

# REFERENCE VALUES

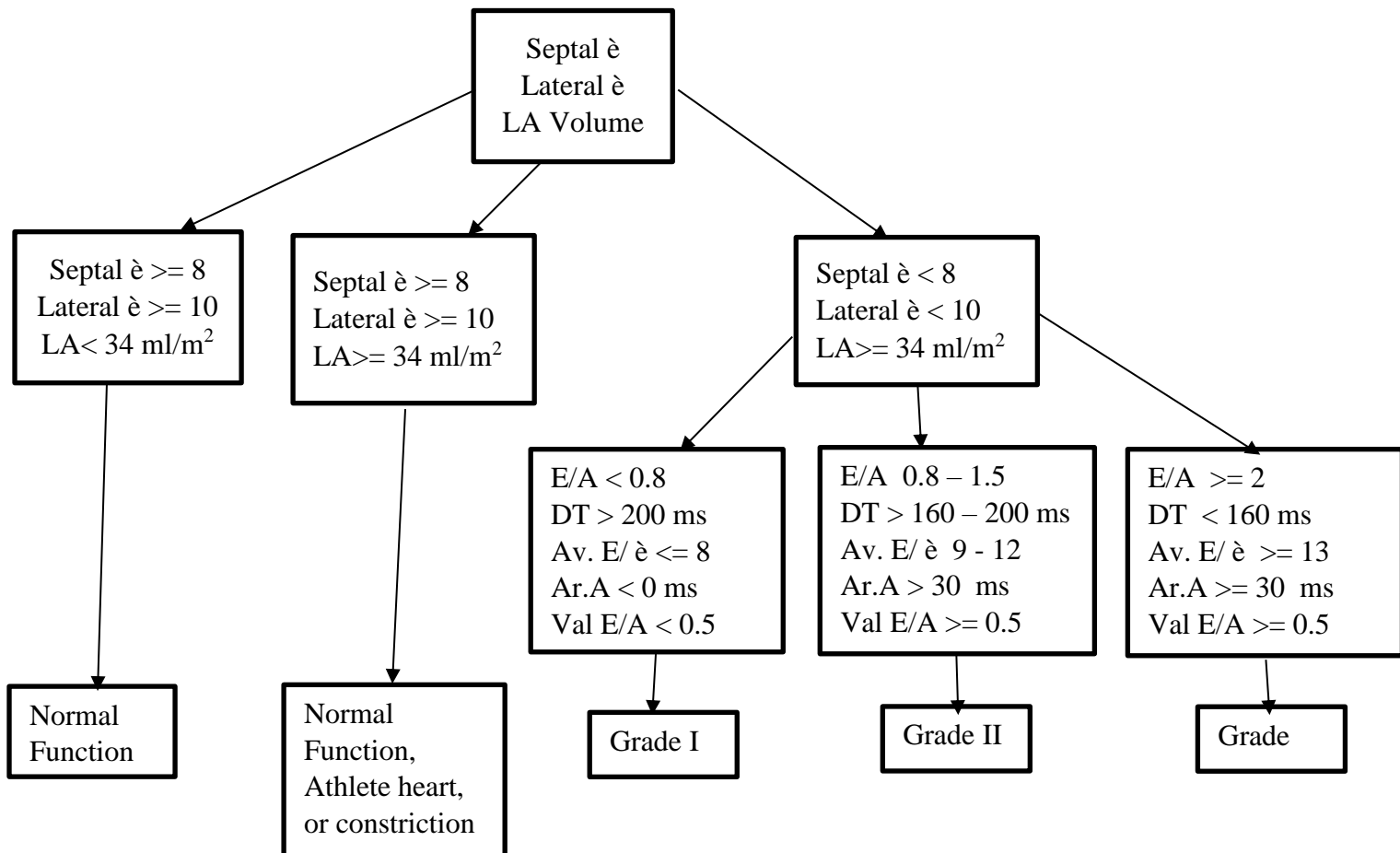
## LEFT VENTRICLE SYSTOLIC FUNCTION

WOMEN				
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
<b>LINEAR METHOD</b>				
Endocardial fractional shortening %	27 - 45	22 - 26	17- 21	$\leq 16$
Midway fractional shortening %	15 - 23	13-14	11 – 12	$\leq 10$
<b>2D METHOD</b>				
Ejection fraction %	$\geq 55$	45 - 54	30 - 44	$< 30$

MEN				
	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
<b>LINEAR METHOD</b>				
Endocardial fractional shortening %	25 - 43	20 - 24	15 - 19	$\leq 14$
Midway fractional shortening %	14 - 22	12 - 13	10 - 11	$\leq 10$
<b>2D METHOD</b>				
Ejection fraction %	$\geq 55$	45 - 54	30 - 44	$< 30$

# LEFT VENTRICULAR DIASTOLIC FUNCTION

## PRACTICAL APPROACH TO GRADE DIASTOLIC FUNCTION



## NORMAL VALUES OF THE DOPPLER DERIVED DIASTOLIC MEASUREMENTS

AGE GROUP				
Measurement	16 - 20	21 - 40	41 - 60	➤ 60
IVRT (ms)	50 ± 9 (32 – 68)	67 ± 8 (51 – 83)	74 ± 7 ( 60- 88)	87 ± 7(73 – 101)
E/A ratio	1.88 ± 0.45 (0.98 – 2.78)	1.53 ± 0.40 ( 0.73 - 2.33)	1.28 ± 0.25 (0.78 – 1.78)	0.96 ± 0.18 (0.6 – 1.32)
DT (ms)	142 ± 19(104 – 180)	166 ± 14(138 – 194)	181 ± 19 ( 143 – 219)	200 ± 29 (142 – 258)
A duration (ms)	113 ± 17(79 – 147)	127 ± 13 (101 – 153)	133 ± 13 (107 – 159)	138 ± 19(100 – 176)
PV S/D ratio	0.82 ± 0.18 ( 0.46 – 1.18)	0.98 ± 0.32 (0.34 – 1.62)	1.21 ± 0.2(0.81 – 1.61)	1.39 ± 0.47 (0.45 – 2.33)
PV Ar (cms/s)	16 ± 10 ( 1 – 36)	21 ± 8 (5.37)	23 ± 3(17 – 29)	25 ± 9 (11 – 39)
PV Ar duration (ms)	66 ± 39(1- 144)	96 ± 33 (30 - 162)	112 ± (15 ( 82 – 142)	113 ± 30(53 – 173)
Septal è (cm/s)	14.9 ± 2.4 (10.1 – 19.7)	15.5 ± 2.7 (10.1 – 20.9)	12.2 ± 2.3(7.6 – 16.8)	10.4 ± 2.1(6.2 – 14.6)
Septal è / à ratio	2.4	1.6 ± 0.5(0.6 – 2.6)	1.1 ± 0.3(0.5 – 1.7)	0.85 ± (0.2(0.45 – 1.25)
Lateral è (cm/s)	20.6 ± 3.8(13 – 28.2)	19.8 ± 2.9 (14 – 25.6)	16.1 ± 2.3(11.5 – 20.7)	12.9 ± 3.5(5.9 – 19.9)
Lateral è / à ratio	3.1	1.9 ± 0.6( 0.7 – 3.1)	1.5 ± 0.5(0.5 to 2.5)	0.9 ± 0.4 ( 0.1 – 1.7)

## LEFT VENTRICULAR SIZE - WOMEN

LV DIMENSION	Reference Range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV diastolic diameter	3.9 - 5.3	5.4 – 5.7	5.8 – 6.1	$\geq 6.2$
LV diastolic diameter/ BSA $\text{cm}/\text{m}^2$	2.4 - 3.2	3.3 – 3.4	3.5 – 3.7	$\geq 3.8$
LV diastolic diameter /height $\text{cm}/\text{m}$	2.5 – 3.2	3.3 – 3.4	3.5 – 3.6	$\geq 3.7$
<b>LV VOLUME</b>				
LV diastolic volume mL	56 - 104	105 - 117	118 - 130	$\geq 131$
LV diastolic volume / BSA $\text{mL}/\text{m}^2$	35 - 75	76 - 86	87 - 96	$\geq 97$
LV systolic volume mL	19 - 49	50 - 59	60 - 69	$\geq 70$
LV systolic volume / BSA $\text{mL}/\text{m}^2$	12 - 13	31 - 36	37 - 42	$\geq 43$

## LEFT VENTRICULAR SIZE - MEN

LV DIMENSION	Reference Range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV diastolic diameter	4.2 – 5.9	6.0 – 6.3	6.4 – 6.8	$\geq 6.9$
LV diastolic diameter/ BSA $\text{cm}/\text{m}^2$	2.2 – 3.1	3.2 – 3.4	3.5 – 3.7	$\geq 3.7$
LV diastolic diameter /height $\text{cm}/\text{m}$	2.4 – 3.3	3.4 – 3.5	3.6 – 3.7	$\geq 3.8$
<b>LV VOLUME</b>				
LV diastolic volume mL	67 - 155	156 - 178	179 - 201	$\geq 201$
LV diastolic volume / BSA $\text{mL}/\text{m}^2$	35 - 75	76 - 86	87 - 96	$\geq 97$
LV systolic volume mL	22 - 58	59 - 70	71 - 82	$\geq 83$
LV systolic volume / BSA $\text{mL}/\text{m}^2$	12 – 30	31 - 36	37 - 42	$\geq 43$

## LEFT VENTRICULAR MASS AND GEOMETRY - WOMEN

LINEAR METHOD	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV mass g	67 - 162	163 - 186	187 - 210	$\geq 211$
LV mass/ BSA g/m <sup>2</sup>	43 - 95	96 - 108	109 - 121	$\geq 122$
LV mass / height g/m	41 - 99	100 - 115	116 - 128	$\geq 129$
LV mass / height <sup>2</sup> g/m <sup>2</sup>	18 - 44	45 - 51	52 - 58	$\geq 59$
Relative wall thickness	0.22 – 0.42	0.43 – 0.47	0.48 – 0.52	$\geq 0.53$
Septal thickness cm	0.6 – 0.9	1.0 – 1.2	1.3 – 1.5	$\geq 1.6$
Posterior wall thickness cm	0.6 – 0.9	1.0 – 1.2	1.3 – 1.5	$\geq 1.6$
<b>2D METHOD</b>				
LV mass g	66 - 150	151 - 171	172 – 182	$\geq 193$
LV mass / BSA g/m <sup>2</sup>	44 - 88	89 - 100	101 - 112	$\geq 113$

## LEFT VENTRICULAR MASS AND GEOMETRY - MEN

LINEAR METHOD	Reference range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV mass g	88 - 224	225 - 258	259 - 292	$\geq 293$
LV mass/ BSA g/m <sup>2</sup>	49 - 115	116 - 131	132 - 148	$\geq 149$
LV mass / height g/m	52 - 126	127 - 144	145 - 162	$\geq 163$
LV mass / height <sup>2</sup> g/m <sup>2</sup>	20 - 48	49 - 55	56 - 63	$\geq 64$
Relative wall thickness	0.22 – 0.42	0.43 – 0.46	0.47 – 0.51	$\geq 0.52$
Septal thickness cm	0.6 – 1.0	1.1 – 1.3	1.4 – 1.6	$\geq 1.7$
Posterior wall thickness cm	0.6 – 1.0	1.1 – 1.3	1.4 – 1.6	$\geq 1.7$
<b>2D METHOD</b>				
LV mass g	96 - 200	201 - 227	228 - 254	$\geq 255$
LV mass / BSA g/m <sup>2</sup>	50 - 102	103 - 116	117 - 130	$\geq 131$

## RIGHT VENTRICULAR PULMONARY ARTERY SIZE

<b>RV DIMENSIONS</b>	<b>Reference range</b>	<b>Mildly abnormal</b>	<b>Moderately abnormal</b>	<b>Severely abnormal</b>
Basal RV diameter (RVD 1) cm	2.0 – 2.8	2.9 – 3.3	3.4 – 3.8	$\geq 3.9$
Mid RV diameter (RVD 2) cm	2.7 – 3.3	3.4 – 3.7	3.8 – 4.1	$\geq 4.2$
Base to apex length (RVD 3) cm	7.1 – 7.9	8.0 – 8.5	8.6 – 9.1	$\geq 9.2$
RVOT diameters				
Above aortic valve (RVOT 1) cm	2.5 – 2.9	3.0 – 3.2	3.3 – 3.5	$\geq 3.6$
Above pulmonic valve (RVOT 2) cm	1.7 – 2.3	2.4 – 2.7	2.8 – 3.1	$\geq 3.2$
<b>PA DIAMETER</b>				
Below pulmonic valve (PA 1) cm	1.5 – 2.1	2.2 – 2.5	2.6 – 2.9	$\geq 3.0$

## RIGHT VENTRICULAR SIZE AND FUNCTION

<b>RV DIMENSIONS</b>	<b>Reference range</b>	<b>Mildly abnormal</b>	<b>Moderately abnormal</b>	<b>Severely abnormal</b>
RA diastolic area cm <sup>2</sup>	11 - 28	29 - 32	33 - 37	$\geq 38$
RA systolic area cm <sup>2</sup>	7.5 - 16	17 - 19	20 - 22	$\geq 23$
RV fractional area change %	32 - 60	25 - 31	18 - 24	$\leq 17$
TAPSE cm	1.5 – 2.0	1.3 - 1.5	1.1 – 1.2	$< 1.0$

## LEFT ATRIAL DIMENSIONS / VOLUMES – WOMEN

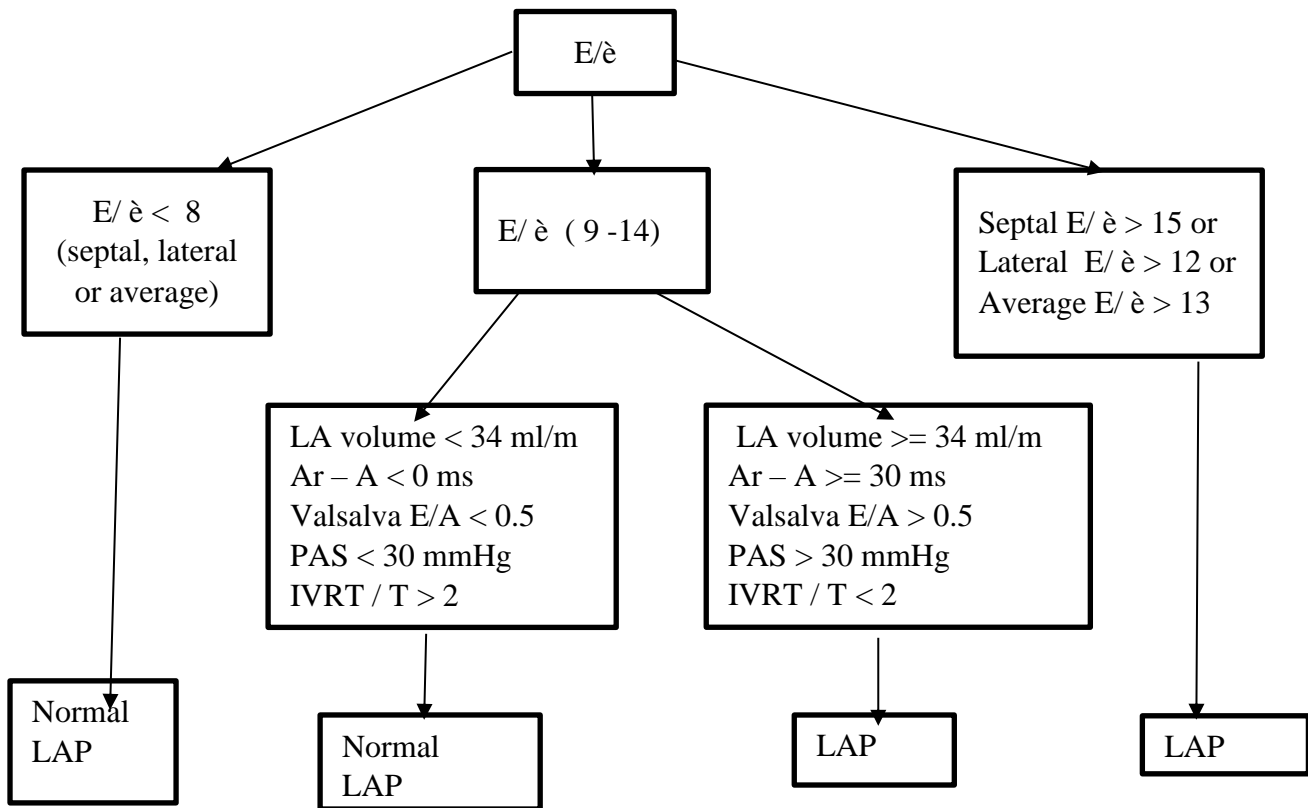
<b>ATRIAL DIMENSIONS</b>	<b>Reference range</b>	<b>Mildly abnormal</b>	<b>Moderately abnormal</b>	<b>Severely abnormal</b>
LA diameter cm	2.7 -3.8	3.9 – 4.2	4.3 – 4.6	$\geq 4.7$
LA diameter / BSA cm/m <sup>2</sup>	1.5 – 2.3	2.4 – 2.6	2.7 – 2.9	$\geq 3.0$
RA minor axis dimension cm	2.9 – 4.5	4.6 – 4.9	5.0 – 5.4	$\geq 5.5$
RA minor axis dimension / BSA cm/m <sup>2</sup>	1.7 – 2.5	2.6 – 2.8	2.9 – 3.1	$\geq 3.2$
<b>ATRIAL AREA</b>				
LA area cm <sup>2</sup>	$\leq 20$	20 - 30	30 – 40	$\geq 41$
Atrial Volumes				
LA volume mL	22 - 52	53 - 62	63 - 72	$\geq 73$
LA volume/BSA mL/m <sup>2</sup>	$22 \pm 6$	29 - 33	34 - 39	$\geq 40$

## LEFT ATRIAL DIMENSIONS / VOLUMES - MEN

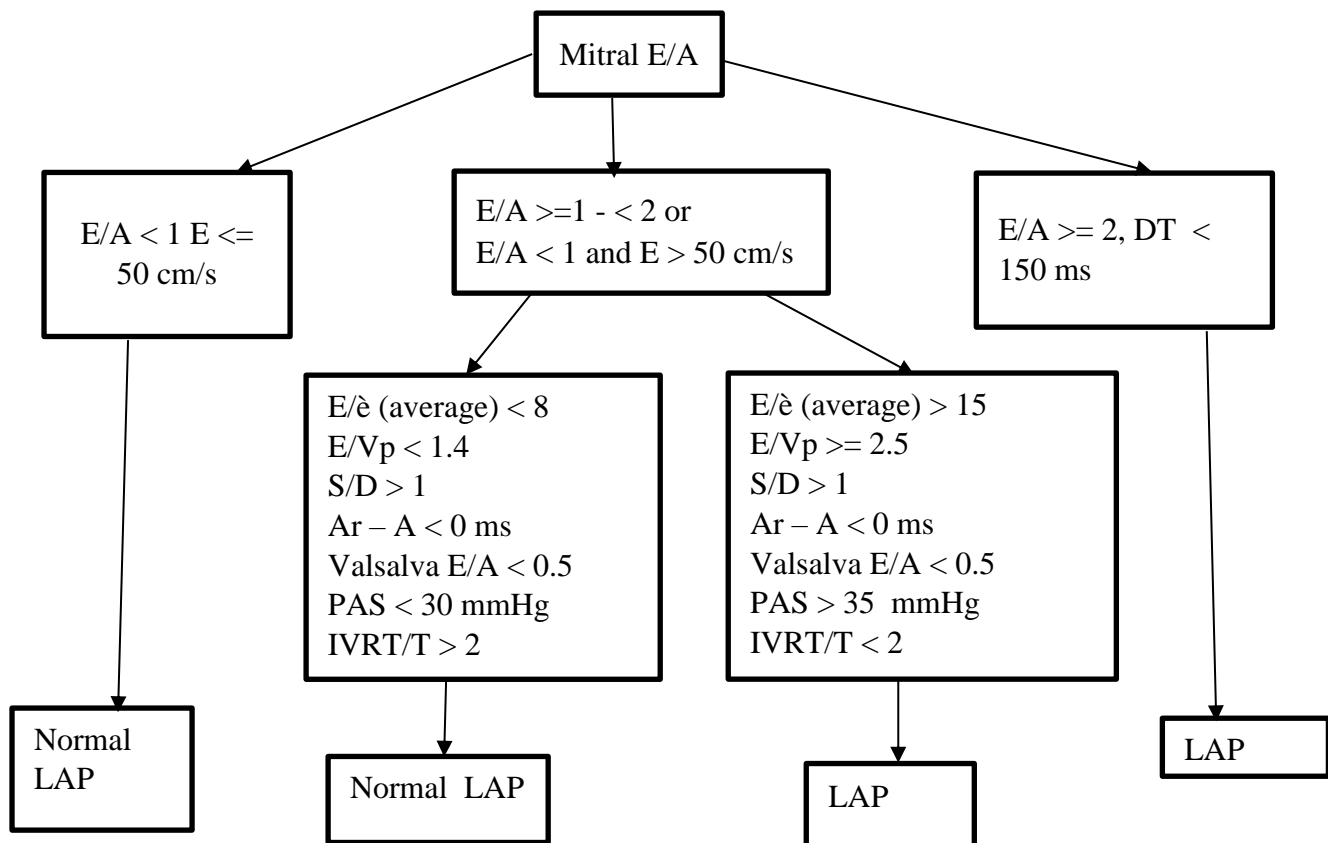
<b>ATRIAL DIMENSIONS</b>	<b>Reference range</b>	<b>Mildly abnormal</b>	<b>Moderately abnormal</b>	<b>Severely abnormal</b>
LA diameter cm	3.0 – 4.0	4.1 – 4.6	4.7 – 5.2	$\geq 5.2$
LA diameter / BSA cm/m <sup>2</sup>	1.5 – 2.3	2.4 – 2.6	2.7 – 2.9	$\geq 3.0$
RA minor axis dimension cm	2.9 – 4.5	4.6 – 4.9	5.0 – 5.4	$\geq 5.5$
RA minor axis dimension / BSA cm/m <sup>2</sup>	1.7 – 2.5	2.6 – 2.8	2.9 – 3.1	$\geq 3.2$
<b>ATRIAL AREA</b>				
LA area cm <sup>2</sup>	$\leq 20$	20 - 30	30 – 40	$\geq 41$
Atrial Volumes				
LA volume mL	18 - 58	59 - 68	69 - 78	$\geq 79$
LA volume/BSA L/m <sup>2</sup>	$22 \pm 6$	29 - 33	34 - 39	$\geq 40$

## LEFT ATRIAL PRESSURE

### ESTIMATION OF THE FILLING PRESSURE IN PATIENTS WITH NORMAL EF



### ESTIMATION OF FILLING PRESSURES IN PATIENTS WITH DEPRESSED EF





## AORTIC VALVE STENOSIS - SEVERITY

	<b>Aortic sclerosis</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Aortic jet velocity (m/s)	$\leq 2.5$ m/s	2.6 – 2.9	3.0 – 4.0	$> 4.0$
Mean gradient		$<20$ ( $<30$ a)	20- 40 b (30-50 a)	$> 40$ b ( $>50$ a)
AVA (cm <sup>2</sup> )		$> 1.5$	1.0 – 1.5	$<1$
Index AVA (cm <sup>2</sup> /m <sup>2</sup> )		$>0.85$	0.60 – 0.85	$<0.6$
Velocity ratio		$>0.50$	0.25 – 0.50	$<0.25$

a – ESC guidelines, b – AHA/ACC guidelines

## AORTIC REGURGITATION - SEVERITY

	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Specific signs for AR severity	Central jet width $< 25\%$ of LVOT  Vena Contracta $< 0.3$ cms <sup>2</sup>  No or brief early diastolic flow reversal in descending aorta	Signs for AR mild present but no criteria for severity	Central jet width $\geq 65\%$ of LVOT  Vena contracts $> 0.6$ cm <sup>2</sup>
Supportive signs	Pressure half time $> 500$ ms  Normal LV size	Intermediate values	Pressure half time $< 200$ ms  Holodiastolic aortic flow reversal in descending aorta  Moderate or greater LV enlargement

