
<td>Intermediate</td>
<td>Very large central jet or eccentric wall impinging jet</td>
</tr>
<tr>
<td>CW signal of TR jet</td>
<td>Faint/Parabolic</td>
<td>Dense/Parabolic</td>
<td>Dense/Triangular with early peaking (peak &lt;2 m/s in massive TR)</td>
</tr>
<tr>
<td>Semi-quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VC width (mm)</td>
<td>Not defined</td>
<td>&lt;7</td>
<td>≥7</td>
</tr>
<tr>
<td>PISA radius (mm)</td>
<td>≤5</td>
<td>6–9</td>
<td>&gt;9</td>
</tr>
<tr>
<td>Hepatic vein flow</td>
<td>Systolic dominance</td>
<td>Systolic blunting</td>
<td>Systolic flow reversal</td>
</tr>
<tr>
<td>Tricuspid inflow</td>
<td>Normal</td>
<td>Normal</td>
<td>E wave dominant (≥1 cm/s)⁴</td>
</tr>
<tr>
<td>Quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EROA (mm²)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥40</td>
</tr>
<tr>
<td>R Vol (mL)</td>
<td>Not defined</td>
<td>Not defined</td>
<td>≥45</td>
</tr>
<tr>
<td>+ RA/RV/IVC dimension</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CW, continuous-wave; EROA, effective regurgitant orifice area; RA, right atrium; RV, right ventricle; R Vol, regurgitant volume; TR, tricuspid regurgitation; VC, vena contracta.

⁴Unless for other reasons, the RA and RV size and IVC are usually normal in patients with mild TR. An end-systolic RV eccentricity index >2 is in favour of severe TR. In acute severe TR, the RV size is often normal. In chronic severe TR, the RV is classically dilated. Accepted cut-off values for non significant right-sided chambers enlargement (measurements obtained from the apical four-chamber view): Mid RV dimension ≤33 mm, RV end-diastolic area ≤28 cm², RV end-systolic area ≤16 cm², RV fractional area change >32%, maximal RA volume ≤33 mL/m². An IVC diameter <1.5 cm is considered normal.
Continuous-wave Doppler is used to assess the severity when even mild stenosis is present. It is important to line up the Doppler sample volume parallel to the flow with the aid of colour flow mapping where appropriate. In adults, this is usually most readily performed from a parasternal short-axis view.

Table 11  Grading of pulmonary stenosis

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak velocity (m/s)</td>
<td>&lt;3</td>
<td>3–4</td>
<td>&gt;4</td>
</tr>
<tr>
<td>Peak gradient (mmHg)</td>
<td>&lt;36</td>
<td>36–64</td>
<td>&gt;64</td>
</tr>
</tbody>
</table>
Pulmonary regurgitation

Figure 15 Assessment of pulmonary regurgitation (PR) severity by using colour flow imaging. (Top) Measurement of the vena contracta width in two patients with PR (left: moderate, right: severe). (Bottom) Continuous-wave Doppler recordings.
List of abbreviations

LV = left ventricle
WMSI = wall motion score index
LVOT = left ventricular outflow tract
TVI = time-velocity integral
LA = left atrium
E = early mitral diastolic velocity
A = late mitral diastolic velocity
DT = deceleration time
IVRT = isovolumetric relaxation time
TDI = tissue Doppler imaging
S’ = myocardial systolic left ventricular velocity
E’ = early myocardial diastolic velocity
A’ = late myocardial diastolic velocity
RV = right ventricle
RA = right atrium
RVOT = right ventricular outflow tract
TAPSE = tricuspid annular plane systolic excursion
IVC = inferior vena cava
PHT = pressure half time
References:


