MITRAL REGURGITATION ECHO CHECKLISTS TOOL

Comprehensive assessment of qualitative and quantitative parameters, along with the use of standardized nomenclature when reporting echocardiographic findings, helps to better define a patient's MR and guide surgical/interventional decision making.

Clinicians Can Use the ACC MR Echo Reporting Checklists to:

- Improve and standardize echo reporting within and across practices
- Reference expert advice on assessing and integrating qualitative and quantitative parameters to determine the mechanism, etiology, and severity of a patient's MR

The Tables Below Include:

- A brief overview of the approach to using qualitative and quantitative echocardiographic parameters as part of an assessment of a patient's MR
- A list the descriptors of MR mechanism and severity that should be included in standardized echocardiographic reports
- Expert advice on the strengths, weakness, and indications of individual parameters as part of an integrative echocardiographic assessment

All advice in this document is derived from the 2020 Focused Update of the 2017 Expert Consensus Decision Pathway on the Management of Mitral Regurgitation. The Pathway includes additional advice on these as well as other topics relating to the management of mitral regurgitation. The information and advice in this tool are meant to support clinical decision making. They are not meant to represent the only or best course of care, or replace clinical judgment. This tool was developed as part of ACC's Emerging Mitral Regurgitation Clinical Care Initiative which was supported by Founding Sponsor Abbott Vascular.

To provide feedback on this tool, please fill out our feedback survey *here.*

January 2020

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Assessing MR Mechanism and Etiology

- The identification of MR mechanism and etiology is most commonly achieved by transthoracic echocardiography (TTE). If image quality is poor with TTE, transesophageal echocardiography (TEE) may often be needed to define anatomy and function more precisely. TEE may identify lesions such as vegetations or flail segments not detected by TTE.
- Mitral valve morphology, LV and LA volumes, and LV size and systolic function are used together to classify the mechanism and etiology of MR.
- Mitral valve morphology should be carefully assessed in multiple views using B-mode imaging to evaluate structure and motion and color flow Doppler (CFD) to localize the origin of MR jet(s).
- Careful measurement of LV and LA volumes and of LV dimensions should be performed according to American Society for Echocardiography guidelines for chamber quantification.

Assessing MR Severity

- Evaluation of MR severity requires a comprehensive TTE study and assessment whereby multiple parameters are evaluated and integrated to form a final determination of MR severity. This should include assessment of these parameters listed in the tables below, and consideration of the strengths and limitations of those parameters (described in further detail in the 2017 ASE Guidelines for Assessment of Native Valve Regurgitation). It is important to emphasize that no single echocardiographic parameter has the measurement precision or reproducibility to serve as the sole arbiter of MR severity.
- It is also crucial to record blood pressure, estimated LV systolic pressure in the presence of aortic stenosis or LV outflow obstruction, heart rate, and rhythm at the time of TTE and to incorporate them when grading MR severity.
- Calculation of EROA, a marker of lesion severity, as well as RVol and regurgitant fraction (RF), is strongly recommended for assessing MR severity. They can be measured by several techniques, including the proximal isovelocity surface area (PISA) method, volumetric methods, and 3D imaging. It is crucial to recognize the technical limitations and imprecision of each method and the overlap of values obtained.
- In secondary MR, symptoms, pulmonary congestion on exam or chest x-ray, elevated brain natriuretic peptide (BNP) or N-terminal-pro-BNP (NT-pro-BNP), and adjunctive findings on TTE or TEE, such as LV or LA dilation and systolic blunting of the pulmonary venous flow pattern, may be due to the underlying cardiomyopathy and therefore are less helpful in grading MR severity.
- After an initial impression of MR severity is formed, one should next consider whether LA and LV sizes are normal and whether the MR is holosystolic. For example, if one assesses MR as severe on the basis of a large CFD jet, but LA and LV sizes are normal and the MR is limited to late systole, the initial impression is most likely an overestimate. One should consider common reasons for overestimation of MR, such as high MR driving velocity and MR duration limited to very early or very late systole.
- When multiple specific parameters for mild or severe MR align with the initial impression of MR severity, MR can be correctly graded with high probability of being accurate. Fortunately, this scenario is relatively common in practice, especially with the finding of mild MR and a structurally normal mitral valve; however, when different parameters are discordant among themselves or with clinical findings, MR severity should be considered uncertain and further testing pursued. In such cases, TEE may be sufficient to define leaflet pathology and quantitate MR severity, although it may underestimate MR severity during general anesthesia due to favorable loading conditions. CMR is generally more accurate and reproducible for quantitating RVol and RF as well as LV volumes and LVEF.

HEMODYNAMIC AND RHYTHM PARAMETERS
Blood Pressure:
Heart Rate:
Rhythm:

<table>
<tr><th>QUALITATIVE PARAMETERS</th><th>ADVICE</th></tr>
<tr><td>Leaflet Morphology
☐ Structurally normal
☐ Nonspecific thickening
☐ Focal calcific or nodular thickening
☐ Diffusely calcified
☐ Myxomatous
☐ Vegetations
☐ Tumor
☐ Clefts
☐ Perforation

Cordal Morphology
Ruptured chordae:
☐ Anterior mitral leaflet
☐ Posterior mitral leaflet

Redundant chordae:
☐ Anterior mitral leaflet
☐ Posterior mitral leaflet

Annulus Size and Morphology (commissure-commissure and anterior-posterior measurements)
☐ Normal
☐ Dilated
☐ Calcified (location and extent)</td><td>• Mitral leaflet morphology abnormalities should be described and reported in detail (diffuse vs focal, size, leaflet location).

• TEE may identify lesions such as vegetations or flail segments not detected by TTE, especially in cases of poor image quality.

• If the mitral apparatus is structurally normal, significant MR is likely to be secondary. In such cases, the mechanism of MR still needs to be identified.

• When using valve morphology for assessing severity
  ∘ Strength:
    – Some morphological abnormalities, such as a flail leaflet with torn chords, severe leaflet retraction without visible coaptation, or leaflet destruction and perforation due to endocarditis, are specific markers of severe MR.

  ∘ Limitations:
    – Other findings are nonspecific.</td></tr>
</table>

Leaflet Mobility	

☐ Normal
☐ Redundant, no prolapse
☐ Systolic anterior motion (SAM)
    ☐ Anterior mitral leaflet
    ☐ Posterior mitral leaflet	

Flail: *Anatomic localization:*
    ☐ A1
    ☐ A2
    ☐ A3
    ☐ P1
    ☐ P2
    ☐ P3
    ☐ Posteromedial commissure
    ☐ Anterolateral commissure
	• Flail leaflets or ruptured papillary muscles are usually specific for severe MR.
	• Occasionally patients with flail leaflets only have moderate MR by integrative assessment.
	• Rare patients with flail leaflet may experience sudden cardiac death. Early surgical referral of the patient with flail leaflet might be considered.

Prolapse: *Anatomic localization:*
    ☐ A1
    ☐ A2
    ☐ A3
    ☐ P1
    ☐ P2
    ☐ P3
    ☐ Posteromedial commissure
    ☐ Anterolateral commissure
	• A common mistake in clinical practice is to misconstrue anterior leaflet override as prolapse.

Restricted or Tethered Leaflets	
☐ Anterior mitral leaflet ☐ Posterior mitral leaflet ☐ Both	
Mitral Stenosis	
☐ Rheumatic ☐ Degenerative ☐ Other	