	<b>Reference value</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
R Vol. ml /beat	$<30$	30 - 44	45 - 59	$\geq 60$
RF %	$< 30$	30 - 39	40 - 49	$\geq 50$
EROA cm <sup>2</sup>	$< 0.10$	0.10 to 0.19	0.20 - 29	$\geq 0.30$

EROA - effective regurgitant orifice area , RF – regurgitant fraction, LV – Left Ventricle, LVOT – Left ventricular outflow tract

## MITRAL REGURGITATION - SEVERITY

	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Specific signs of severity	<p>Small central jet &lt; 4 cm<sup>2</sup> or &lt; 20% of LA area</p> <p>Vena Contracta width &lt; 0.30 cm</p> <p>No or minimal flow convergence</p>	Signs of MR > mild present , but no criteria for severe MR	<p>Vena Contracts width <math>\geq</math> 0.7 cm with large central MR jet ( area &lt; 40% of LA) or with a wall impinging jet of any size</p> <p>Large flow convergence</p> <p>Systolic reversal in pulmonary veins</p> <p>Prominent flail MV leaflet or ruptured papillary muscle</p>
Supportive signs	<p>Systolic dominant flow in pulmonary vein</p> <p>A-wave dominant mitral inflow</p> <p>Soft density : parabolic CW Doppler MR signal</p> <p>Normal LV size</p>	Intermediate signs / findings	<p>Dense triangular CW Doppler MR jet</p> <p>E wave dominant mitral flow ( E &gt; 1.2 m/s)</p> <p>Enlarged LV and LA size ( particularly when the normal LV function is present)</p>

<b>Quantitative parameters</b>	<b>Reference value</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
R Vol (ml/beat)	< 30	30 - 44	45 - 59	$\geq$ 60
RF (%)	< 30	30 - 39	40 - 49	$\geq$ 50
EROA	< 0.20	0.20 – 0.29	0.30 – 0.39	$\geq$ 0.40

## MITRAL STENOSIS - SEVERITY

	Mild	Moderate	Severity
Valve area (cm <sup>2</sup> )	>1.5	1.0 – 1.5	< 1.0
Supportive findings			
Mean Gradient (mmHg) a	< 5	5 – 10	>10
Pulmonary artery pressure (mmHg)	<30	30 – 50	>50
a – heart rates between 60 and 80 bpm and in sinus rhythm			

## MITRAL STENOSIS - ROUTINE MEASUREMENT

Grade	Mobility	Thickening	Calcification	Subvalvular Thickening
1	Highly mobile valve with only leaflet tips restricted	Leaflets near normal in thickness ( 4 – 5 mm)	A single area of increased echo brightness	Minimal thickening just below the mitral leaflets
2	Leaflet mid and base portions have normal mobility	Mid leaflets normal, considerable	Scattered areas of brightness confined to leaflet margins	Thickening of chordal structures extending to one third of the chordal length
3	Valve continues to flow forward in diastole mainly from the base	Thickening extending through the entire leaflet ( 5 – 8 mm)	Brightness extending into mid portions of the leaflets	Thickening extended to distal third of the chords
4	No or minimal forward movement of the leaflets in diastole	Considerable thickness of all the leaflets ( > 8 – 10 mm)	Extensive brightness throughout much of the leaflet tissue	Extensive thickening and shortening of all chordal structures extending down to the papillary muscles

