

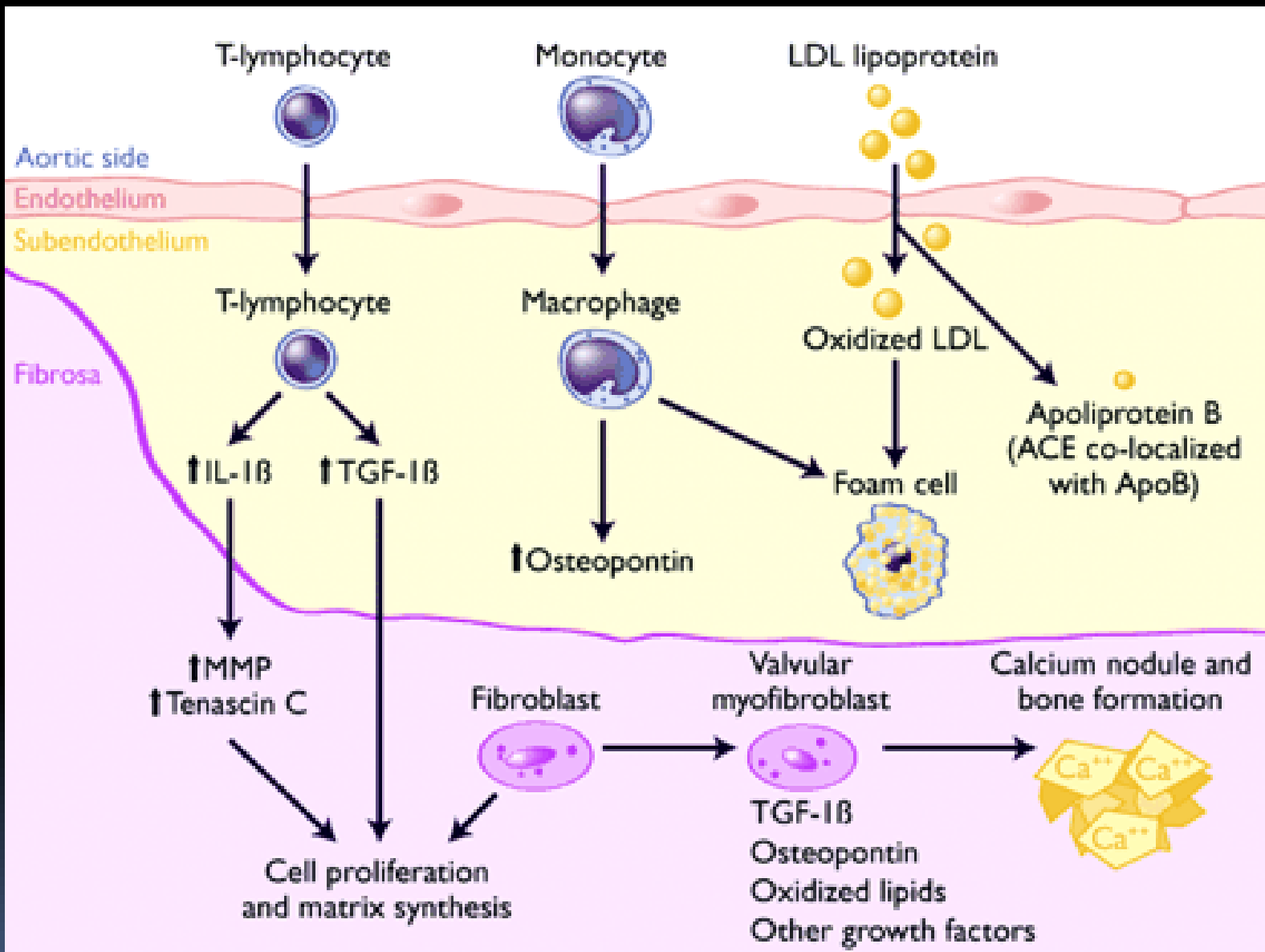
*Aurelio Caruso  
Casa di Cura San Michele  
Maddaloni (CE)*



VI CONGRESSO NAZIONALE DI  
**ECOCARDIO  
CHIRURGIA**

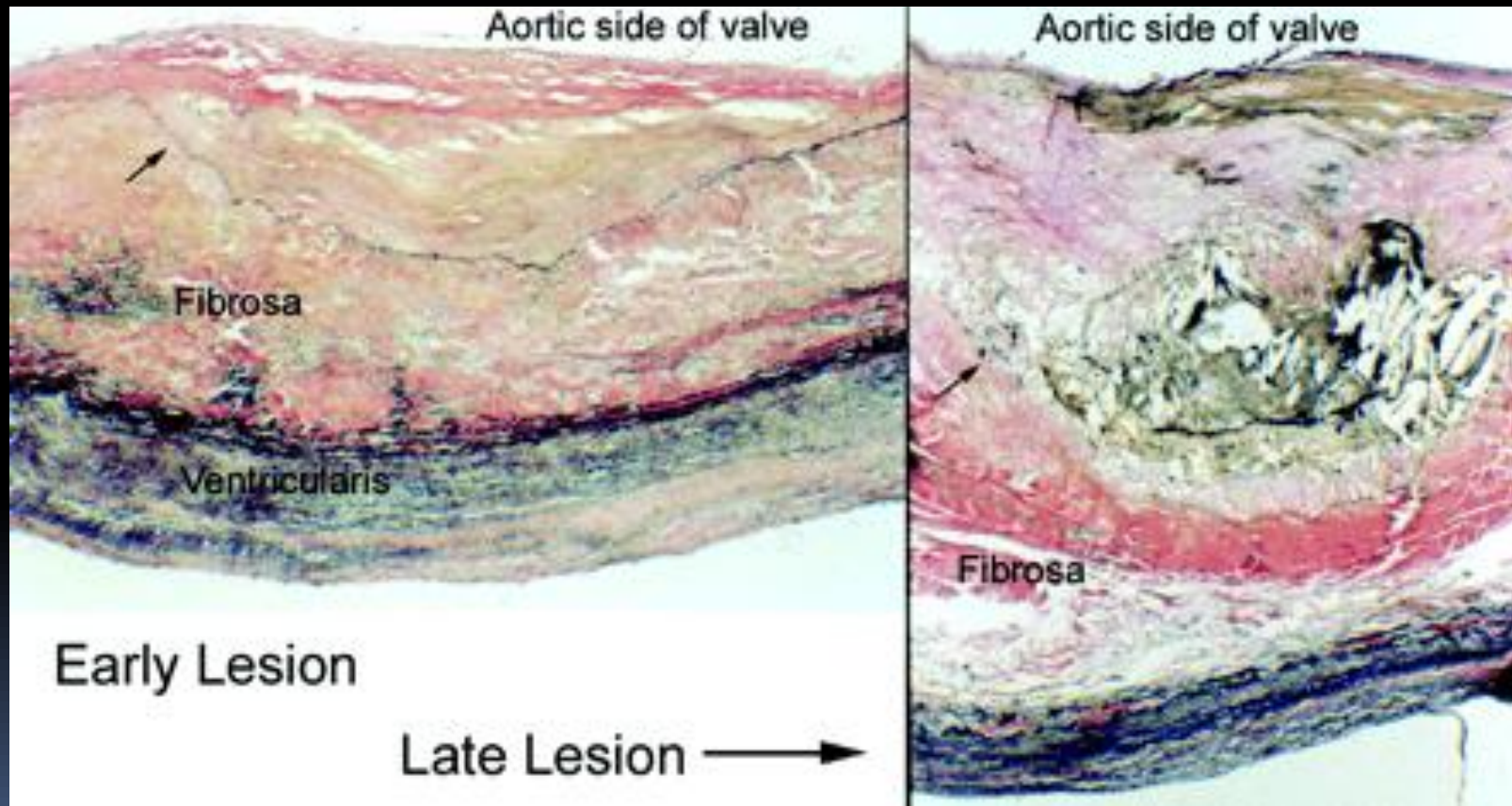
MILANO 15-17 OTTOBRE 2012

**LA STENOSI AORTICA...ETC**

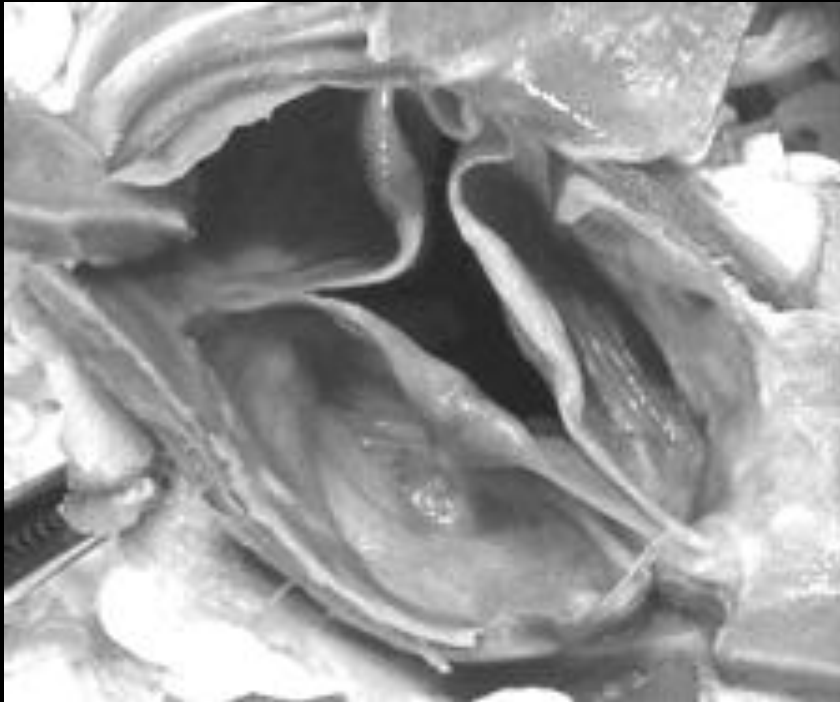


*Freeman e Otto: Circulation 2005; 111:3316-3326*

# Stenosi aortica calcifica dell'anziano: processo “attivo ed evolutivo”

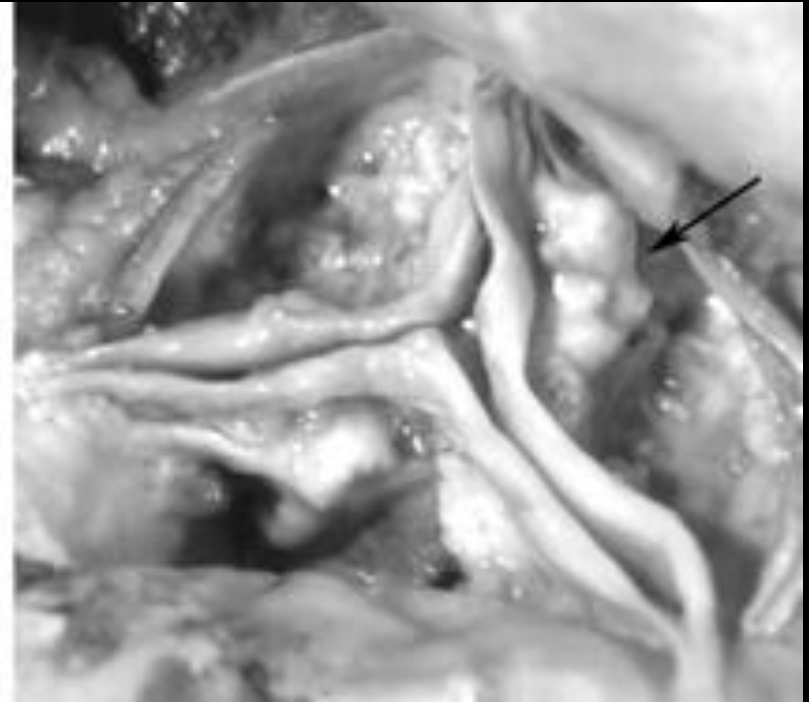


*Freeman e Otto: Circulation 2005; 111:3316-3326*



Early lesion

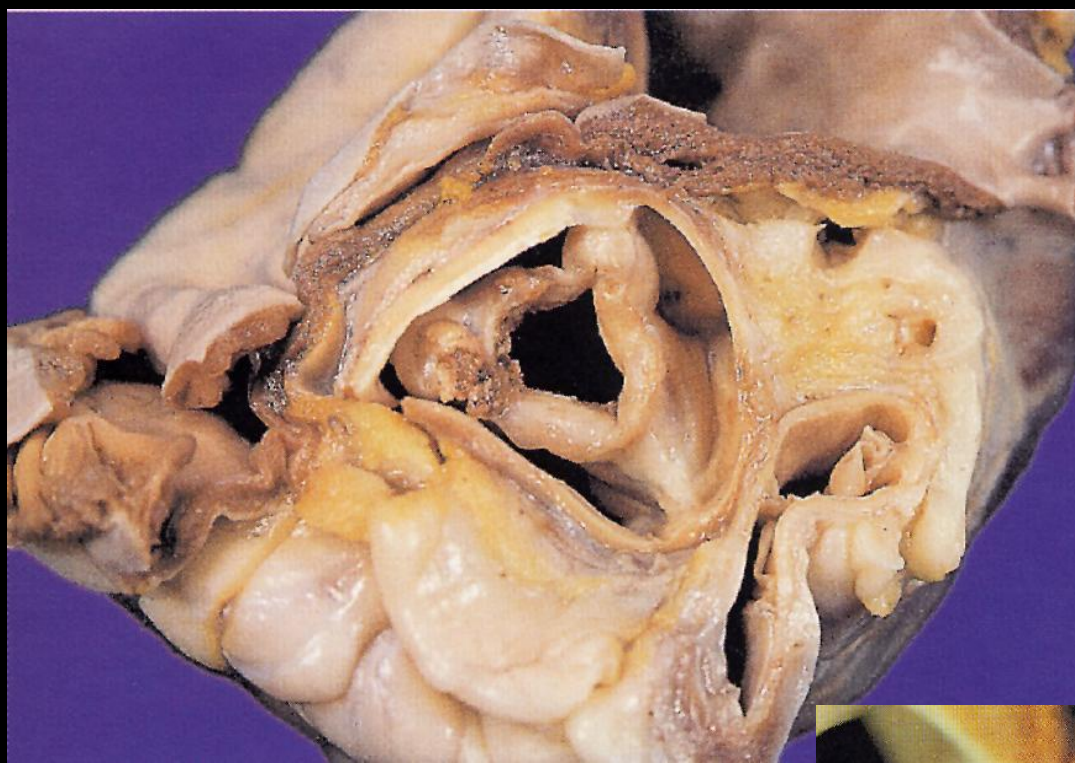
“sclerosi aortica”



Late lesion

“stenosi aortica”



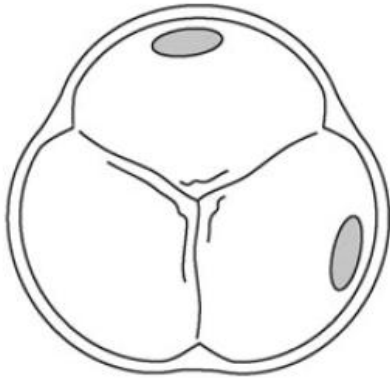


Stenosi aortica  
reumatica

Stenosi aortica  
“degenerativa”



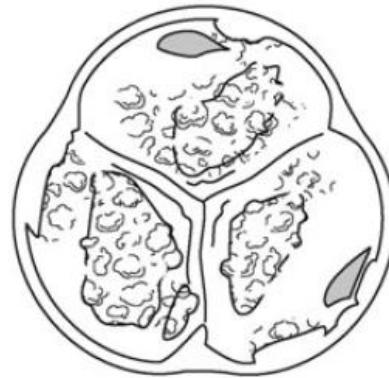
Normal



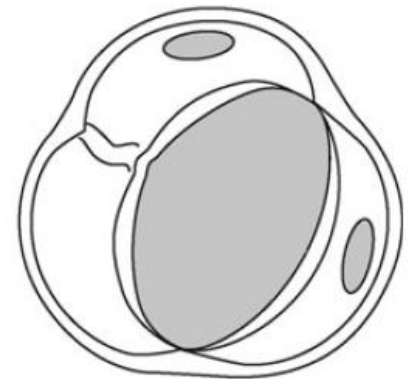
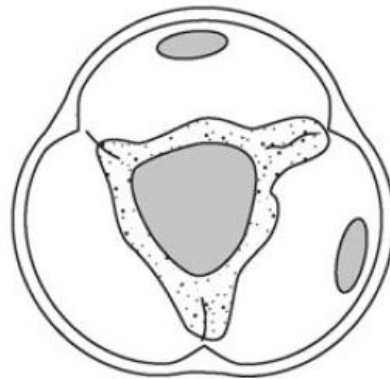
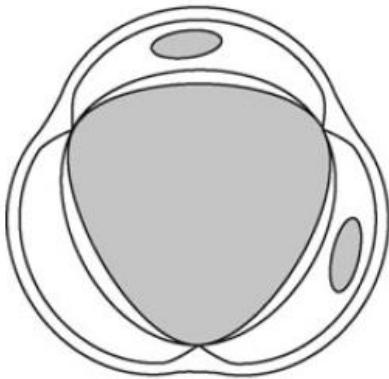
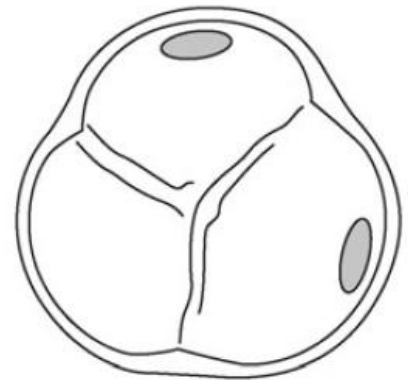
Rheumatic



Calcific



Bicuspid



# Le dimensioni del problema

- **Sclerosi aortica:**

in ~ 16 (25) % della popolazione > 65 anni di età

in ~ 48% (53) della popolazione > 84 anni di età

- **stenosi aortica:** 1,3% tra 65 e 75 anni

*Supino et al.* 2,4% tra 75 e 85 anni

*Heart Fail Clin.* 2006;

2:379-393

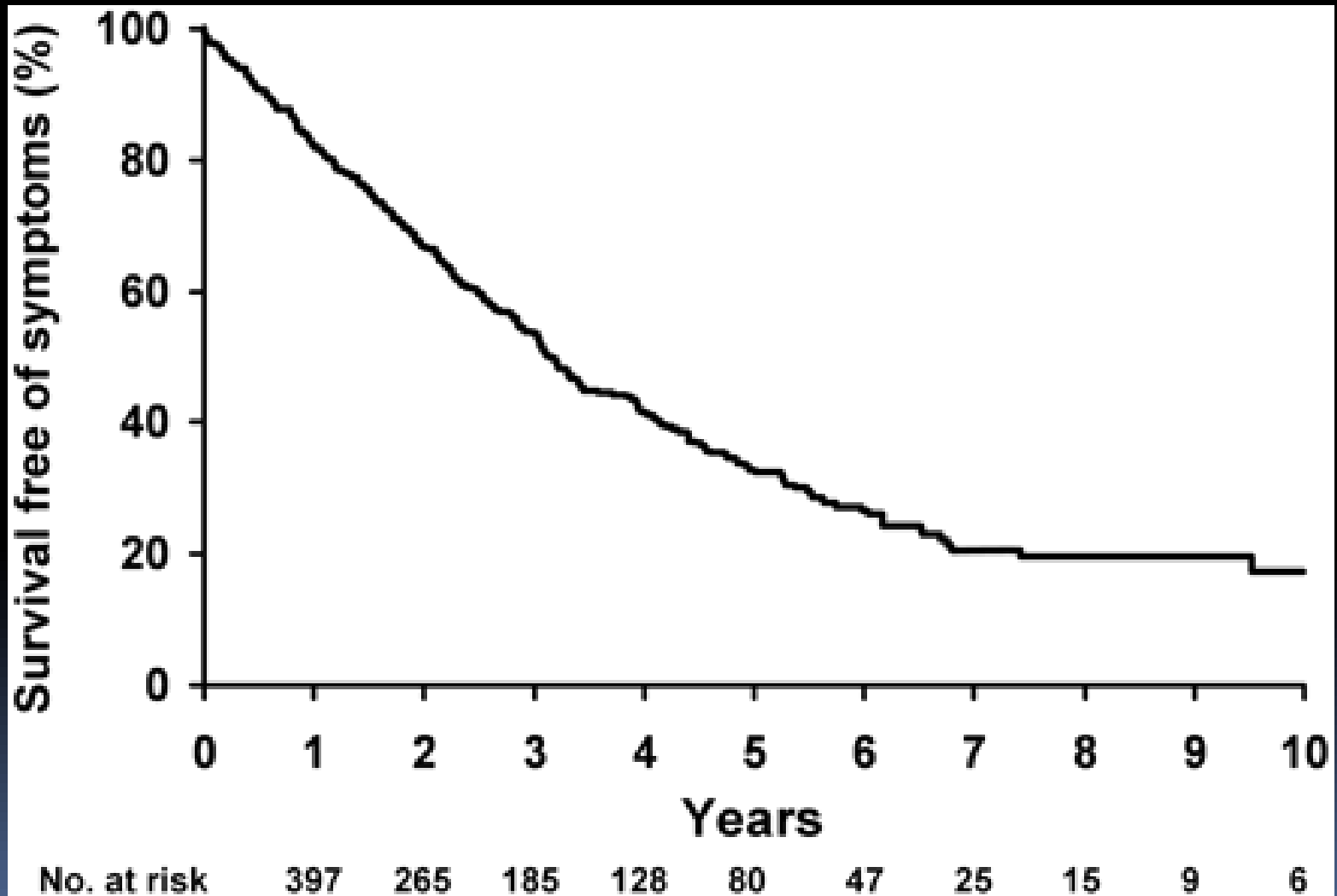
4% oltre 85 anni

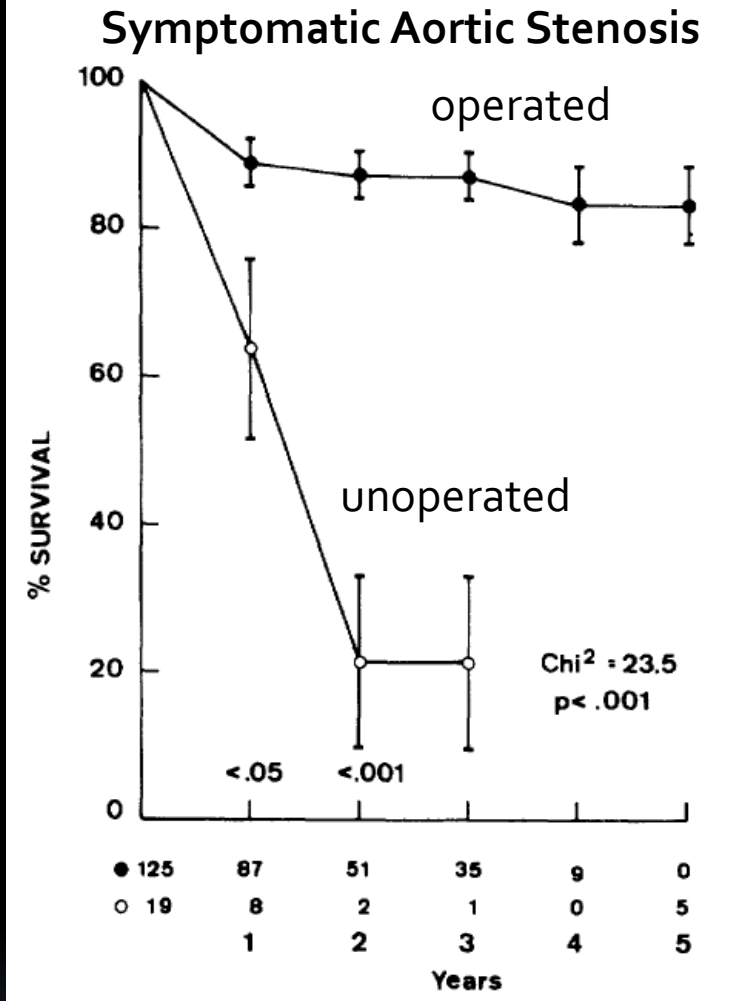
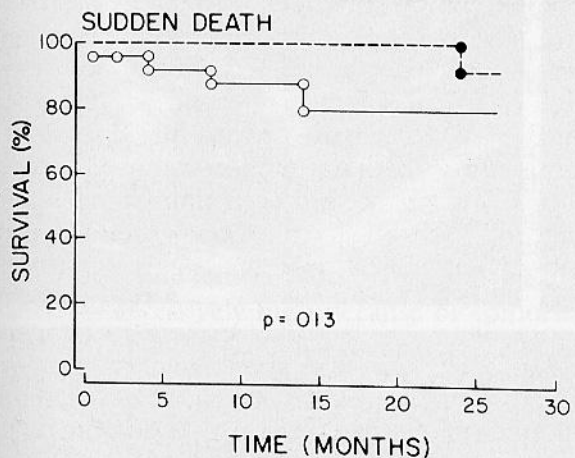
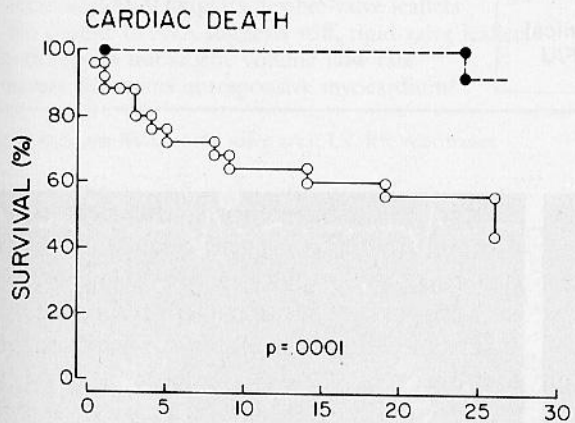
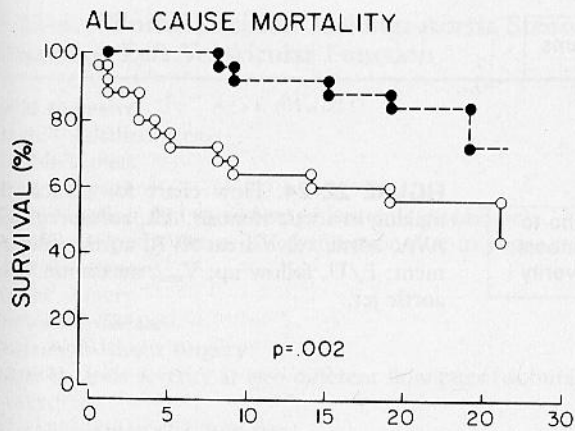
# Le dimensioni del problema

- Stenosi aortica in 2-9% di pz > 65 anni
- La valvulopatia più frequente
- La 2<sup>a</sup> più comune indicazione alla cardiocirurgia
- 80% di rischio, entro i 5 anni, di insufficienza cardiaca, sostituzione valvolare, morte



Outcome of 622 Adults with Asymptomatic, Hemodynamically Significant Aortic Stenosis During Prolonged Follow-up  
*Pellika et al. Circulation 2005;111:3290-3295*





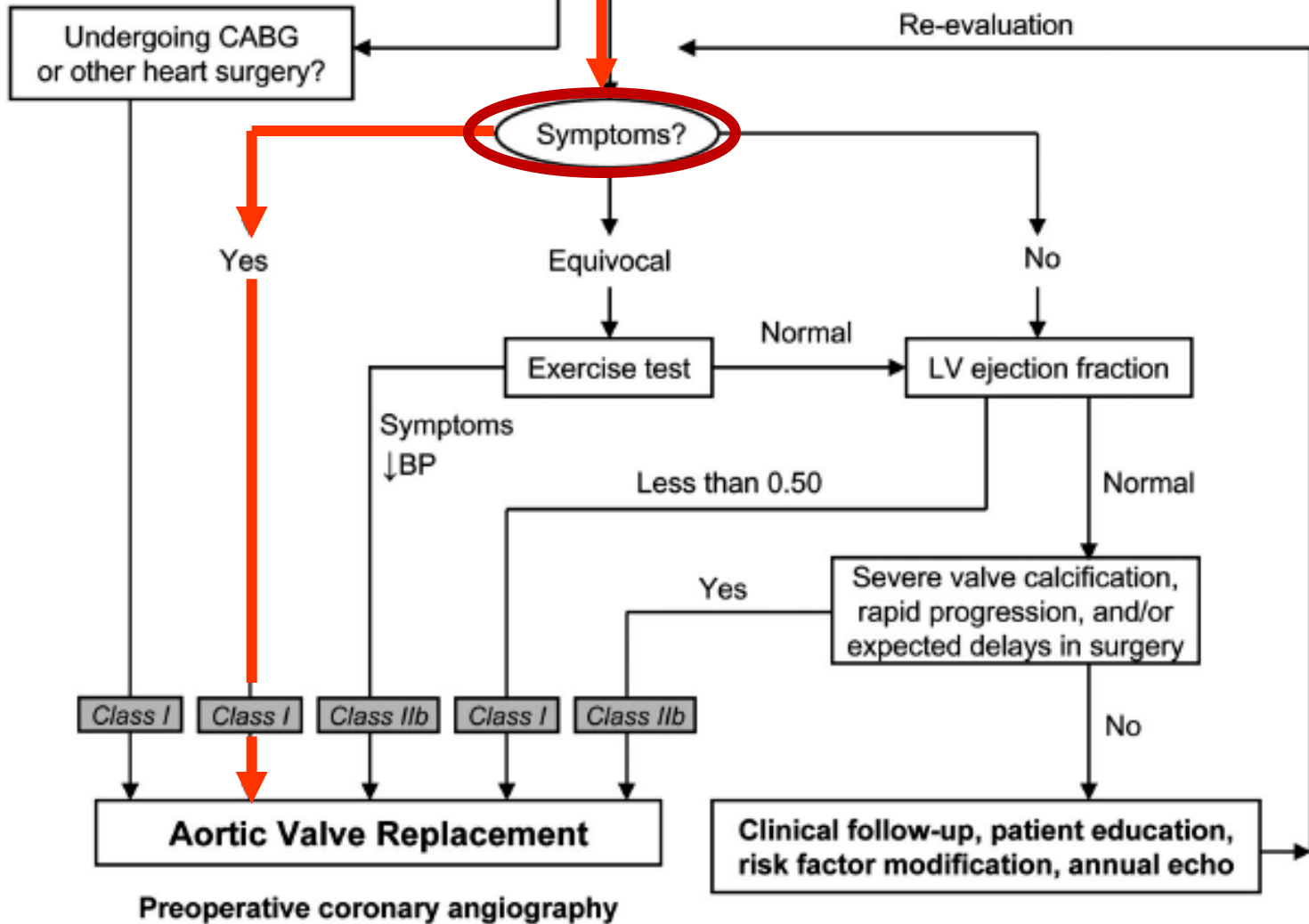
*Schwarz et al Circulation 1982;66:1105-10*

**Asymptomatic (*closed circles*)**  
**Symptomatic (*open circles*)**

*Kelly et al. Am J Cardiol 1988;61:123-130*

## Severe Aortic Stenosis

$V_{max}$  greater than 4 m/s  
AVA less than 1.0 cm<sup>2</sup>  
Mean gradient > 40 mm Hg





**Table 9** Indications for aortic valve replacement in aortic stenosis

	Class <sup>a</sup>	Level <sup>b</sup>
AVR is indicated in patients with severe AS and any symptoms related to AS.	I	B

AVR is indicated in patients with severe AS and any symptoms related to AS.

cause.

AVR is indicated clearly related to

**Table 4** Echocardiographic criteria for the definition of severe valve stenosis: an integrative approach

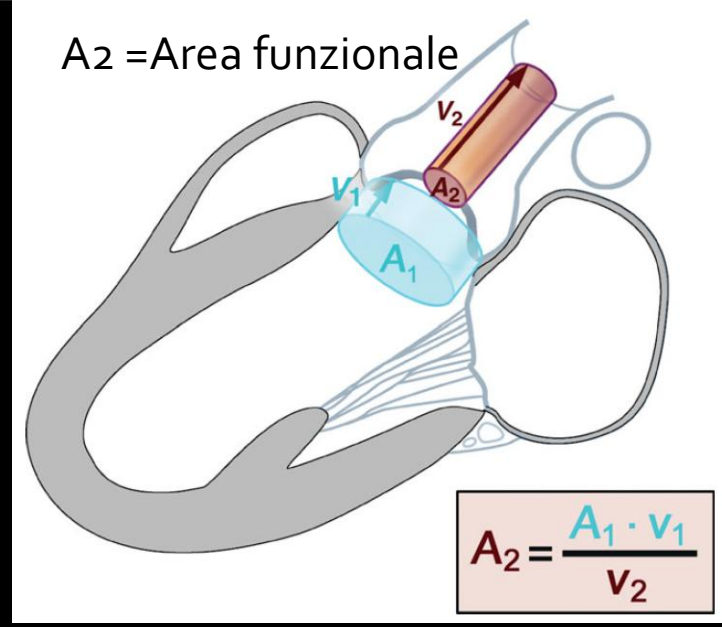
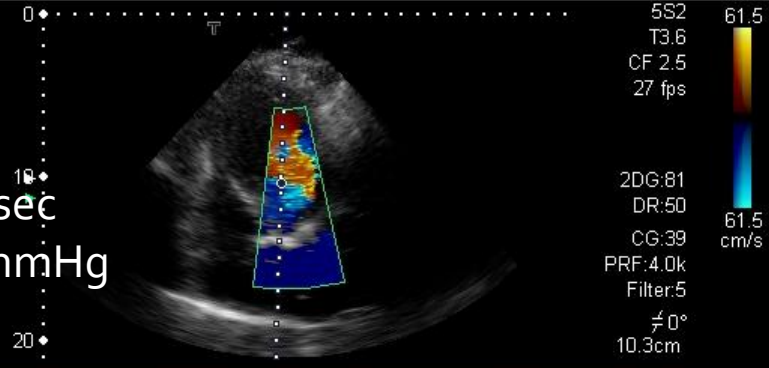
	Aortic stenosis	Mitral stenosis	Tricuspid stenosis
Valve area (cm <sup>2</sup> )	<1.0	<1.0	–
Indexed valve area (cm <sup>2</sup> /m <sup>2</sup> BSA)	<0.6	–	–
Mean gradient (mmHg)	>40 <sup>a</sup>	>10 <sup>b</sup>	≥5
Maximum jet velocity (m/s)	>4.0 <sup>a</sup>	–	–
Velocity ratio	<0.25	–	–

B



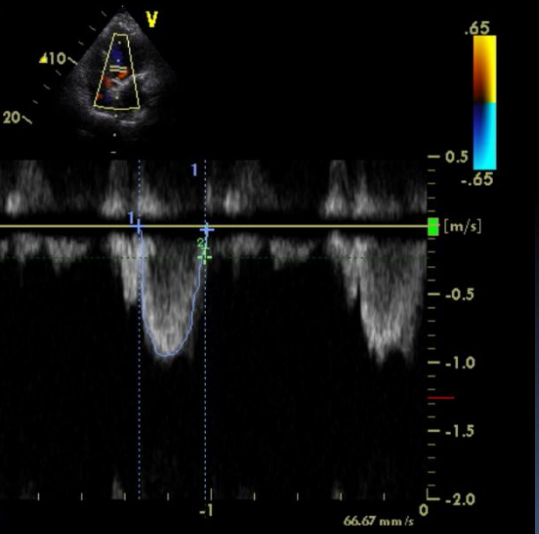
Aortic	
AoV VP	-449.5 cm/s
AoV VTI	-109.84 cm
AoV PPG	80.8 mmHg
AoV MPG	53.7 mmHg
LVOT Diam	25.0 mm

Vel max 4,49 m/sec  
Grad medio 53 mmHg



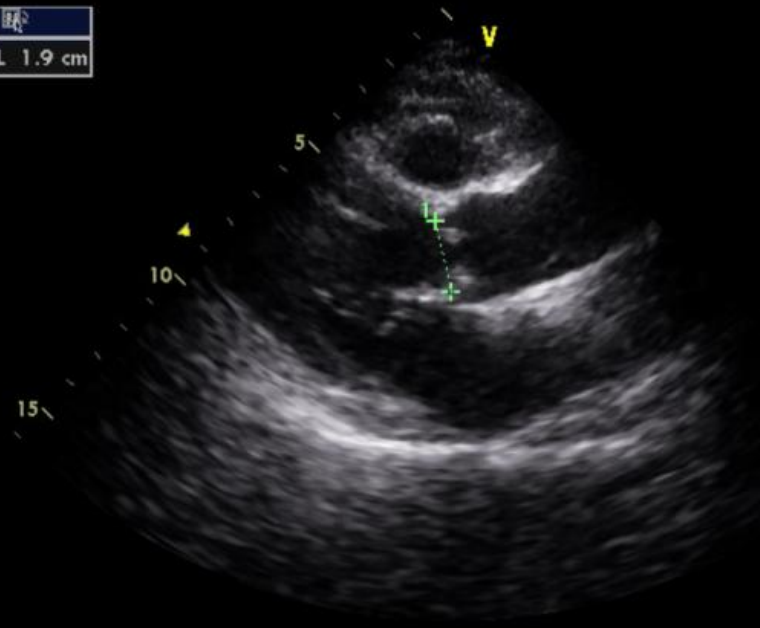
Area valvolare funzionale 0.9 cm<sup>2</sup>

2	
LVOT Vmax	0.20 m/s
LVOT Vmean	0.00 m/s
LVOT maxPG	0.17 mmHg
LVOT meanPG	0.00 mmHg
LVOT VTI	0.0 cm
LVOT Env.Ti	0 ms
LVSV Dopp	0 ml
AVA	
AVA Vmax	0.9 cm <sup>2</sup>
AVA (VTI)	0.9 cm <sup>2</sup>
1	
LVOT Vmax	0.94 m/s
LVOT Vmean	0.70 m/s
LVOT maxPG	3.57 mmHg
LVOT meanPG	2.27 mmHg
LVOT VTI	22.0 cm
LVOT Env.Ti	316 ms
HR	197 BPM
LVSV Dopp	79 ml
LVCO Dopp	15.48 l/min



LVOT

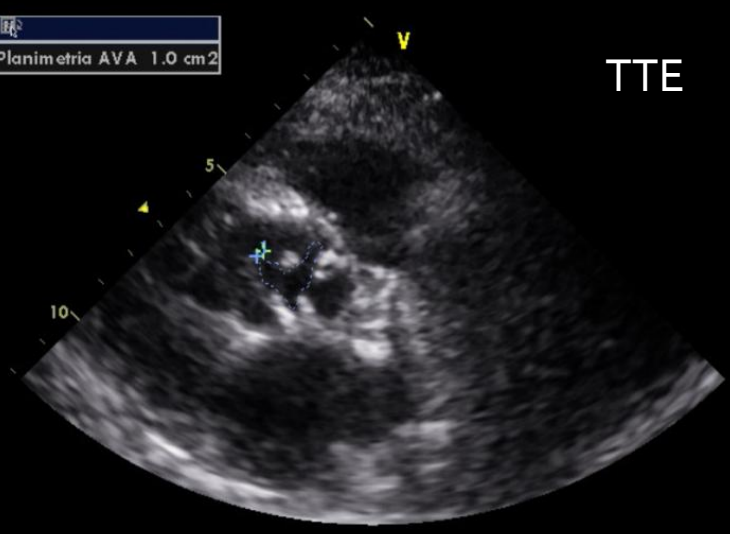
1 L 1.9 cm	
------------	--



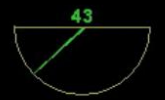
Area anatomica  
"planimetrica"

1 Planimetria AVA 1.0 cm<sup>2</sup>

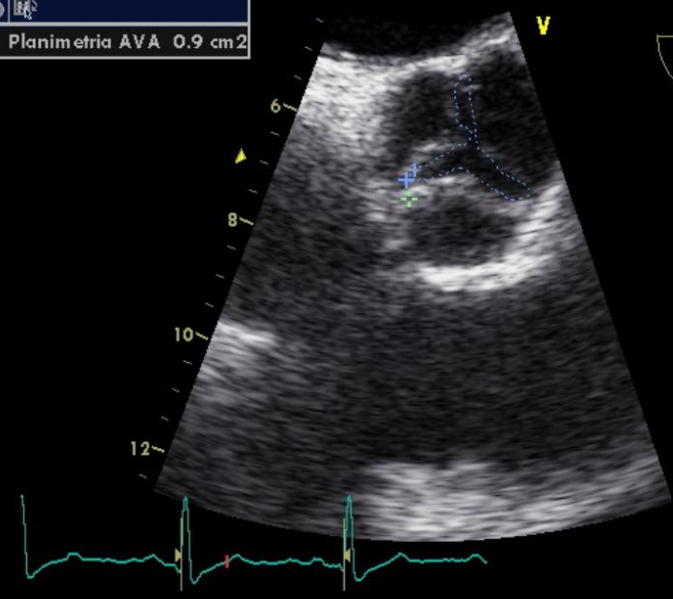
TTE



1 Planimetria AVA 0.9 cm<sup>2</sup>

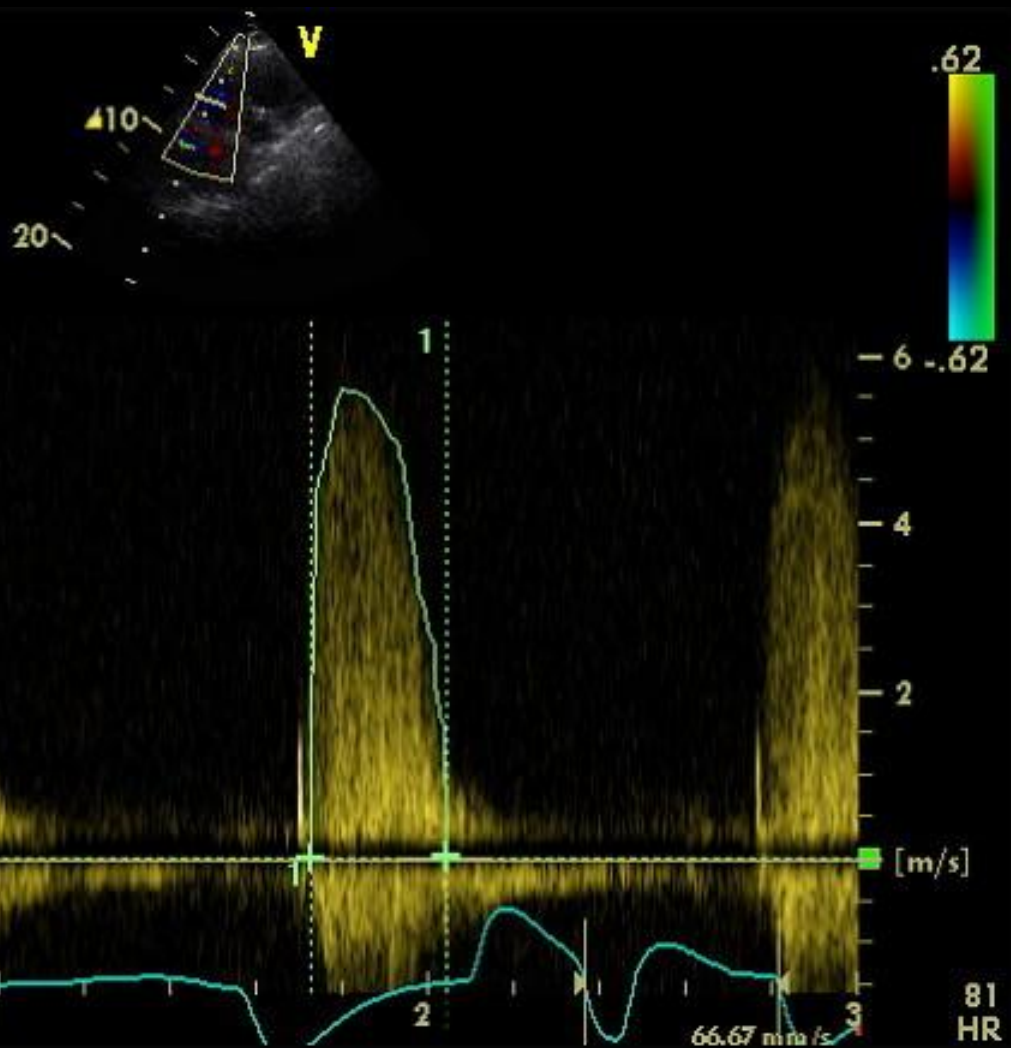


TEE



67  
HR

+	v	0.01 m/s
	p	0.00 mmHg
1	AV Vmax	5.60 m/s
	AV Vmean	4.40 m/s
	AV maxPG	125.6 mmHg
	AV media PG	77.3 mmHg
	AV VTI	139.0 cm
	HR	189.8 BPM



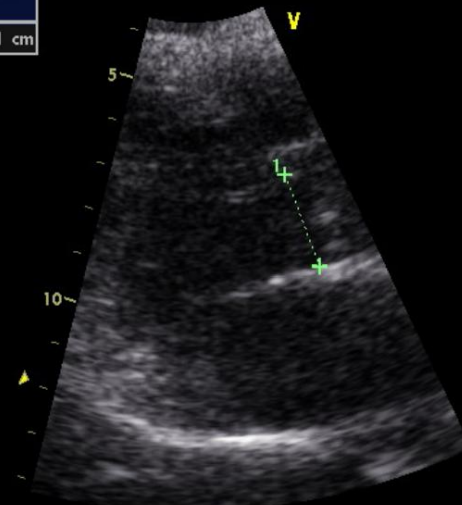
66.67 mm/s

81 HR

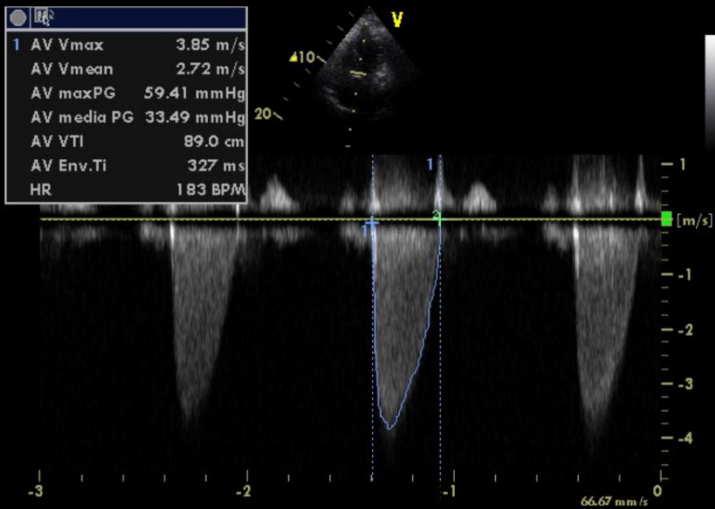
Area planimetrica 0,8 cm<sup>2</sup>



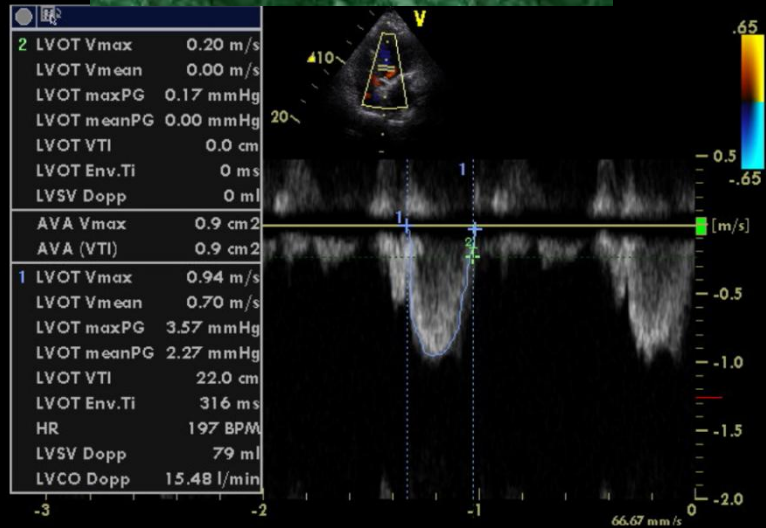
1 LVOT Diam 2.1 cm



Gradiente medio 33 mmHg



Area funzionale 0.9 cm<sub>2</sub>





# Low-flow low-gradient Aortic Stenosis

*EAE-ASE Recommendations Eur J Echocard 2009;10:1-25*

**5-10% dei casi**

- Effective orifice area  $< 1\text{cm}^2$
- LV ejection fraction  $< 40\%$
- Mean pressure gradient  $< 30\text{-}40\text{ mmHg}$



# Test alla dobutamina a basse dosi (fino a $20\mu\text{g}/\text{kg}/\text{m}^2$ )

1 – riserva contrattile SI  
(aumento SV  $\geq 20\%$ )



Area valvolare  $\uparrow > 0.3 \text{ cm}^2$   
(area finale  $> 1 \text{ cm}^2$ )

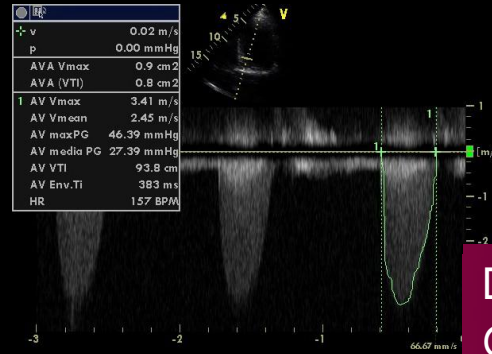
$\sim 7\%$

Area valvolare fissa o  $\uparrow < 0.3 \text{ cm}^2$   
(area finale  $< 1 \text{ cm}^2$ )

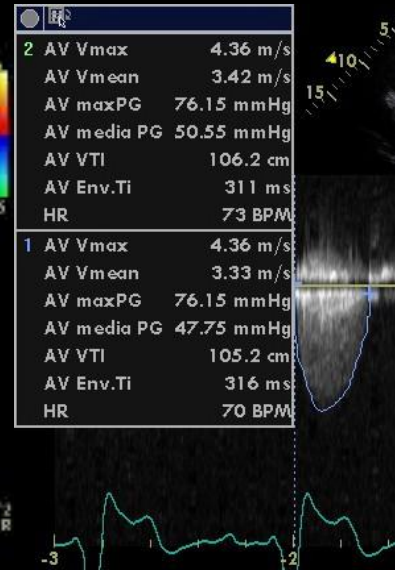
## Vera stenosi serrata

2 – riserva contrattile NO  
(SV fisso o poco modificato :  $< 20\%$ )

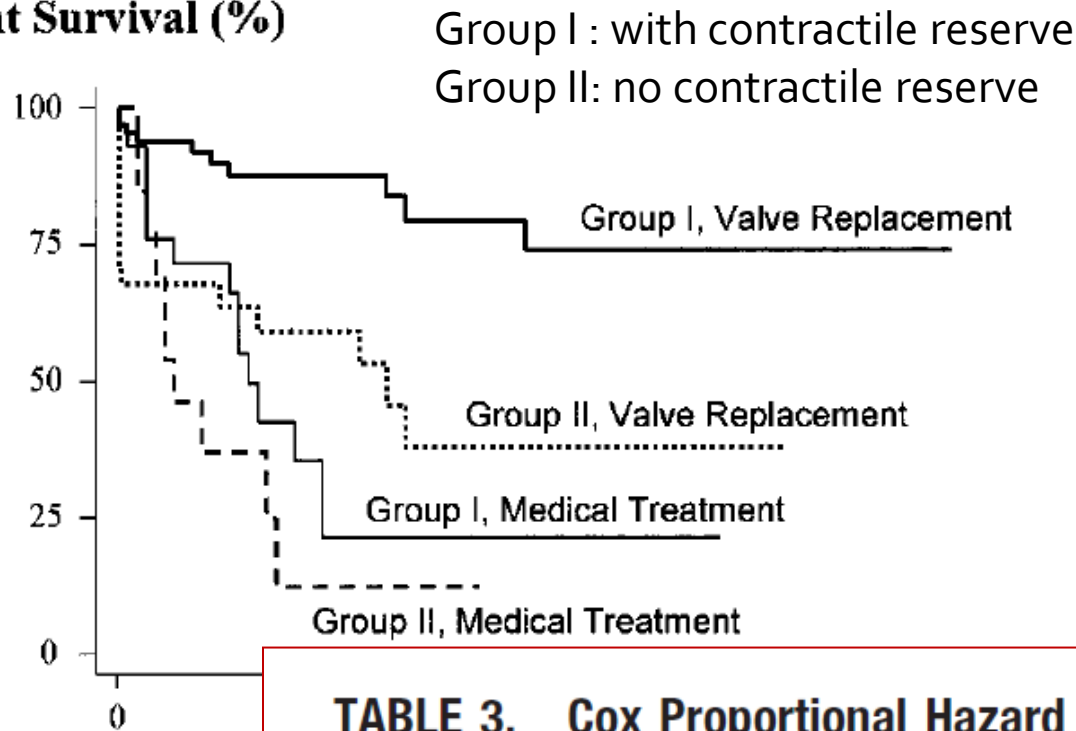
Gradiente medio 30 mmHg  
 Area valvolare 0.78 cm<sup>2</sup>(0.41/m<sup>2</sup>BSA)  
 FE<sub>32</sub>%



**Dobutamina**  
**Grad. medio 50 mmHg**



## Patient Survival (%)



Kaplan-Meier survival

**TABLE 3. Cox Proportional Hazard Analysis of the Effect of Surgical Treatment on Survival Duration in the 2 Groups**

	Hazard Ratio for Death	95% Confidence Interval	<i>P</i>
Group 2, medical	1.0	...	Reference
Group 1, medical	0.61	0.27–1.35	0.22
Group 2, surgical	0.47	0.31–1.05	0.07
Group 1, surgical	0.12	0.05–0.3	0.001



- 217 pts (AVR)
- Aortic area  $< 1 \text{ cm}^2$
- EF  $< 35\%$
- Mean gradient  $\leq 30 \text{ mmHg}$

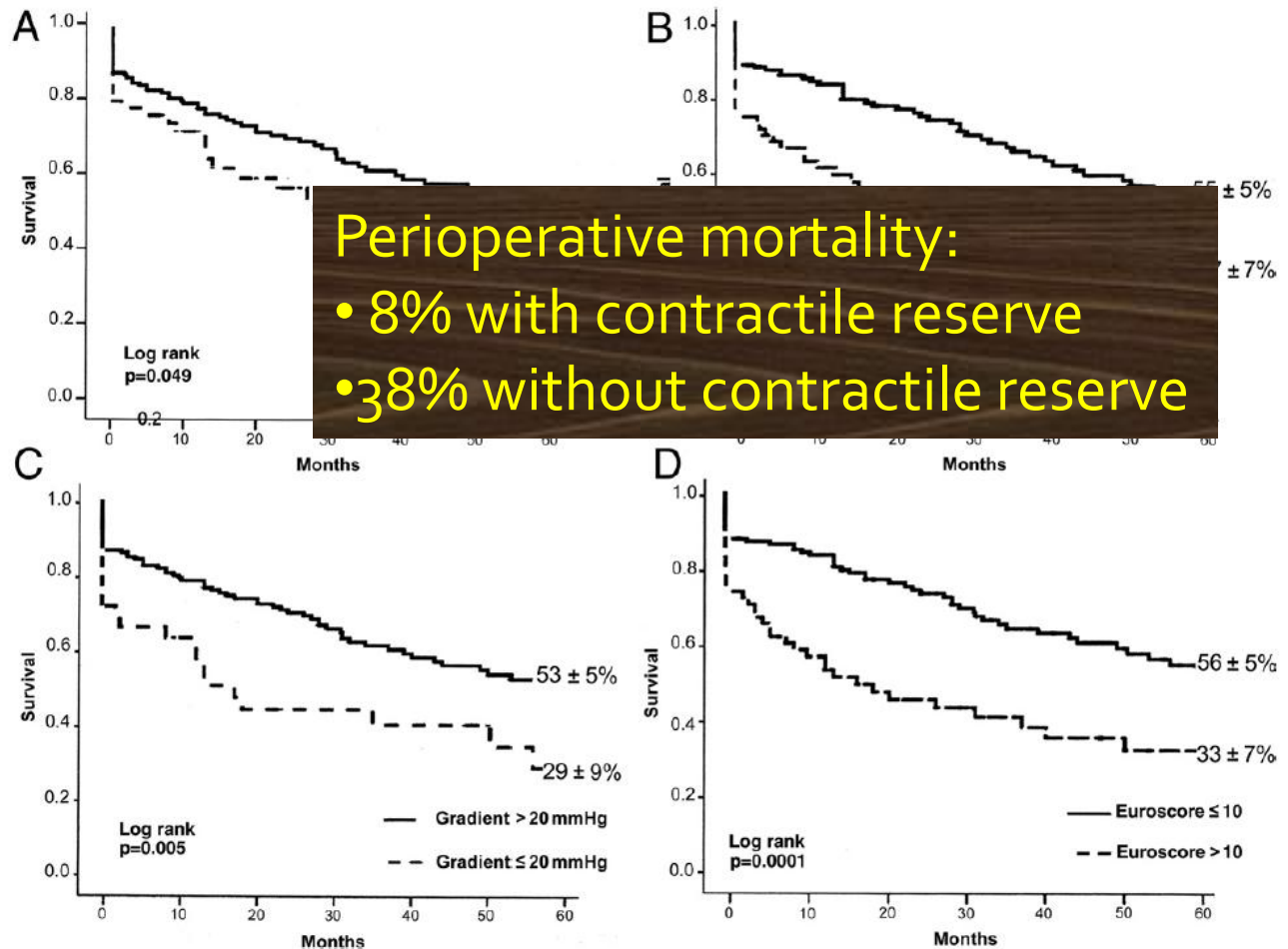


Figure 2 5-Year Overall Survival Curves

# ESC/EACTS GUIDELINES

2012



AVR should be considered in symptomatic patients with low flow, low gradient (<40 mmHg) AS with normal EF only after careful confirmation of severe AS. <sup>e</sup>	IIa	C
AVR should be considered in symptomatic patients with severe AS, low flow, low gradient with reduced EF, and evidence of flow reserve. <sup>f</sup>	IIa	C
<b>AVR should be considered in symptomatic pts with severe AS, Low flow, low gradient with reduced EF and evidence of flow reserve</b>		
AVR may be considered in symptomatic patients with severe AS low flow, low gradient, and LV dysfunction without flow reserve. <sup>f</sup>	IIb	C
<b>AVR may be considered in symptomatic pts with severe AS, Low flow, low gradient and LV dysfunction without flow reserve</b>		
• Excessive LV hypertrophy in the absence of hypertension.		C

## AHA-ACCP guidelines 2008

Although patients with low-output severe AS have a poor prognosis, in those with contractile reserve, outcome is still better with AVR than with medical therapy.<sup>148</sup> Some patients without contractile reserve may also benefit from AVR, but decisions in these high-risk patients must be individualized because there are no data indicating who will have a better outcome with surgery.

# Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

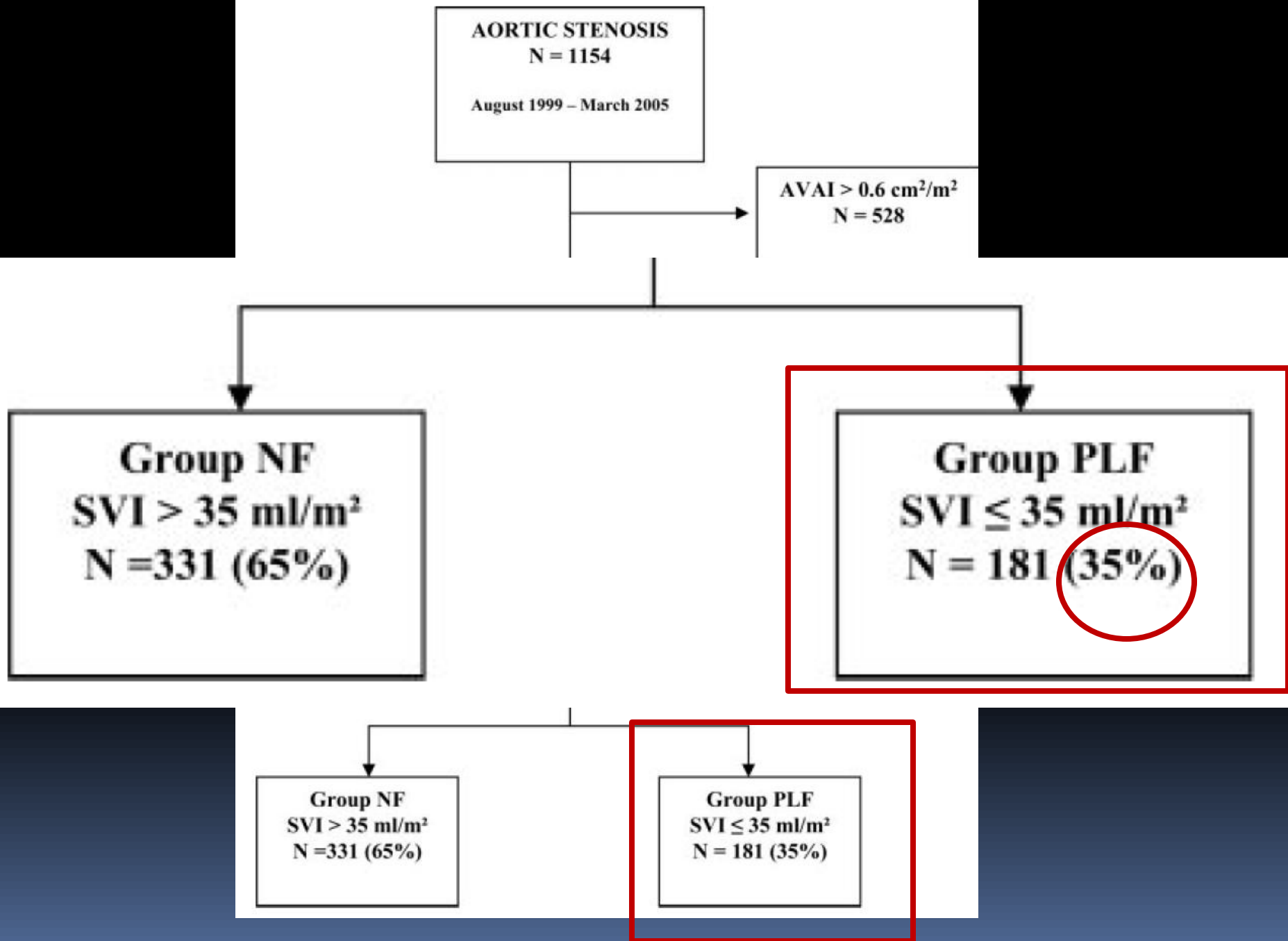
American Heart  
Association®   
*Learn and Live*™

## **Paradoxical Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Preserved Ejection Fraction Is Associated With Higher Afterload and Reduced Survival**

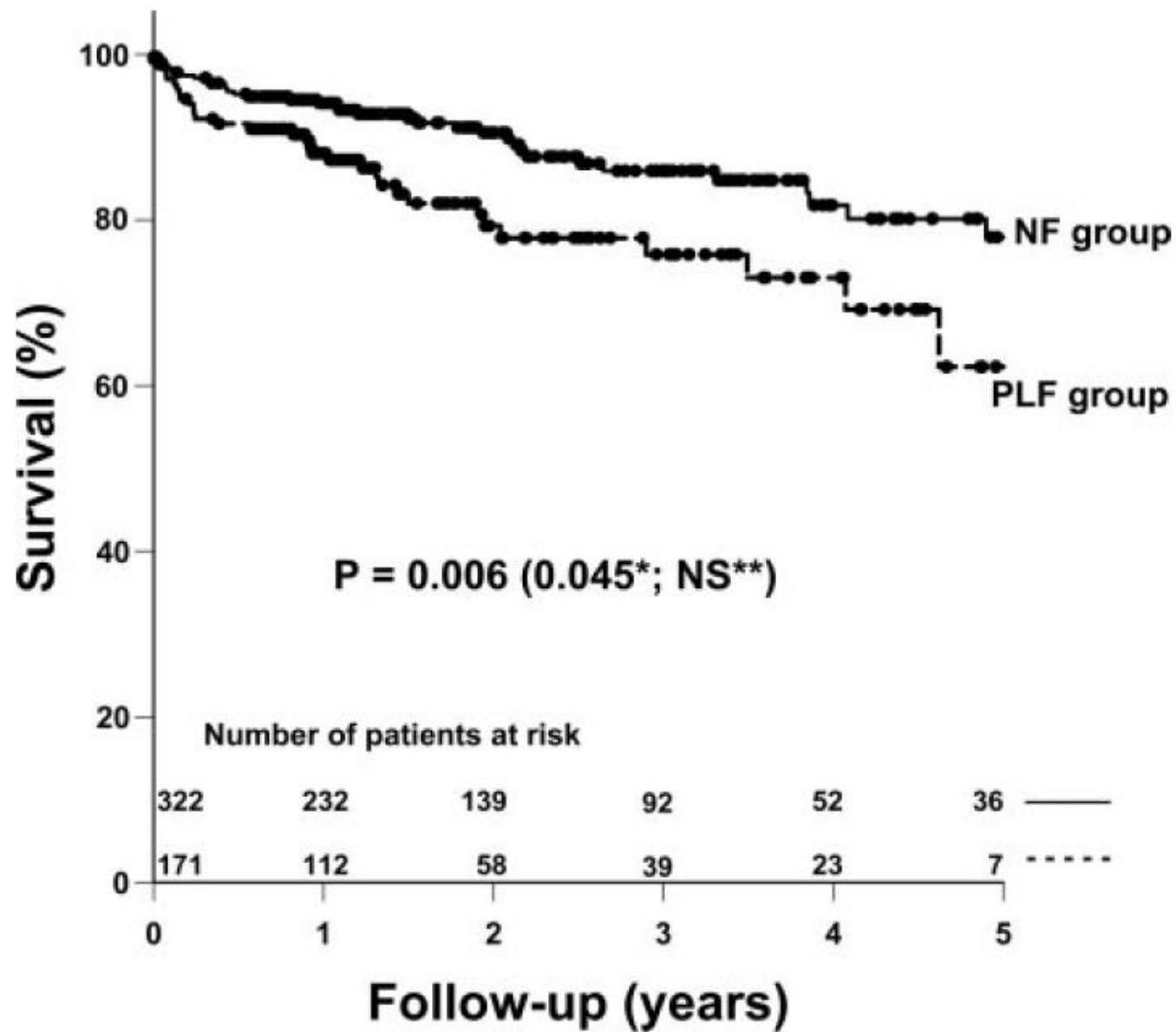
Zeineb Hachicha, Jean G. Dumesnil, Peter Bogner, and Philippe Pibarot  
*Circulation* 2007;115:2856-2864; originally published online May 28, 2007;  
DOI: 10.1161/CIRCULATIONAHA.106.668681

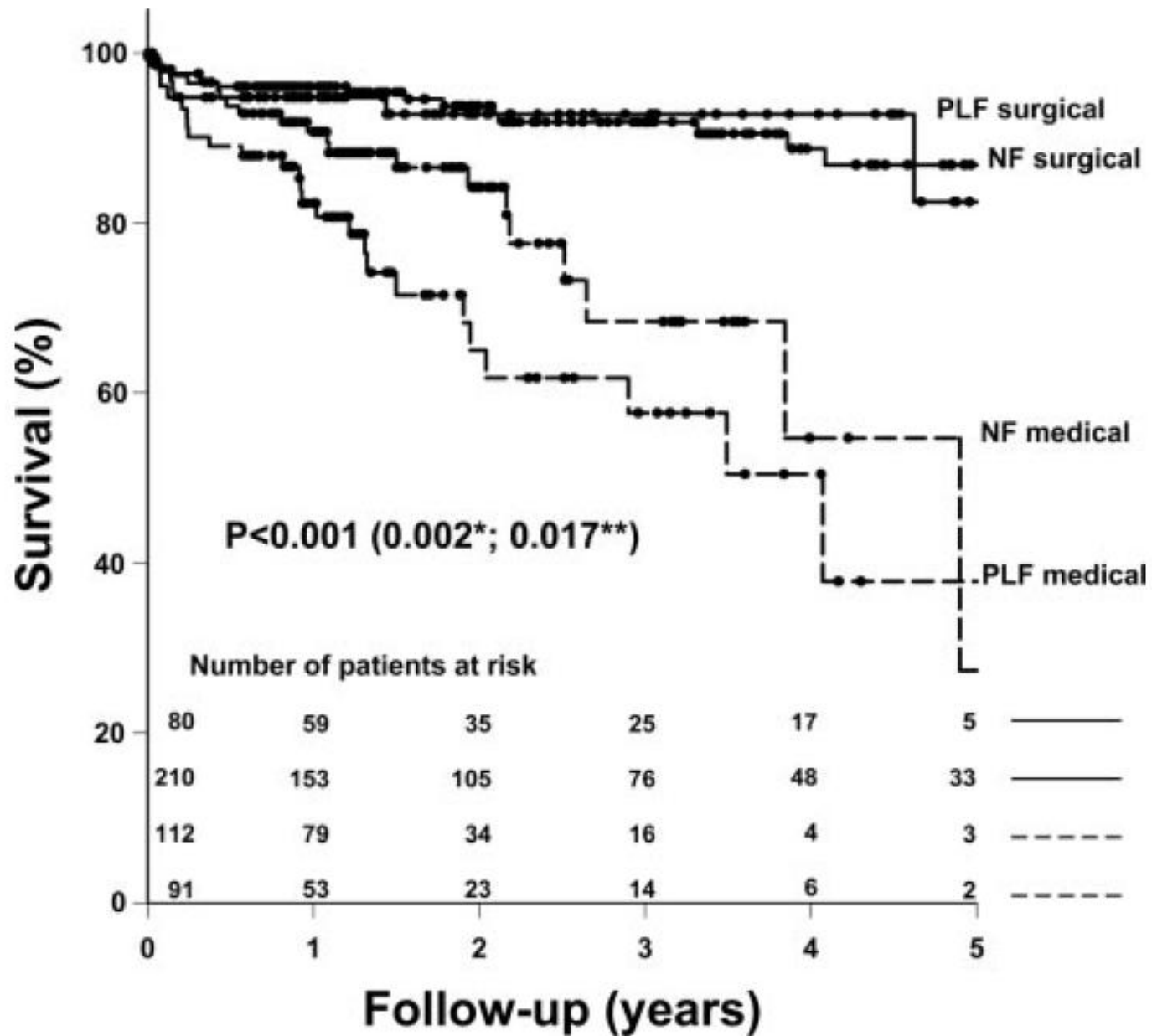
Paradoxical Low-Flow, Low-Gradient  
Severe Aortic Stenosis

Despite Preserved Ejection Fraction

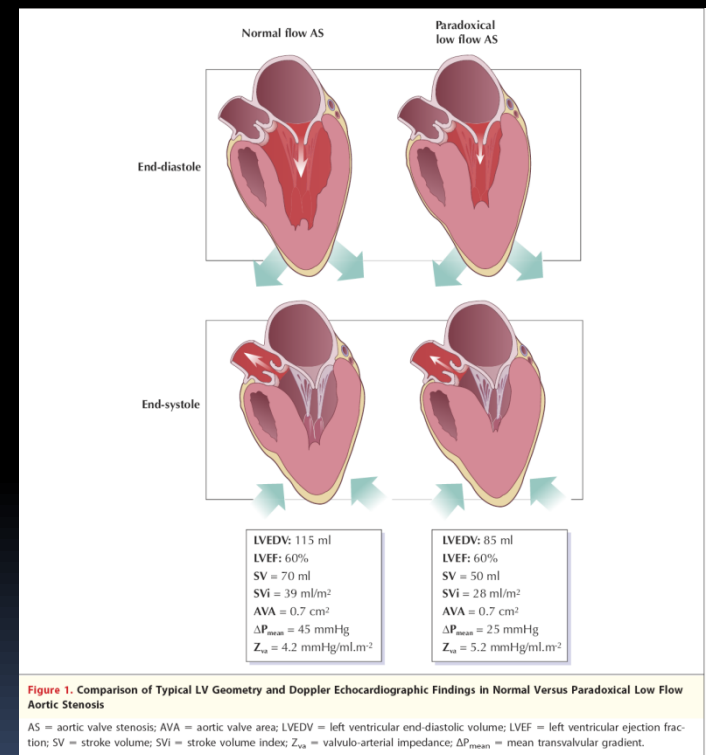








- Errori nelle misurazioni
- Ventricoli ipertrofici con piccole cavità e ridotto stroke volume
- Riduzione “fisiologica” della gittata nei pz anziani:
  - ridotta attività metabolica
  - aumento resistenze periferiche
  - aumentata rigidità arteriosa
  - altri fattori



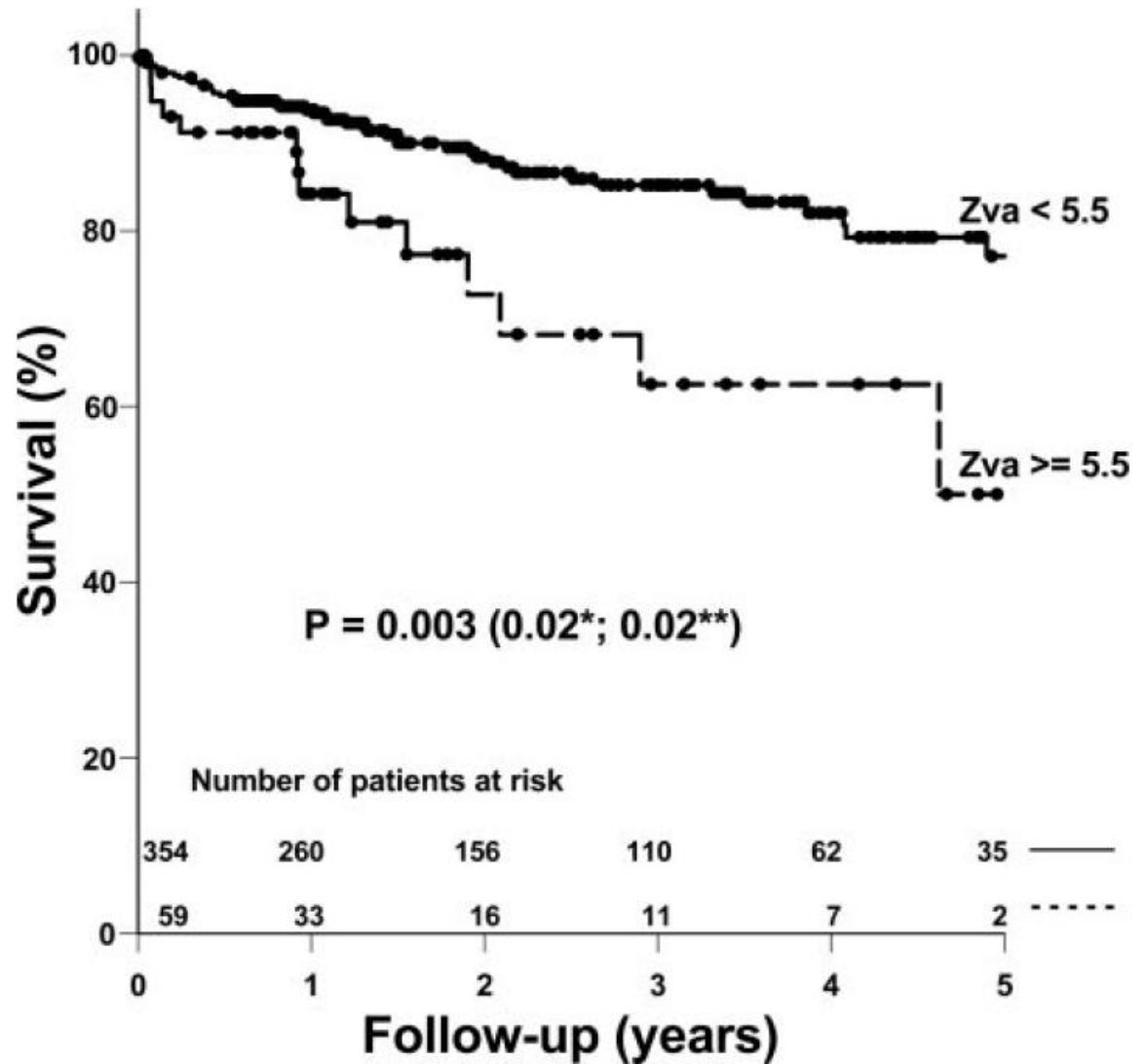
$$Z_{va} = \frac{SAP + MG}{SVI},$$

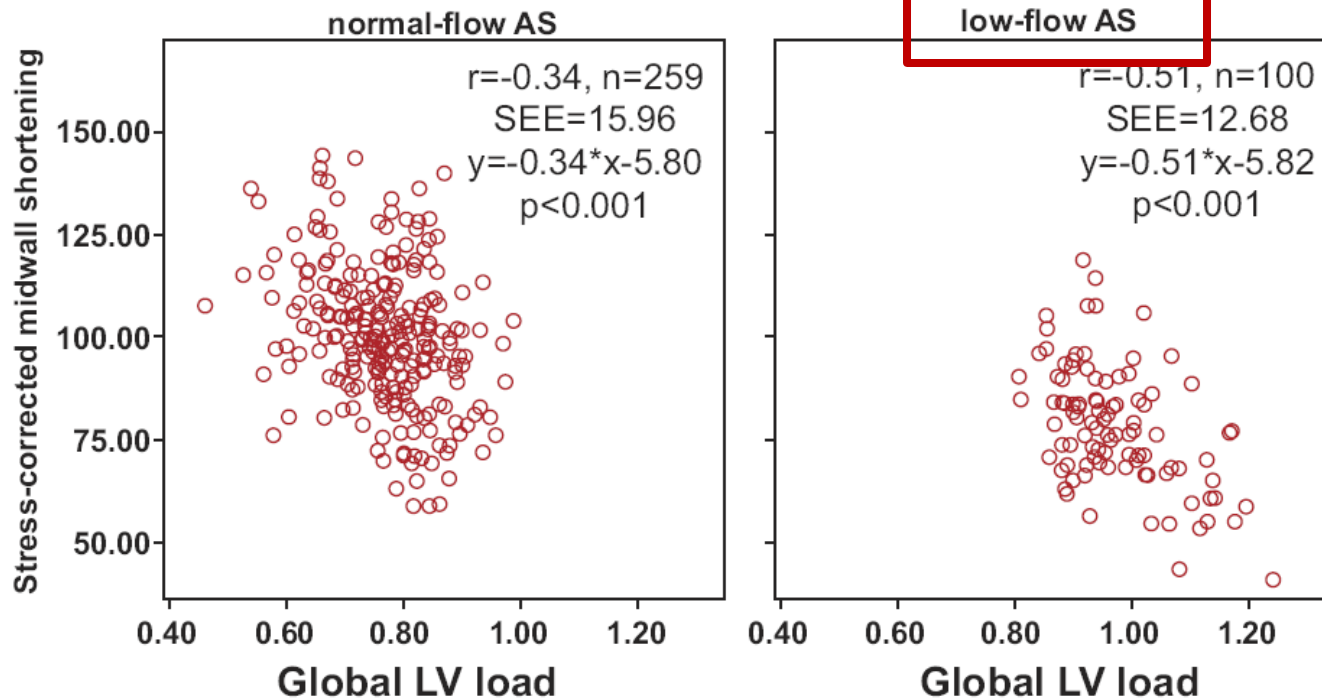
**Z<sub>va</sub>** : valvulo-arterial impedance

**SAP**: Systolic arterial pressure

**MG** : mean transvalvular gradient

**SVI**: stroke volume index



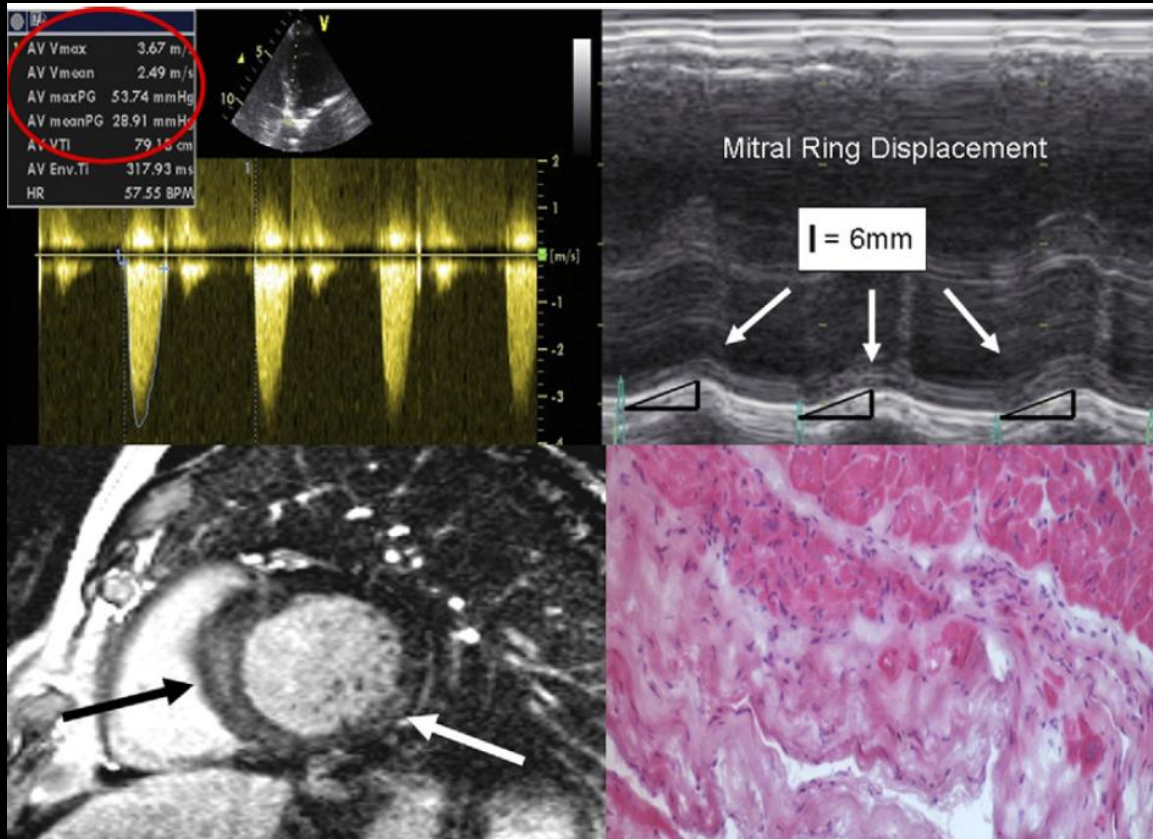


**Figure 4. Load and Function in Low-Flow Aortic Stenosis**

Global left ventricular (LV) load (log-transformed global load, horizontal axis) has a stronger negative relation with stress-corrected mid-wall shortening (vertical axis) in patients with low-flow severe aortic stenosis (AS) (Pearson correlation coefficient  $r = -0.51$ ,  $p < 0.001$ , right panel) than in patients with normal-flow severe AS (Pearson correlation coefficient  $r = -0.34$ ,  $p < 0.001$ , left panel).

Stress-corrected midwall shortening





Hermann et al. JACC 2011;58:402-12

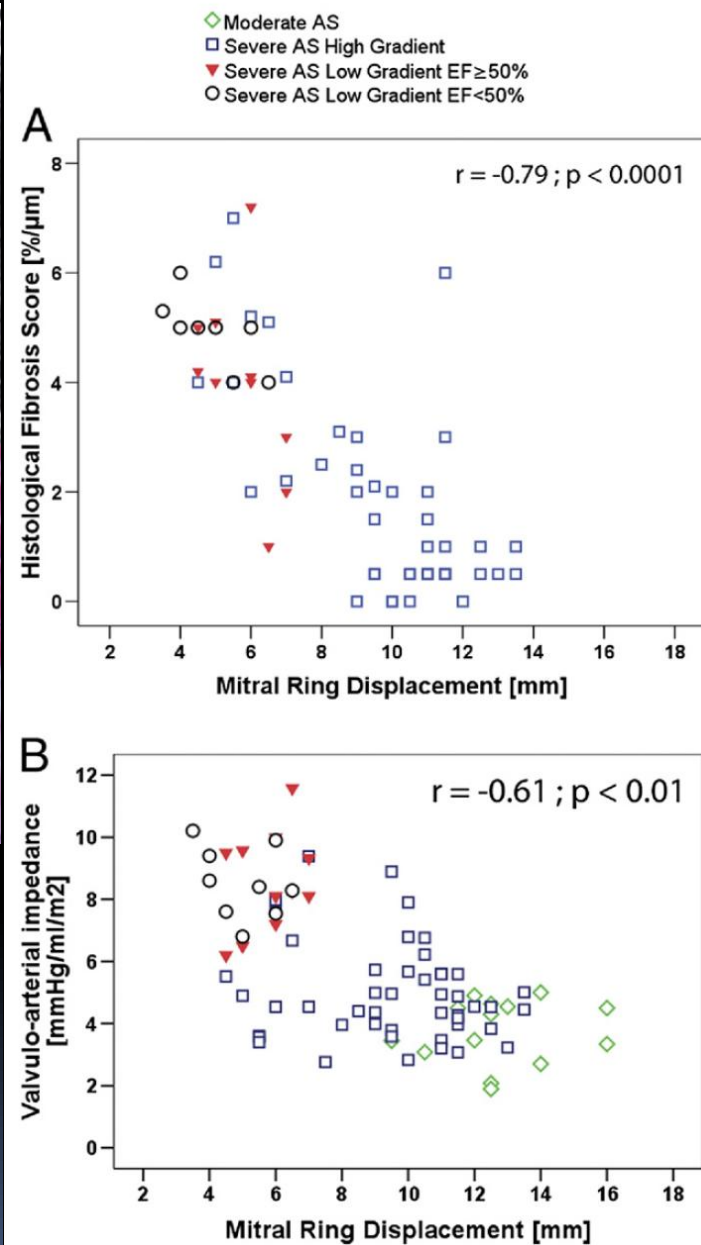
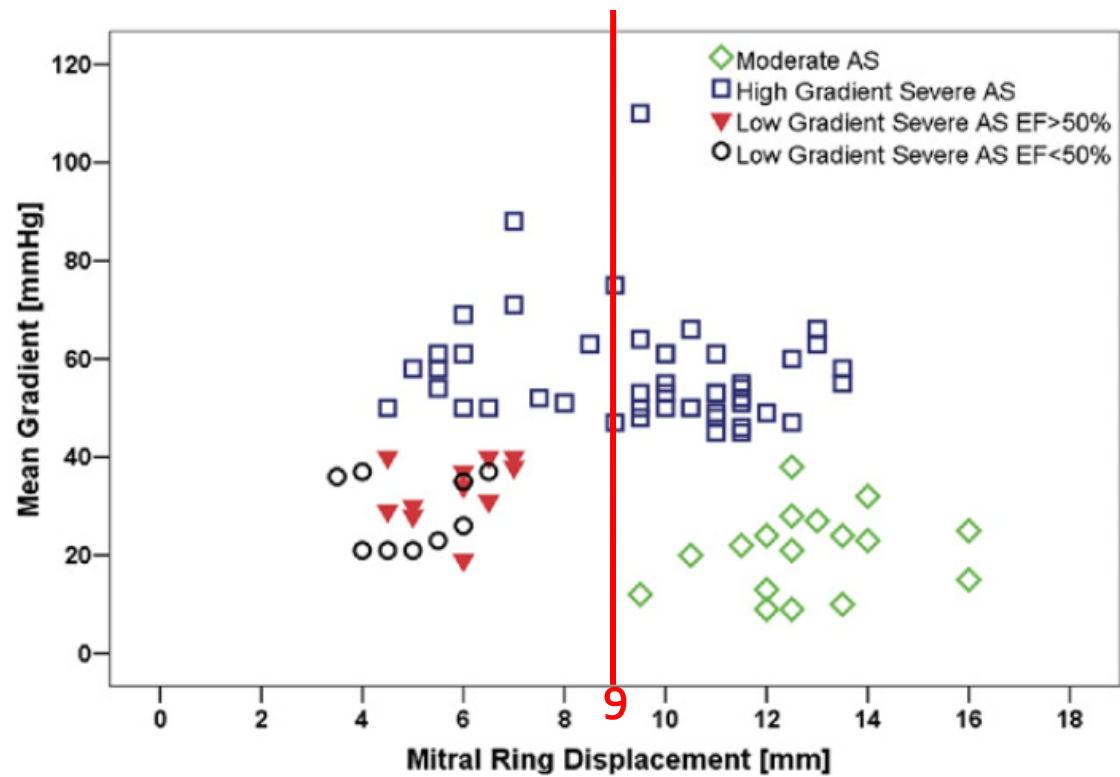


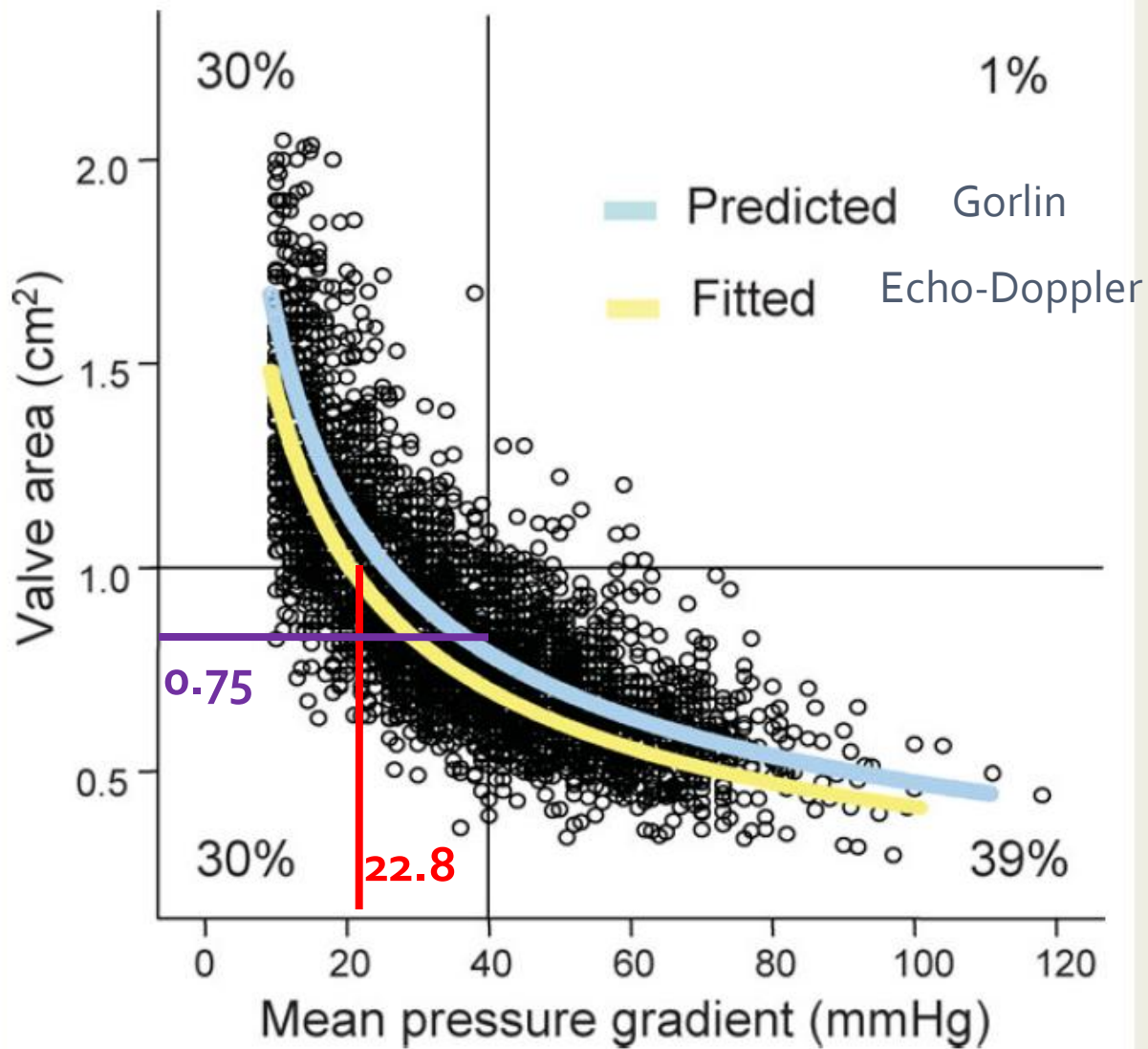
Figure 1

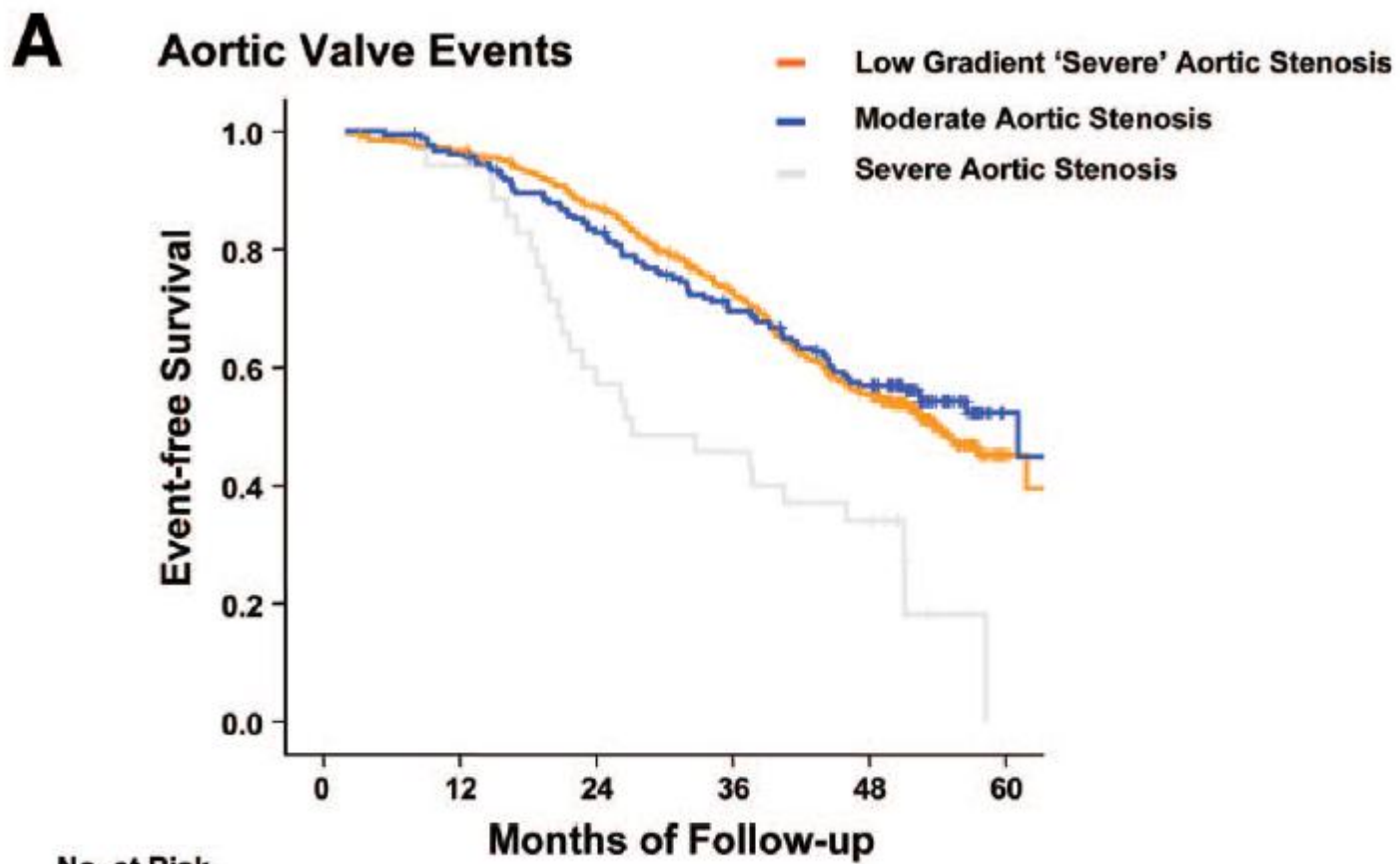
Correlations Between Myocardial Fibrosis and Functional Parameters



**Figure 2** Scatterplot of Mean Transvalvular Gradient (mm Hg) Versus Mitral Ring Displacement (mm)

Note that a clear differentiation between moderate AS and severe AS with low gradients is possible by the assessment of mitral ring displacement. Abbreviations as in Figure 1.