Carpentier Classification	
☐ Normal Leaflet motion (Type I)	• May be seen in primary MR due to endocarditis, perforation, or clefts, or in secondary MR due to pure annular dilation.
☐ Excessive Leaflet motion (Type II)	• Most commonly seen with mitral valve prolapse or flail leaflet.
☐ Restricted leaflet motion (Type IIIA): during systole and diastole	• Classic for rheumatic mitral valve disease, radiation- or drug-induced injury, or other inflammatory conditions
☐ Restricted leaflet motion (Type IIIB): during systole only, e.g. ischemic etiology	• Typical of MR secondary to ischemic or nonischemic cardiomyopathy • The posterior leaflet is often severely tethered and the anterior leaflet overrides it but does not move above the annular plane. This finding should not be equated with anterior leaflet prolapse or with mixed-etiology MR.
Submitral Morphology	
☐ Thickening ☐ Calcification ☐ Retraction ☐ Tumor ☐ Vegetation	• Morphology abnormalities should be described and reported in detail by size and location.
MR Mechanism	
☐ Primary	• Defined by principal involvement of the leaflets and/or chordae tendineae in the pathologic process (e.g., myxomatous disease, endocarditis).
☐ Secondary ☐ Dilated Cardiomyopathy ☐ Ischemic Cardiomyopathy ☐ Other	• Secondary - characterized by incompetence due to adverse changes in left ventricular size, shape, or function with or without annular dilatation (e.g., ischemic cardiomyopathy) • Atrial functional - secondary to pure annular dilation in patients with severe LA dilation. Most commonly seen in persistent or long-standing persistent AF or in restrictive cardiomyopathies, such as that due to amyloid. • Most patients with secondary MR have a dilated LV with global or regional wall motion abnormalities with systolic tethering of the leaflets, annular dilation, or both; however, isolated regional wall motion abnormalities, particularly in the inferobasal or posterobasal segments, may cause severe secondary MR despite preserved LV function and dimensions.

☐ Mixed	• Due to both primary and secondary causes. Examples of mixed pathology include: –Untreated primary MR eventually results in irreversible LV dilation/ dysfunction in which both leaflet prolapse and tethering may coexist –Patients with long-standing secondary MR due to ischemic heart disease or atrial fibrillation who subsequently rupture a chord –Patients with mitral valve prolapse who have a myocardial infarction or develop a cardiomyopathy

MR Jets
☐ Single
☐ Multiple
 	
MR Jet Duration
(CW Doppler and frame-by-frame analysis of color flow Doppler)
☐ Holosystolic
☐ Early systolic
☐ Midsystolic
☐ Late systolic
☐ Bimodal
☐ CW Doppler density
 	
MR Jet Direction
☐ Centrally directed
☐ Eccentric
    ☐ Posteriorly directed
    ☐ Posterolaterally directed
    ☐ Laterally directed
    ☐ Anteriorly directed
    ☐ Anteromedially directed
    ☐ Medially directed
	• When using Regurgitant Color Flow for assessing severity
	∘ Strengths:
	– Easy to use;
	– evaluates spatial orientation of MR jet;
	– differentiates mild vs. severe
	∘ Limitations:
	– Subject to technical and hemodynamic variation;
	– can be underestimated with wall-impinging jets;
	– image quality-dependent
	• When using Jet Profile –CW to assess MR severity
	∘ Strengths:
	– Simple, readily available;
	– easy assessment of MR timing
	∘ Limitations:
	– Qualitative;
	– complementary data;
	– complete signal difficult to obtain in eccentric jet;
	– gain dependent
	• If the jet direction is eccentric, but the mechanism uncertain, TEE is indicated to clarify leaflet pathology and motion.
	• High-velocity MR jets, such as occur with hypertension, aortic stenosis, or LV outflow tract obstruction, will make MR appear worse on CFD, which should be recognized by the interpreting physician.
	• Low-velocity jets (e.g., 4 m/s) suggest high LA pressure and low LV pressure and therefore indicate severe MR with hemodynamic compromise (assuming proper alignment of the continuous wave (CW) Doppler beam with the MR jet.)
	• In addition to jet driving velocity and eccentricity, CFD jet size is affected by multiple other technical and hemodynamic factors. Thus, both U.S. and European guidelines recommend that MR jet size assessed by CFD not be used alone to assess MR severity.