## MITRAL STENOSIS ROUTINE MEASUREMENTS

Data element	Recording	Measurement
Planimetry	<p>2D parasternal short axis view</p> <p>Determine the smallest orifice by scanning from apex to base</p> <p>Positioning of the measurement plan can be orientated by 3D echo</p> <p>Lowest gain setting to visualise the whole mitral orifice</p> <p>Continuous wave Doppler</p>	<p>Contour of the inner mitral orifice</p> <p>Include commissures when opened</p> <p>In mid diastole</p> <p>Average measurement if atrial fibrillation</p> <p>Mean gradient from the traced contour of the diastolic mitral flow</p>
Mitral flow	<p>Apical windows often suitable (optimise intercept angle)</p> <p>Adjust gain setting to obtain well defined flow contour</p>	<p>Pressure half time from the descending slope of the E wave (mid diastole slope if not linear)</p> <p>Average measurement if atrial fibrillation</p>
Systolic pulmonary artery pressure	<p>Continuous wave Doppler</p> <p>Multiple acoustic windows to optimise intercept angle</p>	<p>Maximum velocity of the tricuspid regurgitant flow</p> <p>Estimation of right atrial pressure according to inferior vena cava diameter</p>

	Parasternal short axis view	Valve thickness (maximum and heterogeneity)
	Parasternal long axis view	<p>Commissural fusion</p> <p>Extension and location of the localised bright zones ( fibrous nodules or calcification)</p>
Valve anatomy	Apical two chamber view	<p>Valve thickness</p> <p>Extension of calcification</p> <p>Valve pliability ( chordal thickening, fusion or shortening)</p> <p>Subvalvular apparatus ( chordal thickening, fusion or shortening)</p> <p>Subvalvular apparatus ( chordal thickening, fusion or shortening)</p>

## TRICUSPID REGURGITATION – SEVERITY

Parameter	Mild	Moderate	Severe
Tricuspid valve	Usually normal	Normal or abnormal	Abnormal / Fail leaflet / Poor coaptation
RV/RA/IVC	Normal	Normal or dilated	Usually dilated
Jet area – central jets ( cm <sup>2</sup> )	< 5	5 – 10	>10
VC width	Not defined	Not defined but < 0.7	>0.7
PISA radius cm	<= 0.5	0.6 – 0.9	>0.9
Jet density and contour - CW	Soft and parabolic	Dense variable contour	Dense, triangular with early peaking
Hepatic vein flow	Hepatic vein flow	Systolic blunting	Systolic reversal

## TRICUSPID STENOSIS – SEVERITY

Specific findings	
Mean pressure gradient	>= 5 mmHg
Inflow time velocity integral	>60 cm
T <sub>1/2</sub>	>190 ms
Valve area by continuity equation	<= 1 cm <sup>2</sup>
<b>SUPPORTIVE FINDINGS</b>	
Enlarged right atrium >= moderate	
Dilated inferior vena cava	

## PULMONARY REGURGITATION – SEVERITY

Parameter	Mild	Moderate	Severe
Pulmonic valve	Normal	Normal or abnormal	Abnormal
RV size	Normal	Normal or dilated	Dilated
Jet size by color doppler	Thin ( usually < 10 mm in length) with a narrow origin	Intermediate	Usually large, with a wide origin. May be brief in duration
Jet density and deceleration	Slow soft deceleration	Dense variable deceleration	Dense, steep deceleration, early termination of the diastolic flow
Pulmonic systolic flow compared to systemic flow	Slightly increased	Intermediate	Greatly increased

## PULMONARY STENOSIS - SEVERITY

Parameter	Mild	Moderate	Severe
Peak velocity (m/s)	< 3	3 – 4	> 4
Peak gradient (mmHg)	< 36	36 - 64	> 64

## **INFERIOR CAVAL VEIN : ESTIMATE OF THE CENTRAL VEINOUS PRESSURE USING ICD ECHO**

CVP	IVC collabs on inspiration	IVC diameter
CVP 0 – 5 cm	Total collabs	< 1.5 cm
CVP 5 – 10 cm	>50%	1.5 – 2.5 cm
CVP 11 – 15 cm	<50%	1.5 – 2.5 cm
CVP 16- 20 cm	<50%	>2.5 cm
CVP > 20 cm	No change	>2.5 cm