No. at Risk	0	12	24	36	48	60
LGSAS	435	420	376	310	232	17
Moderate AS	184	176	151	126	99	10
Severe AS	35	33	21	16	11	0

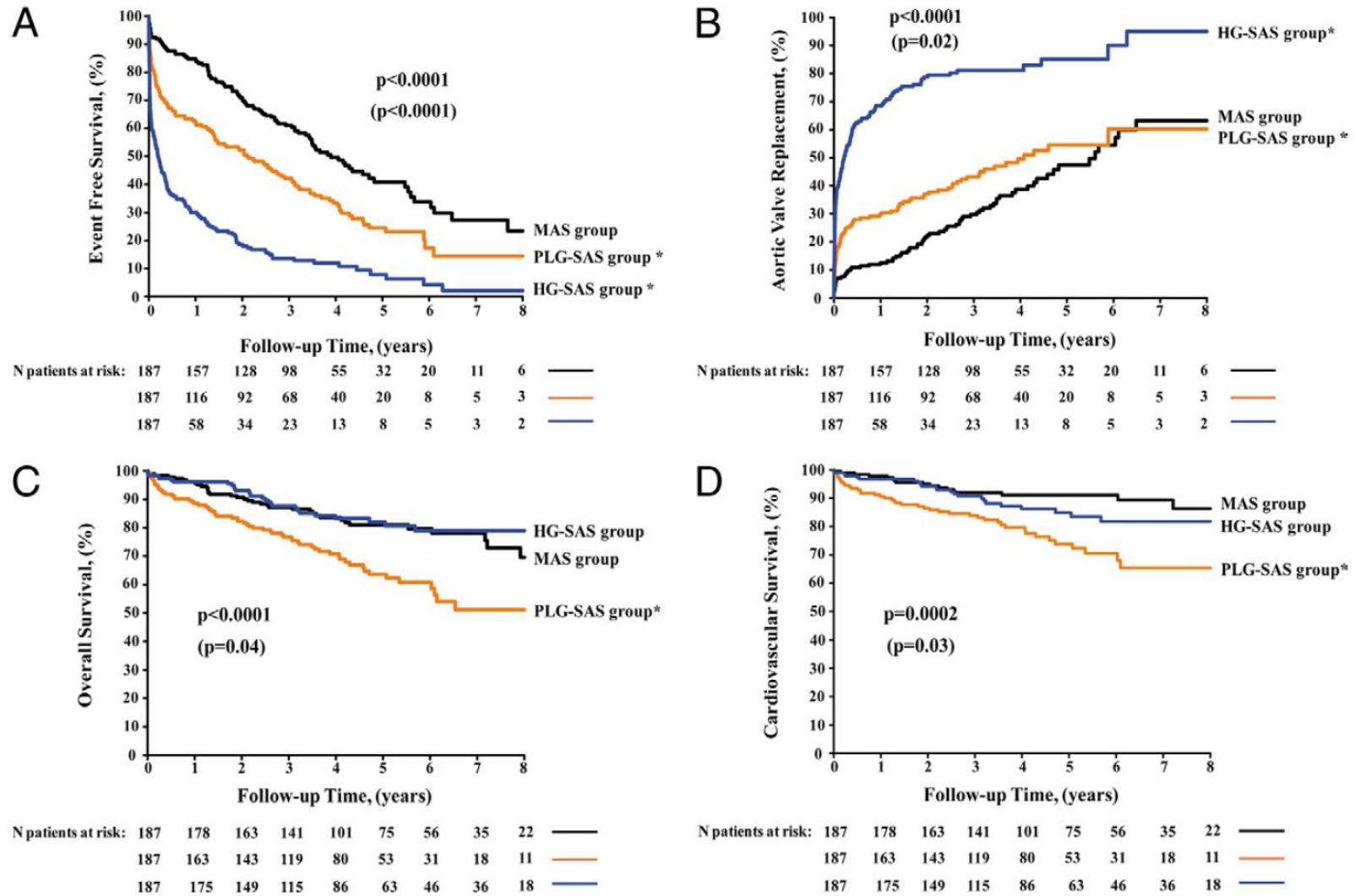
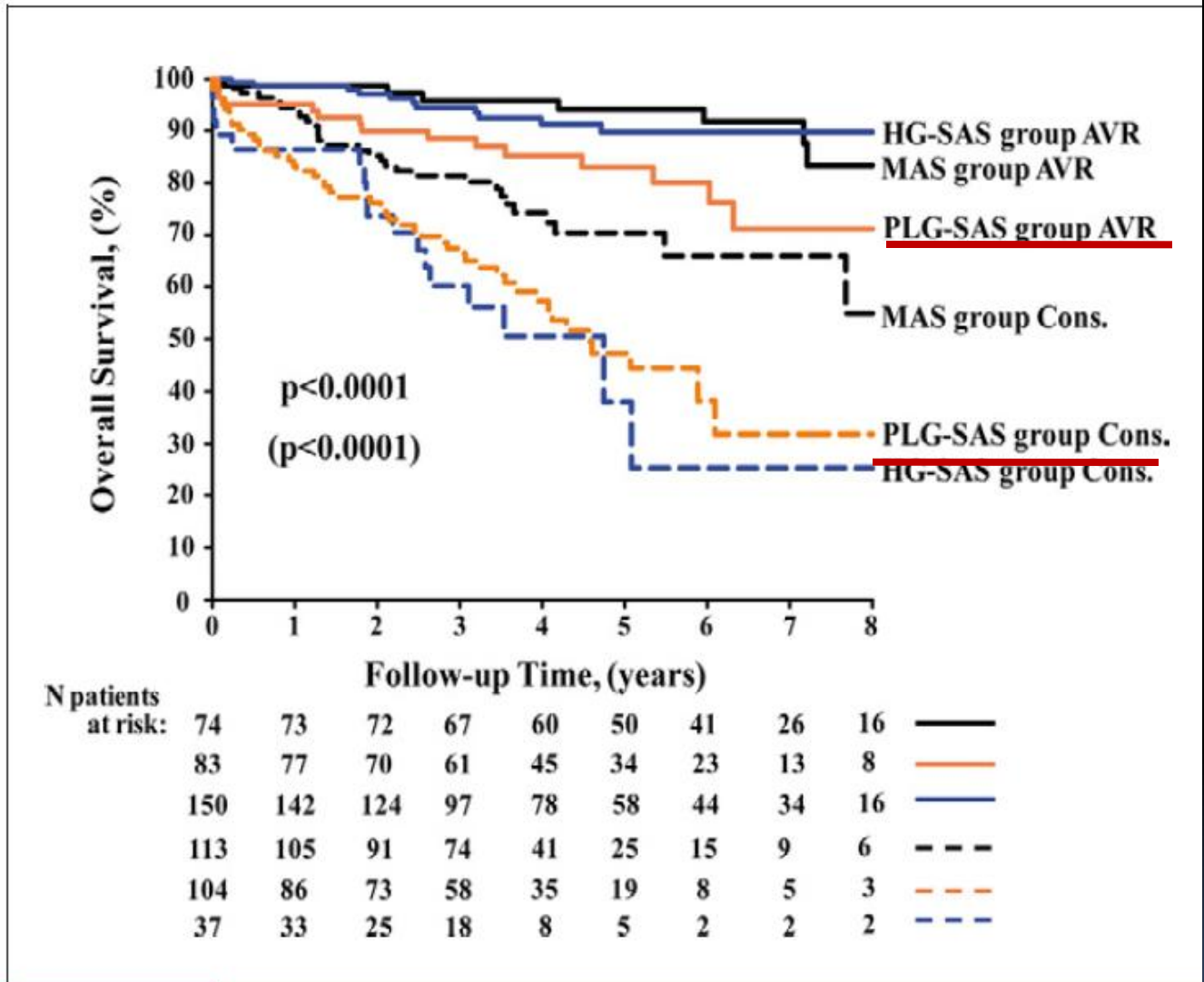


Figure 2

Kaplan-Meier Analysis of Combined Events, AVR, Overall Survival, and Cardiovascular Survival





**Figure 3** Kaplan-Meier Curves of Overall Survival According the Group of Patients and Type of Treatment

# ESC/EACTS GUIDELINES

2012



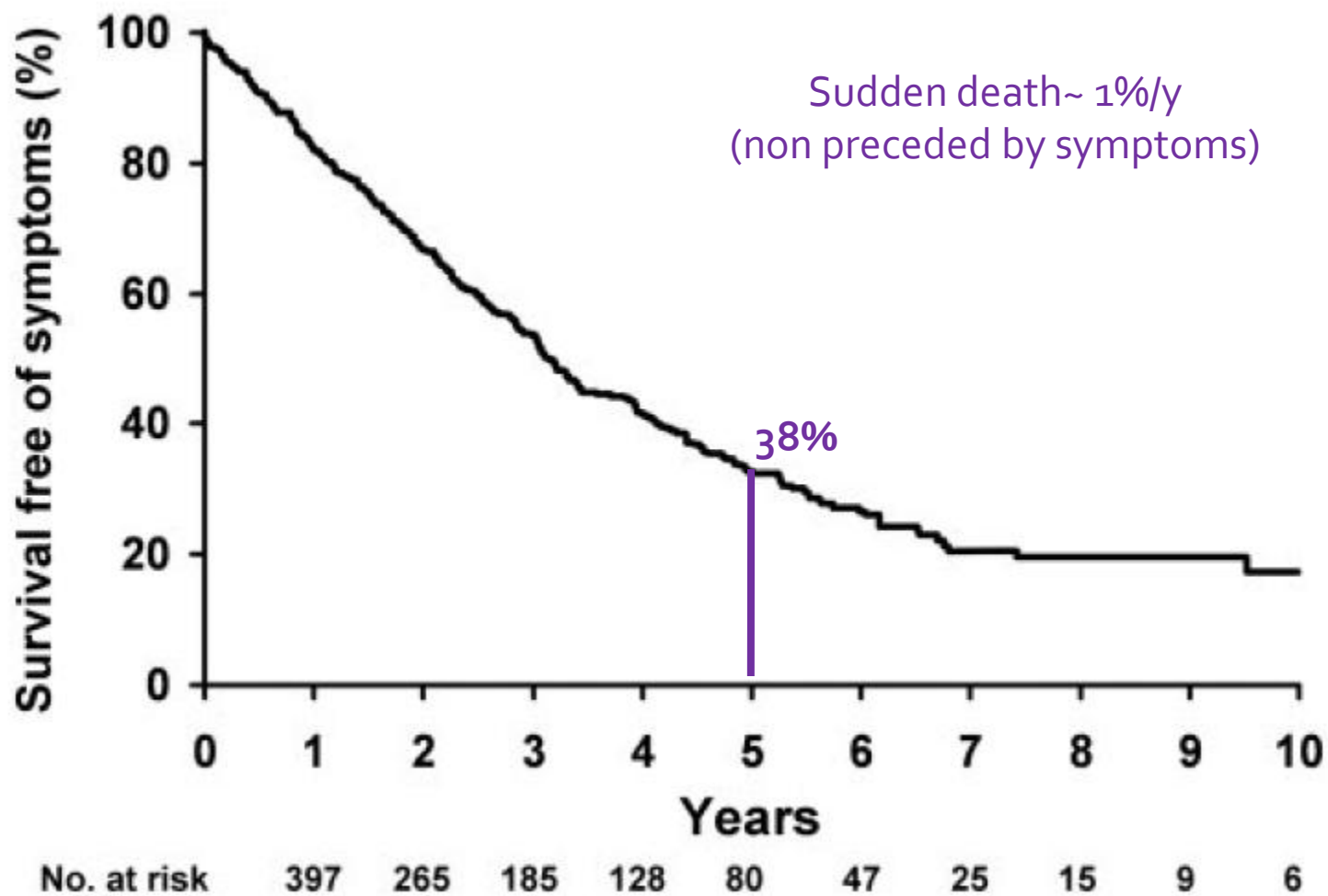
AVR should be considered in symptomatic patients with low flow, low gradient (<40 mmHg) AS with normal EF only after careful confirmation of severe AS. <sup>e</sup>	IIa	C
<b>AVR should be considered in symptomatic pts with low flow, low gradient (&lt; 40 mmHg) AS with normal EF only after careful confirmation of severe AS</b>		
• Severe valve calcification and a rate of peak transvalvular velocity progression $\geq 0.3$ m/s per year.		C
AVR may be considered in symptomatic patients with severe AS low flow, low gradient, and LV dysfunction without flow reserve. <sup>f</sup>	IIb	C
AVR may be considered in asymptomatic patients with severe AS, normal EF and none of the above mentioned exercise test abnormalities, if surgical risk is low, and one or more of the following findings is present: <ul style="list-style-type: none"><li>• Markedly elevated natriuretic peptide levels confirmed by repeated measurements and without other explanations</li><li>• Increase of mean pressure gradient with exercise by &gt;20 mmHg</li><li>• Excessive LV hypertrophy in the absence of hypertension.</li></ul>	IIb	C

# .....e per i pazienti asintomatici?

## Sostituzione valvolare “preventiva”?

### Pro

- morte improvvisa ~ 1%/anno
- > 60% sintomi entro 4 anni
- da allora mortalità ~ 2% /mese
- deterioramento VS (raddoppio mortalità)



## Midwall Fibrosis Is an Independent Predictor of Mortality in Patients With Aortic Stenosis

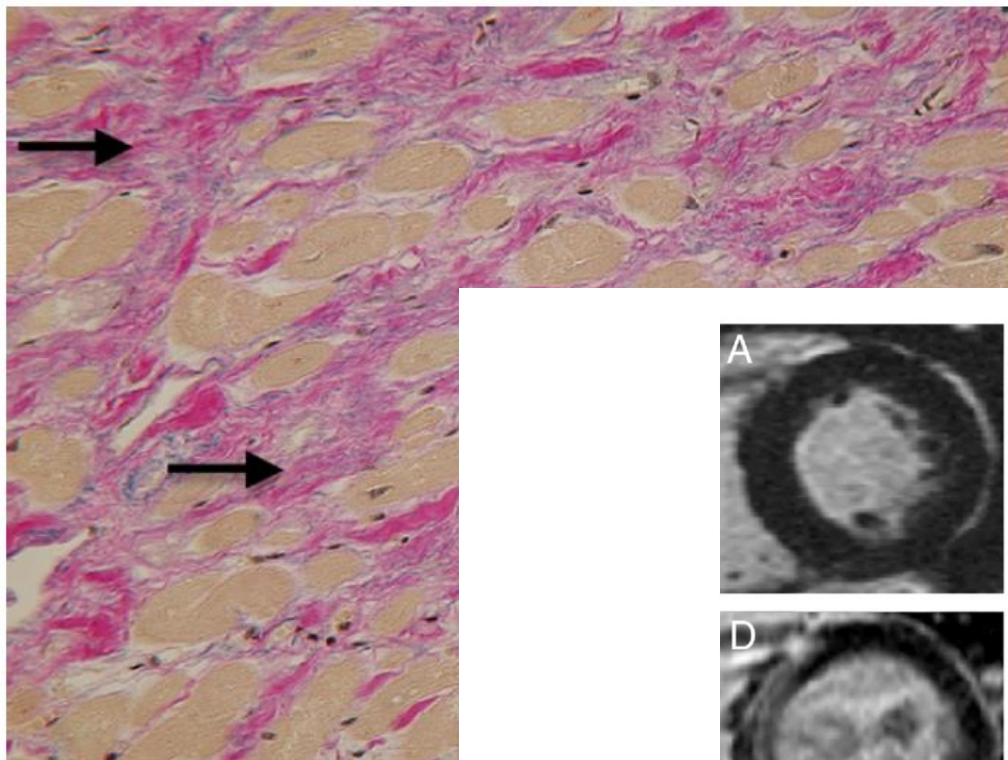


Figure 2

Histology of the Myocardium in a Patient With Aortic Stenosis

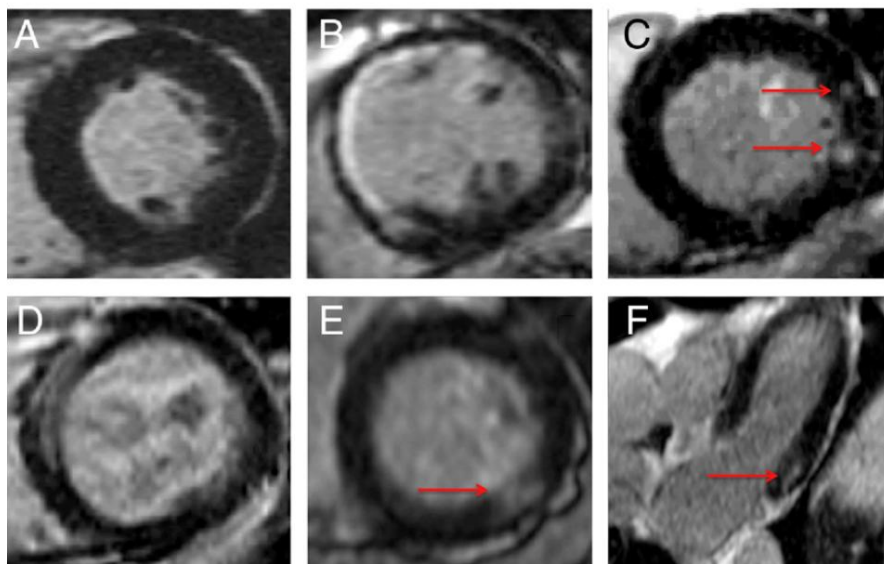


Figure 1 Patterns of LGE in Aortic Stenosis

Images showing the different patterns of late gadolinium enhancement (LGE) observed in patients with aortic stenosis. (A) No LGE. (B) Infarct LGE with a subendocardial pattern observed in the septum and anterior wall. (C) Two focal areas of midwall LGE in the lateral wall of the left ventricle (red arrows); (D) Midwall LGE in a more linear pattern affecting the septum. (E) Short- and (F) long-axis views of midwall LGE (red arrows) of the inferolateral wall in the same patient.



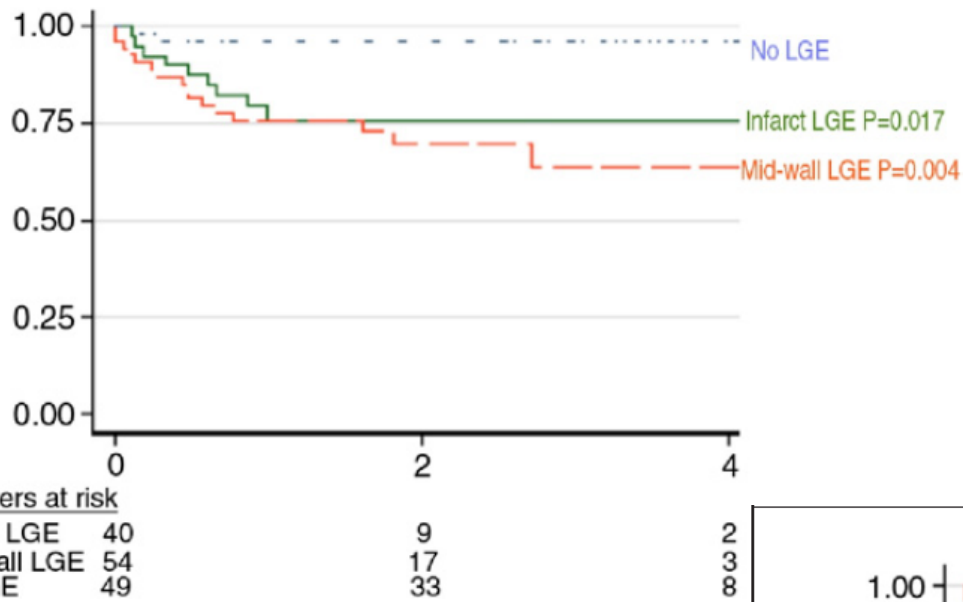


Figure 3

Kaplan-Meier Survival Estimates by Pattern of LGE for All-Cause Mortality in 143 Patients With Moderate or Severe Aortic Stenosis

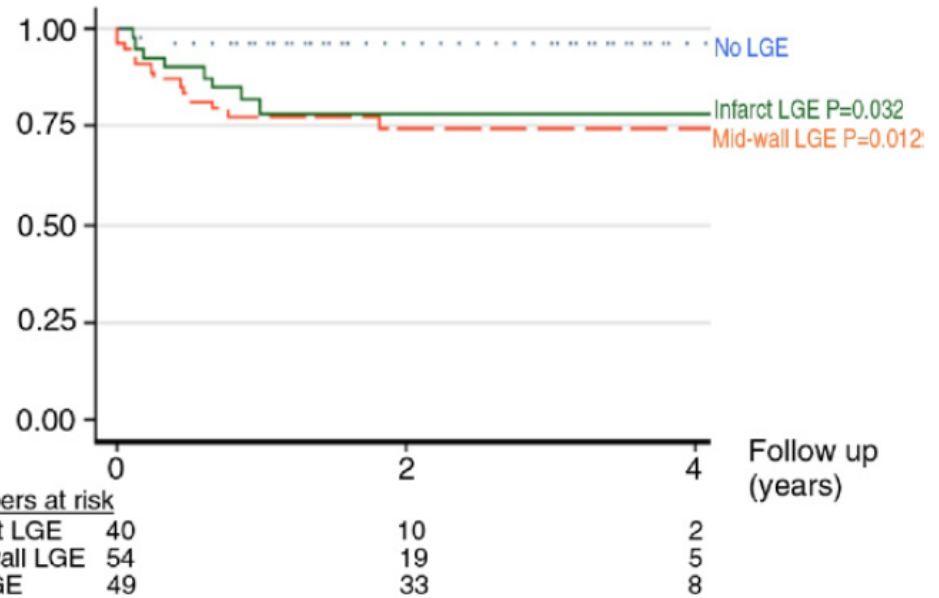


Figure 4

Kaplan-Meier Survival Estimates by Pattern of LGE for Cardiac Mortality in 143 Patients With Moderate or Severe Aortic Stenosis

# .....e per i pazienti asintomatici?

## Sostituzione valvolare "preventiva"?

### Pro

- morte improvvisa ~ 1%/anno
- > 60% sintomi entro 4 anni
- da allora mortalità ~ 2% /mese
- deterioramento VS (raddoppio mortalità)

Indicatori prognostici  
"precoci"?

### Contro

- rischio operatorio ~ 1-3% (~ 5-7% con BPAC)
- rischio annuale protesi ~ 1-3%/anno
- morbilità peri e post-operatoria (stroke 1.4-4.8%)

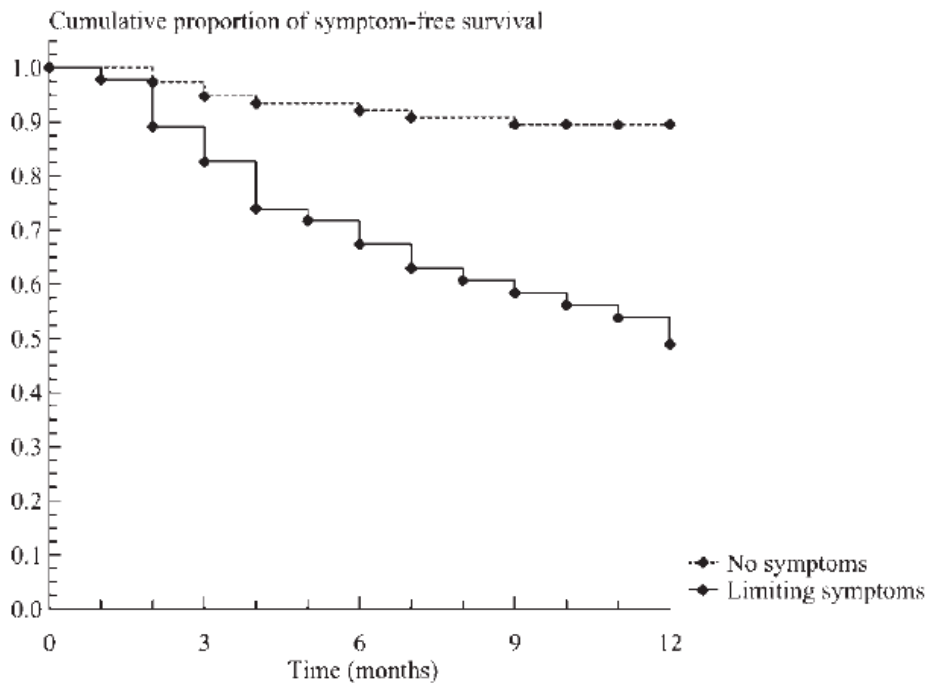


AVR: symptoms on exercise test

class I

AVR: fall of blood pressure below baseline on exercise test

class IIa



At risk	79	77	73	71	70	No symptoms
	46	41	33	28	25	Limiting symptoms

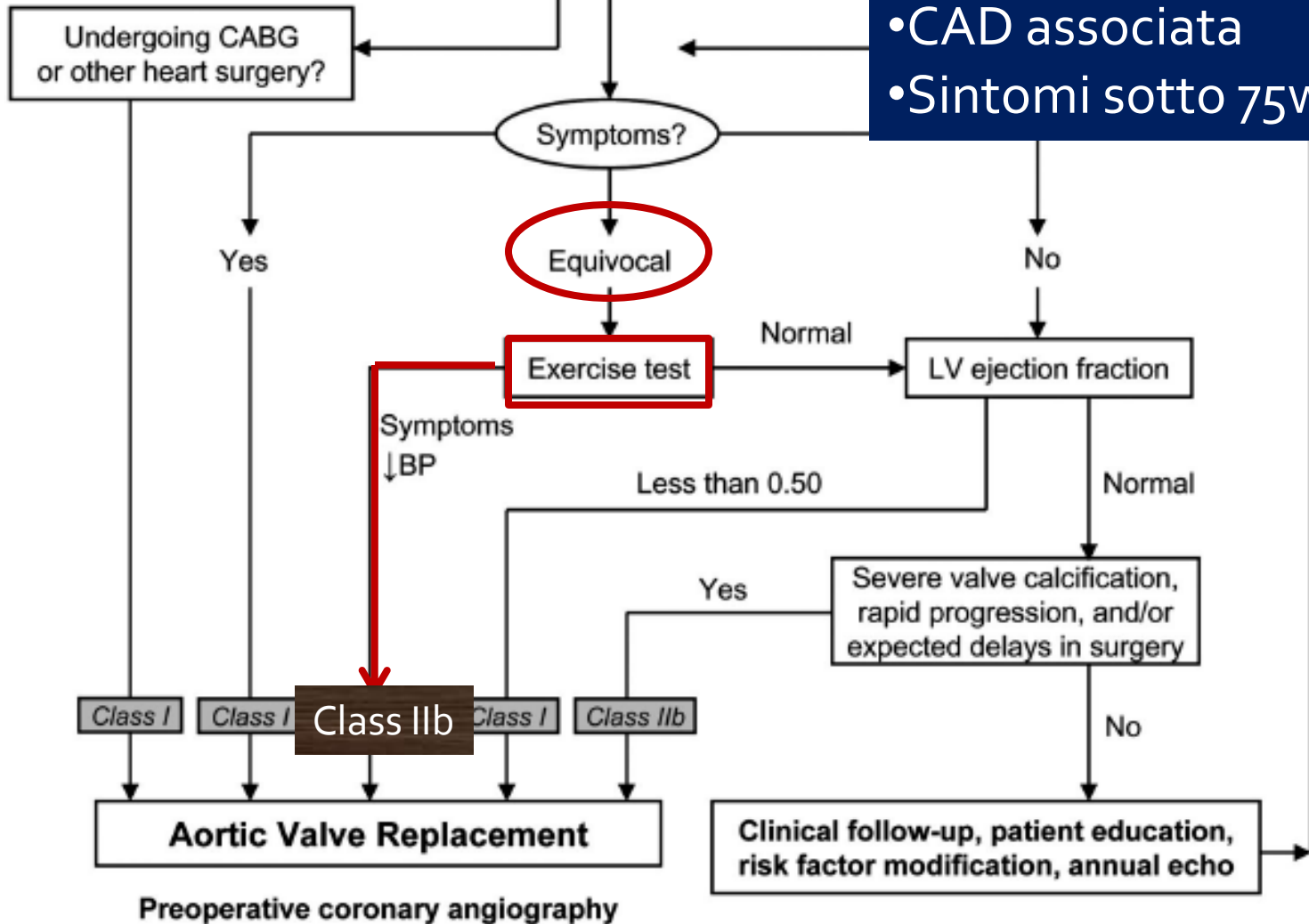
Figure 1 Kaplan-Meier plot of cumulative symptom-free survival over 12 months according to the incidence of limiting symptoms on baseline exercise testing.  $P < 0.0001$  (log rank test).

AHA-ACC  
guidelines 2008

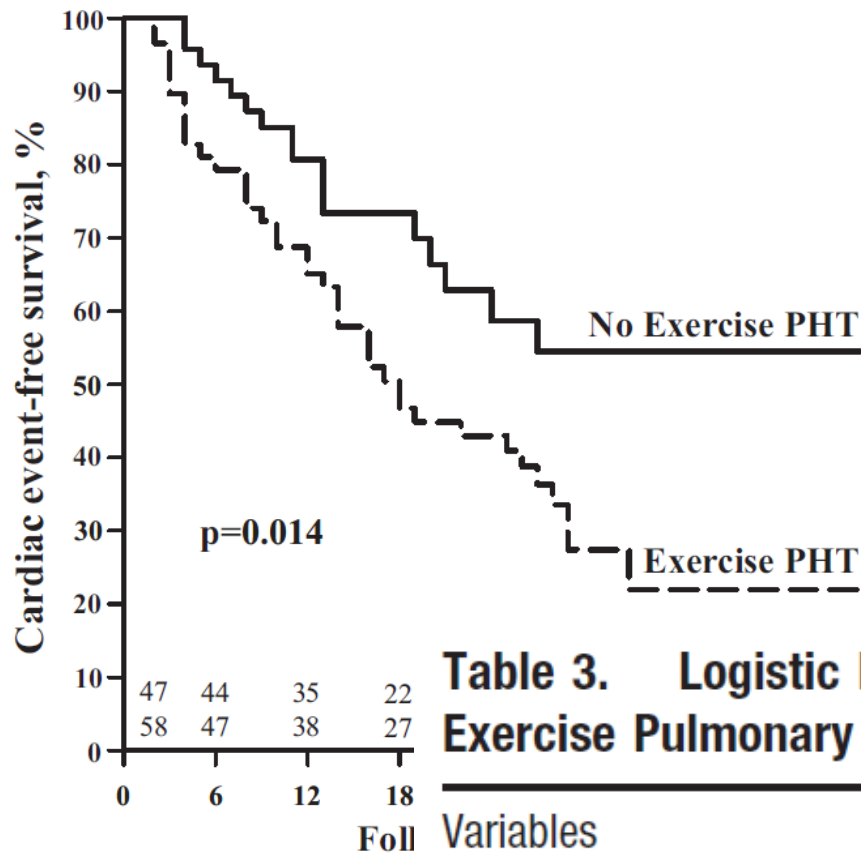
**Severe Aortic Stenosis**

Vmax greater than 4 m/s  
AVA less than 1.0 cm<sup>2</sup>  
Mean gradient > 40 mm Hg

- Età
- Inattività
- Decondizionamento
- CAD associata
- Sintomi sotto 75watt?



Exercise PHT = SPAP > 60 mmHg



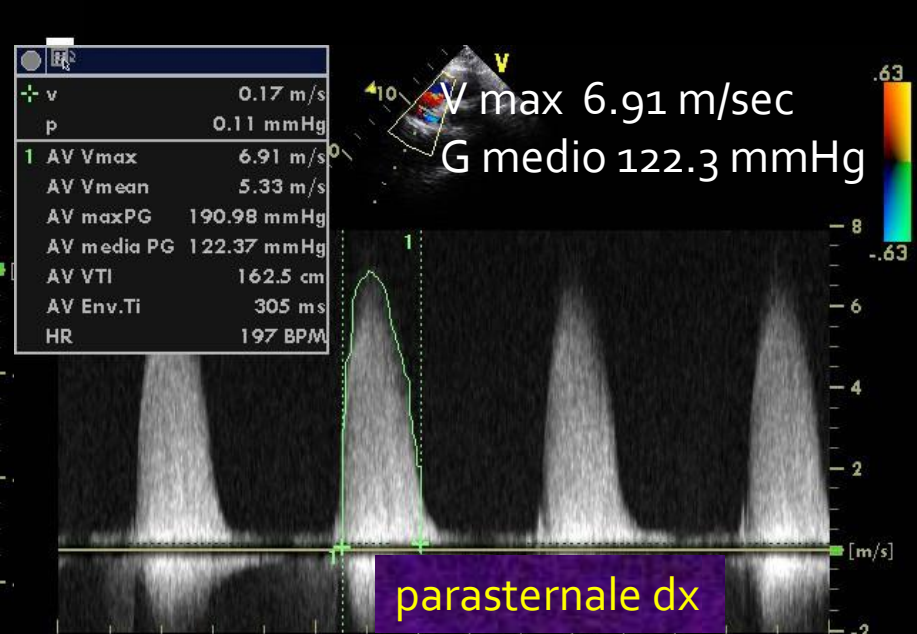
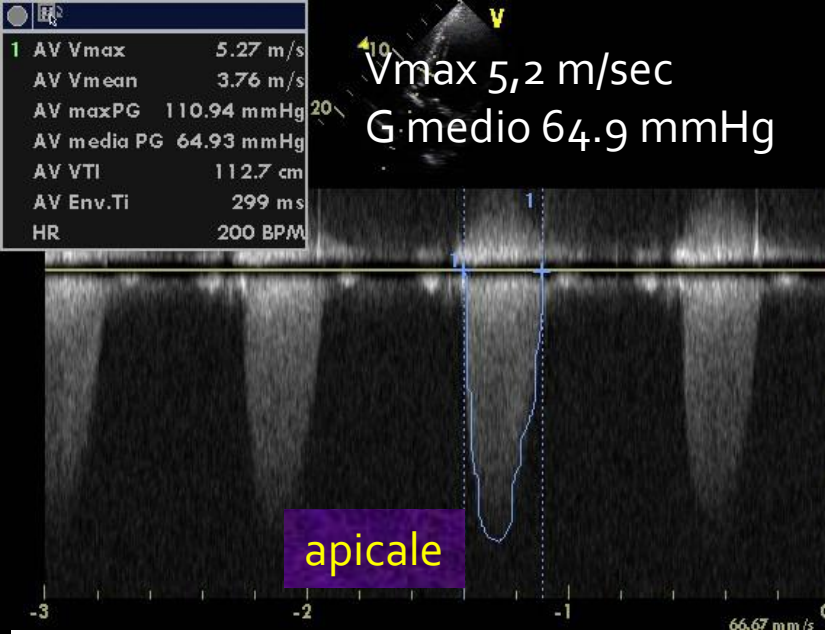
**Table 3. Logistic Regression: Independent Determinants of Exercise Pulmonary Arterial Hypertension**

Variables	Odds Ratio	95% CI	P
Male sex	4.3	1.2–15.1	0.002
Resting SPAP (per mm Hg)	1.16	1.06–1.27	0.002
Exercise indexed LV end-diastolic volume (per mL/m <sup>2</sup> )	1.04	1.00–1.07	0.026
Exercise-induced changes in indexed LA area (per cm <sup>2</sup> /m <sup>2</sup> )	1.36	1.1–1.7	0.006
Exercise e'-wave velocity (per cm/s)	1.35	1.00–1.8	0.047

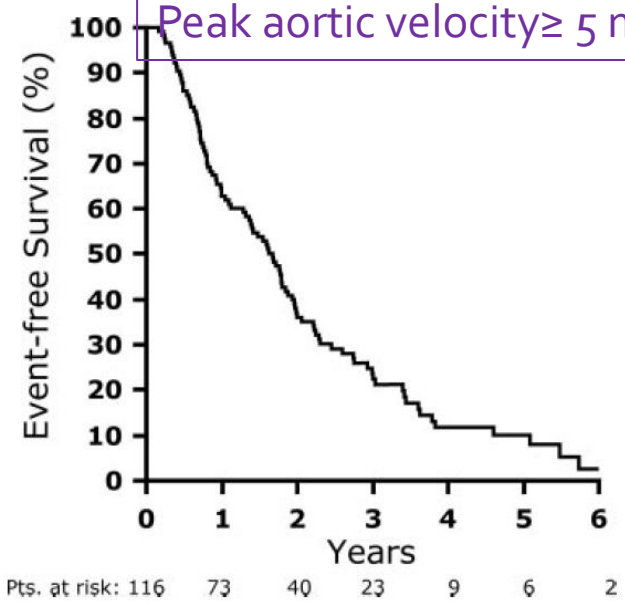
Indici di  
disfunzione  
diastolica







Very severe aortic stenosis:  
Peak aortic velocity  $\geq 5$  m/sec



Rosenhek et al. *Circulation* 2010;121:151-156

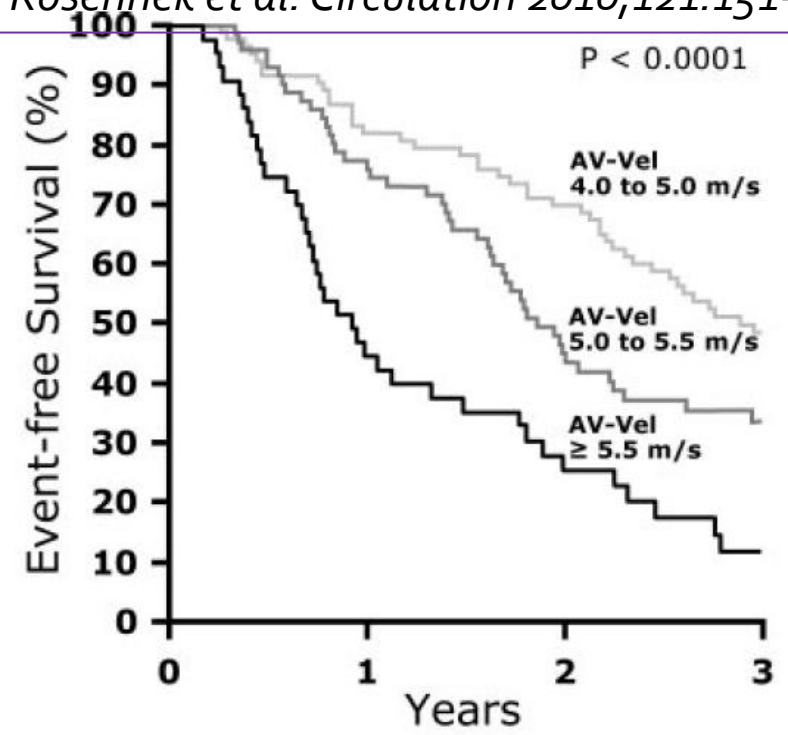
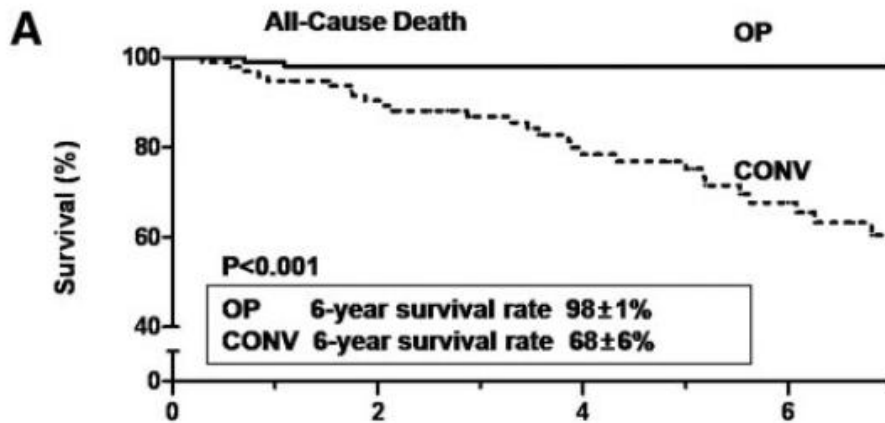
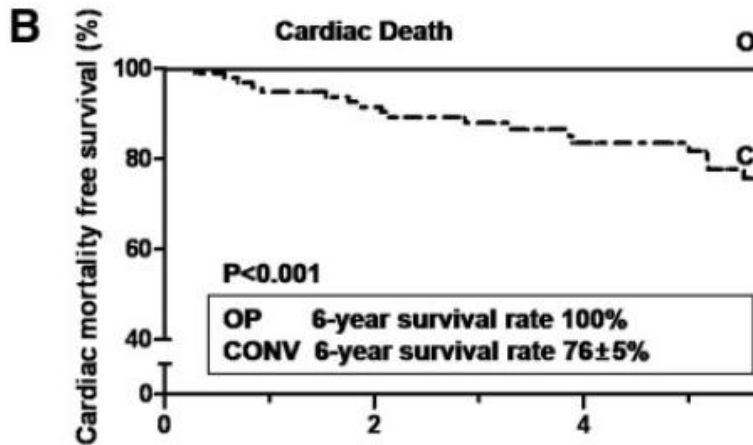


Figure 1. Kaplan-Meier event-free survival rate for the entire patient population with very severe aortic stenosis defined by a peak aortic jet velocity  $\geq 5.0$  m/s.