Pulmonary Vein Flow Profile	
☐ Normal ☐ Systolic flow blunting ☐ Systolic flow reversal ☐ Number of veins exhibiting systolic reversal	• When using pulmonary vein flow to assess MR severity ∘ Strengths: – Simple; – systolic flow reversal is specific for severe MR ∘ Limitations: – Influenced by LA pressure, atrial fibrillation; – not accurate if MR jet directed into the sampled vein; – absence does not rule out severe MR
Mitral Inflow Profile	
☐ E dominant pattern ☐ A dominant pattern	• When using Peak Mitral E Velocity to assess MR severity ∘ Strengths: – Simple, readily available; – A-wave dominance excludes severe MR ∘ Limitations: – Influenced by LA pressure/compliance, LV relaxation, MV area, and atrial fibrillation; – complementary data only; – does not quantify MR severity

<table>
<tr><th>QUANTITATIVE PARAMETERS</th><th>ADVICE</th></tr>
<tr><td>Vena Contracta
☐ Vena Contracta width (mm)
☐ Vena Contracta area (cm^2)</td><td>• When using vena contracta width to assess MR severity
∘ Strengths:
– Quick and easy to use;
– independent of hemodynamic and instrumentation factors;
– applies to eccentric jets;
– can differentiate mild vs. severe MR
∘ Limitations:
– Not applicable to multiple jets;
– intermediate values require confirmation;
– small measurement errors can lead to big changes;
– 2D measure of a 3D structure;
– limited lateral resolution</td></tr>
<tr><td>Threshold values specific for severe MR
☐ EROA ≥ 0.4 cm^2
☐ Regurgitant volume > 60 mL/beat
☐ Regurgitant fraction > 50%</td><td>• EROA and RVol thresholds that define severe MR should account for LV volumes and ejection fraction.
• It is recognized that the accepted EROA threshold for severe MR (>0.40 cm^2) can be lower in patients with secondary MR and elliptical orifices, emphasizing the need for an integrative assessment of severity.
• In secondary MR, the shape of the regurgitant orifice is often markedly crescentic, leading to underestimation of EROA by the PISA method because the latter assumes a circular orifice. This inaccuracy can be ameliorated by 3D PISA measurements or direct 3D measurement of EROA by TTE or TEE.</td></tr>
<tr><td>Mitral valve area (cm^2):
☐ 2D planimetry (Biplane)
☐ 3D planimetry (Multiplanar Reconstruction)
☐ Pressure half-time
☐ Continuity equation
☐ PISA</td><td>• For patients with coexisting rheumatic or degenerative mitral stenosis or for planning edge-to-edge clip
• When using PISA to assess MR severity:
∘ Strengths:
– Can be applied to eccentric jets (when angle-corrected);
– not affected by etiology of MR;
– quantitative;
– provides both lesion severity (EROA) and volume data (RVol);</td></tr>
</table>

	(using PISA to assess MR severity, cont'd) ∘ Limitations: – Not valid with multiple jets; – provides peak flow and maximal EROA; – interobserver variability; – errors in radius measurement are squared; – multiple potential sources of measurement error
☐ Mean transmitral Doppler Gradient: mm Hg @ heart rate	• Input concurrently recorded during CW Doppler acquisition
Left atrial size	• When using LA and LV size to assess MR severity ∘ Strengths: – Enlargement sensitive for chronic severe MR; – important for outcomes; – normal size virtually excludes severe chronic MR ∘ Limitations: – Enlargement seen in other conditions (nonspecific); – may be normal in acute severe MR • LV or LA dilation in chronic primary MR is most often a consequence of the MR and a strong clue that the MR is severe. Exceptions could occur if a patient with long-standing mitral valve prolapse and mild MR develops an ischemic or nonischemic cardiomyopathy. On the other hand, when MR is primary and LV and LA size are normal, severe MR is very unlikely.
☐ Left atrial dilation ☐ Left atrial volume index: mL/m^2	
Left ventricular size	
☐ End diastolic LV dimension ☐ End systolic LV dimension and/or ☐ End diastolic volume/volume index ☐ End systolic volume/volume index	
Left ventricular function	
☐ Ejection fraction (normal > 60%) ☐ Global LV dysfunction ☐ Regional LV Dysfunction (detail wall motion)	
Right ventricular size (tricuspid annular and midventricular measurements)	
☐ Normal ☐ Dilated	
Right ventricular systolic function	
☐ Normal ☐ Impaired	

Tricuspid annulus	
☐ Normal ☐ Dilated	
Tricuspid valve regurgitation	
☐ Mild ☐ Moderate ☐ Severe	
PA systolic pressure:	
mm Hg	
Estimated RA pressure:	
mm Hg	