No at Risk

OP	102	96	48
CONV	95	82	54



No at Risk

OP	102	96	48
CONV	95	82	54

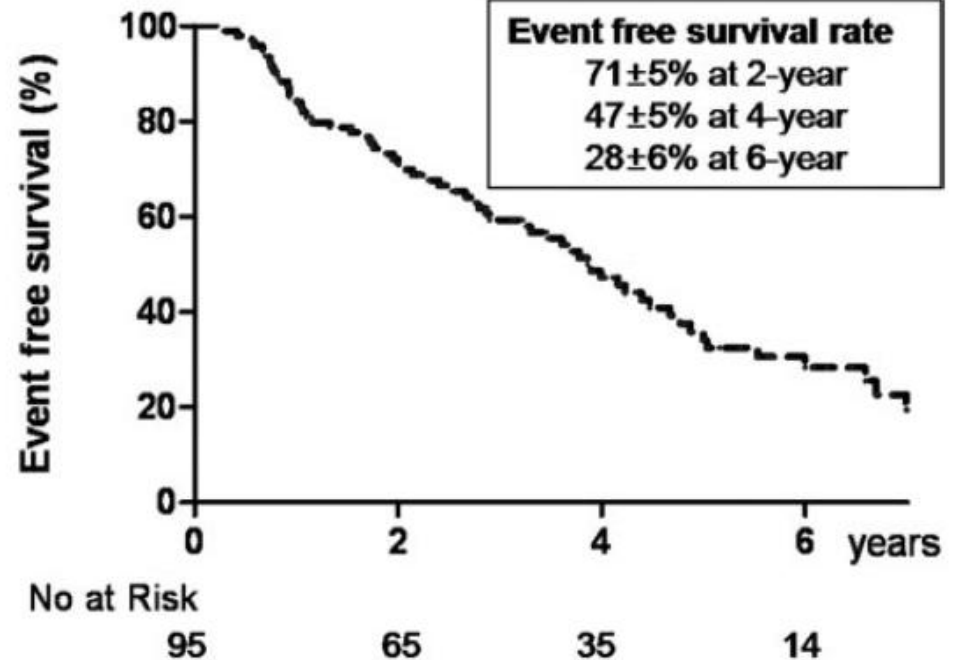


Figure 5. Survival free of cardiac death or surgery in the conventional treatment group.

Very severe aortic stenosis:  
 Valve area  $\leq 0.75$  cm<sup>2</sup> +  
 Peak velocity  $\geq 4.5$  m/sec or  
 Mean gradient  $\geq 50$  mmHg

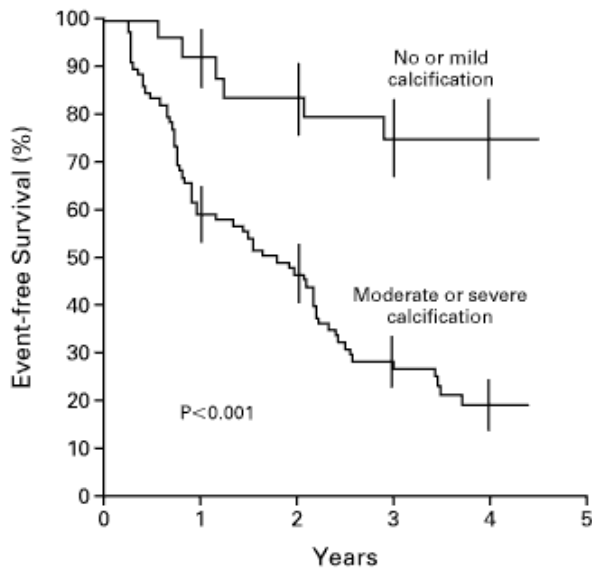
Compressione con perdita - Non consigliata per la diagnosi



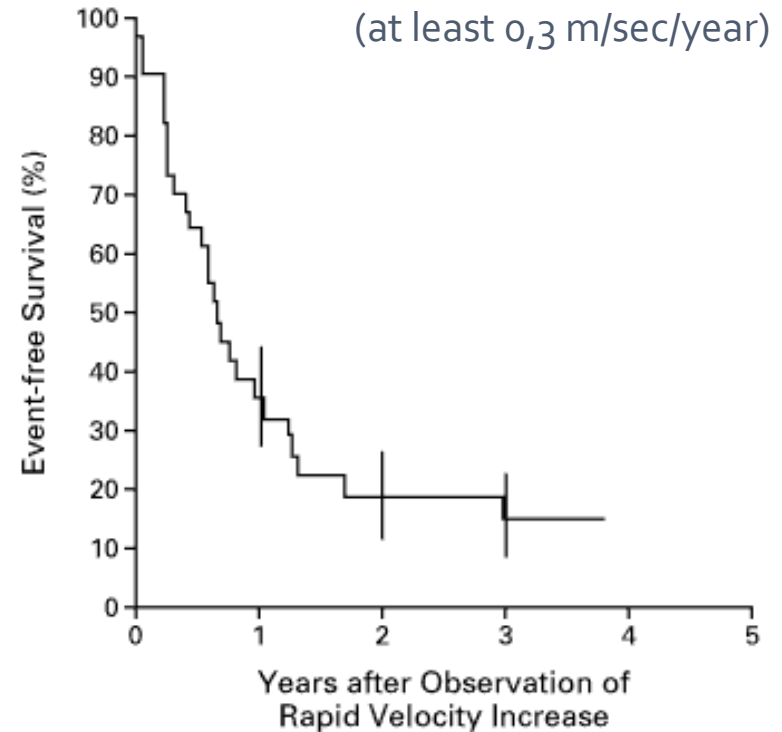
# Predictors of outcome in severe, asymptomatic aortic stenosis

Rosenhek et al. *N Engl J Med* 2000; 343:611-617

113 HR



NO. OF PATIENTS AT RISK					
	0	1	2	3	4
No or mild calcification	25	23	20	17	9
Moderate or severe calcification	101	48	38	21	7

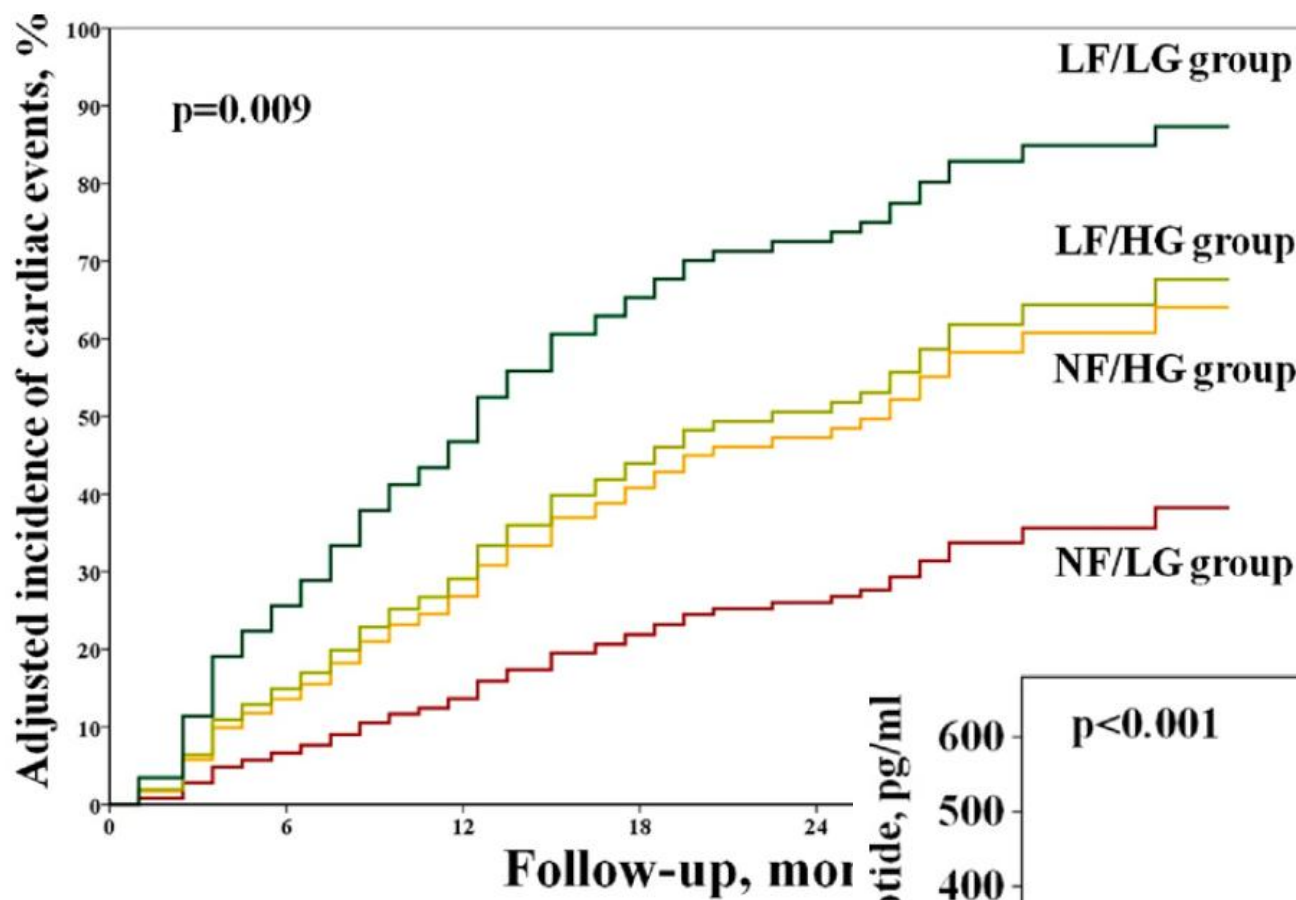


NO. OF PATIENTS AT RISK				
0	1	2	3	4
34	12	7	5	

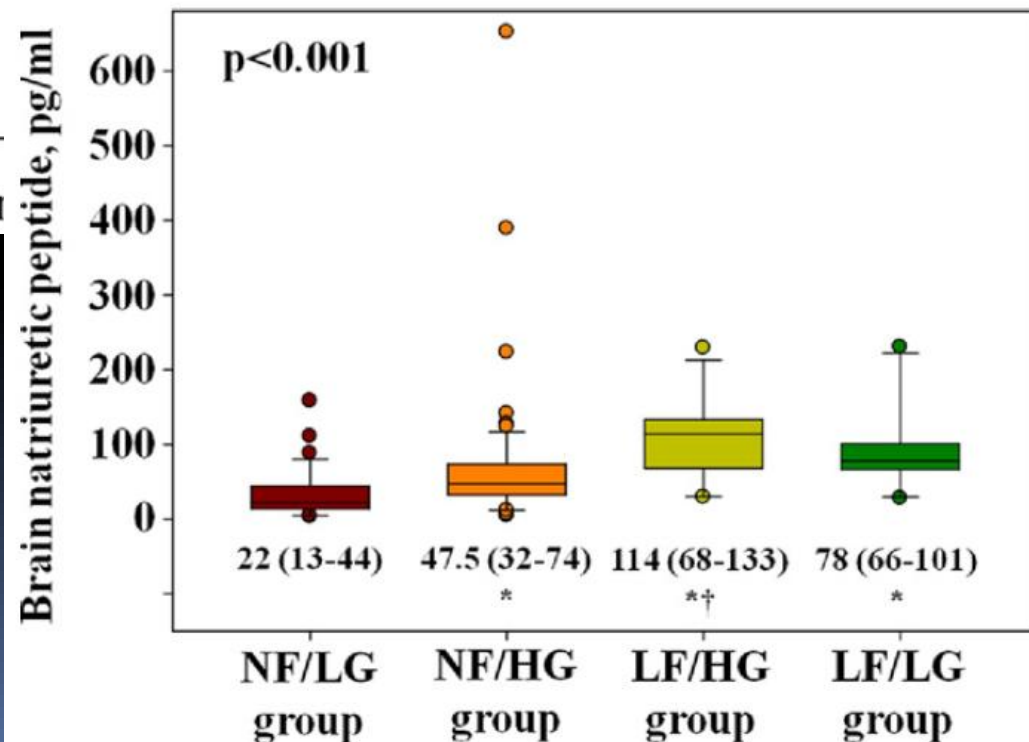
# BNP

Lancellotti et al.  
JACC 2012;59:235-53

LF = low flow  
NF = normal flow  
LG = low gradient  
NG = normal gradient



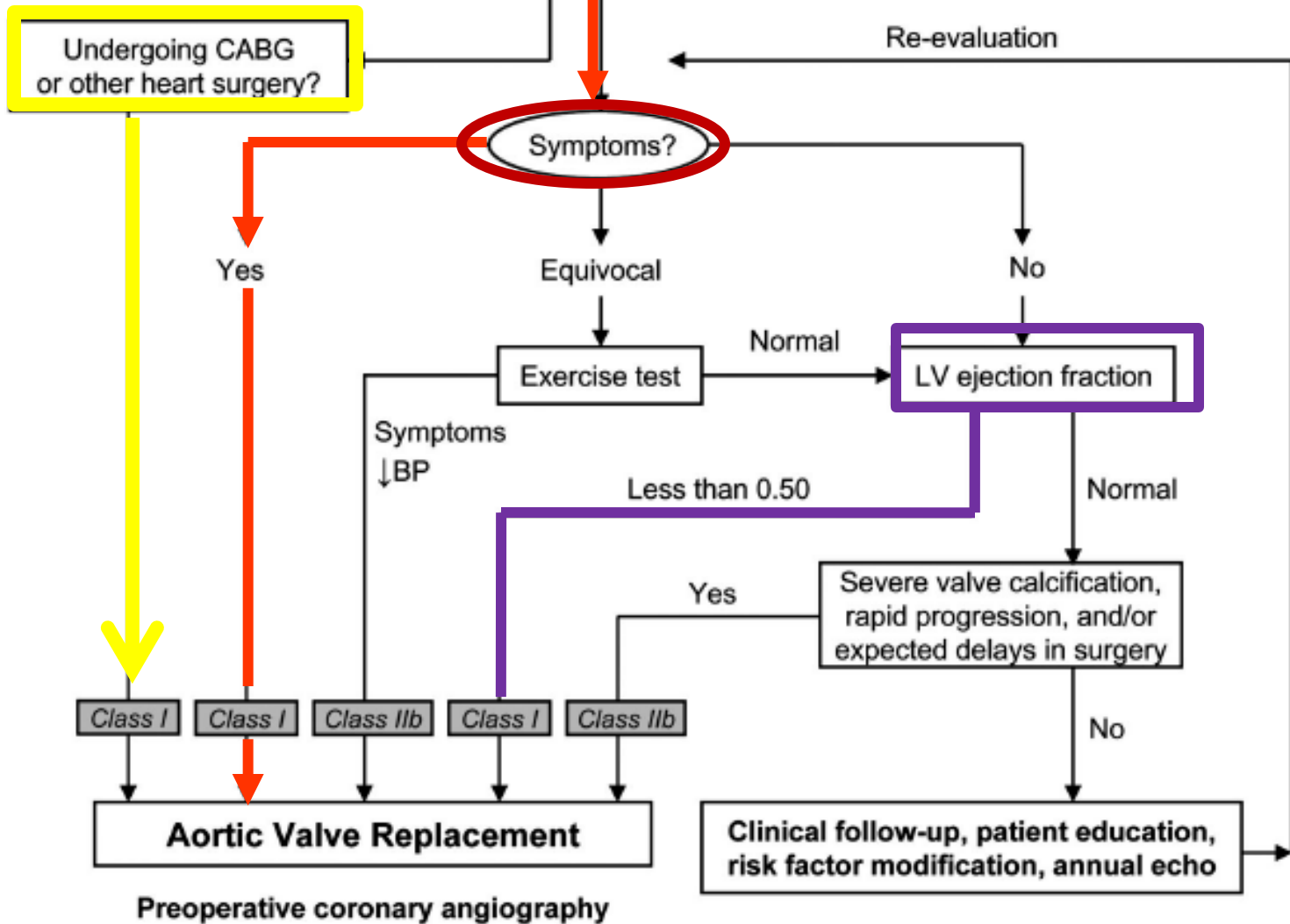
- AVA < 1cm<sup>2</sup>
- Test ergometrico negativo (veri asintomatici)



AHA-ACC  
guidelines 2008

**Severe Aortic Stenosis**

Vmax greater than 4 m/s  
AVA less than 1.0 cm<sup>2</sup>  
Mean gradient > 40 mm Hg



# ESC/EACTS GUIDELINES

2012



## Indications for aortic valve replacement in aortic stenosis

	Class <sup>a</sup>	Level <sup>b</sup>
AVR is indicated in patients with severe AS and any symptoms related to AS.	I	B
AVR is indicated in patients with severe AS undergoing CABG, surgery of the ascending aorta or another valve.	I	C
AVR is indicated in asymptomatic patients with severe AS and systolic LV dysfunction (LVEF <50%) not due to another cause.	I	C
AVR is indicated in asymptomatic patients with severe AS and <u>abnormal exercise test</u> showing symptoms on exercise clearly related to AS.	I	C



- La valvulopatia è severa?
- Il paziente è sintomatico?
- I sintomi sono correlati alla valvulopatia?
- Quali sono le aspettative di vita e di qualità di vita?
- I benefici attesi dall'intervento superano i rischi?
- Cosa desidera il paziente?
- Sono disponibili le risorse ottimali per l'intervento?

**Grazie**