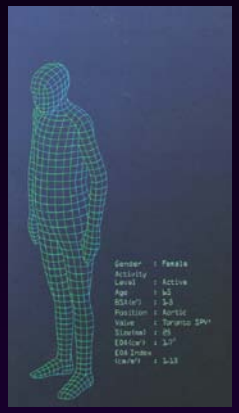

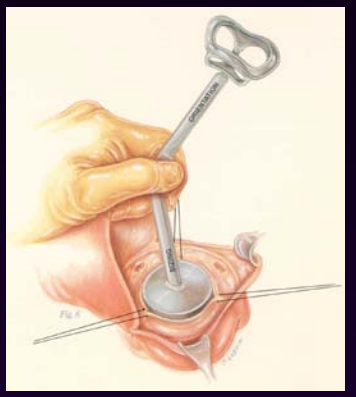

Prosthesis-Patient Mismatch

Implications for Outcome in Aortic Valve Disease

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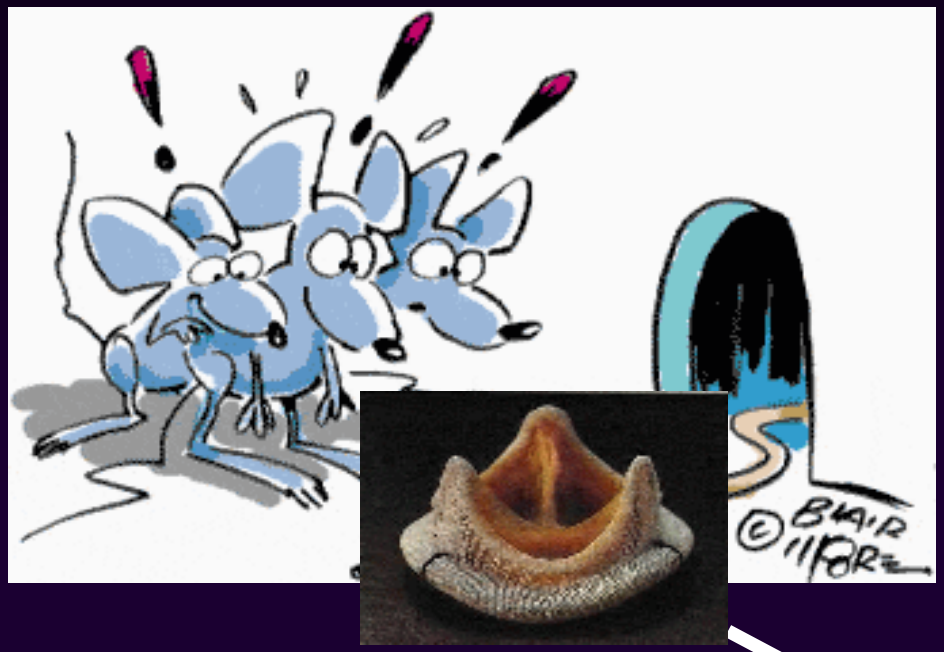
Disclosure

- **Honoraria:** Edwards Life Sc., Medtronic, St. Jude Medical
- **Consultant:** St. Jude Medical, Sorin
- **Research support:** Medtronic, Edwards Life Sc., St. Jude Medical, MCRI

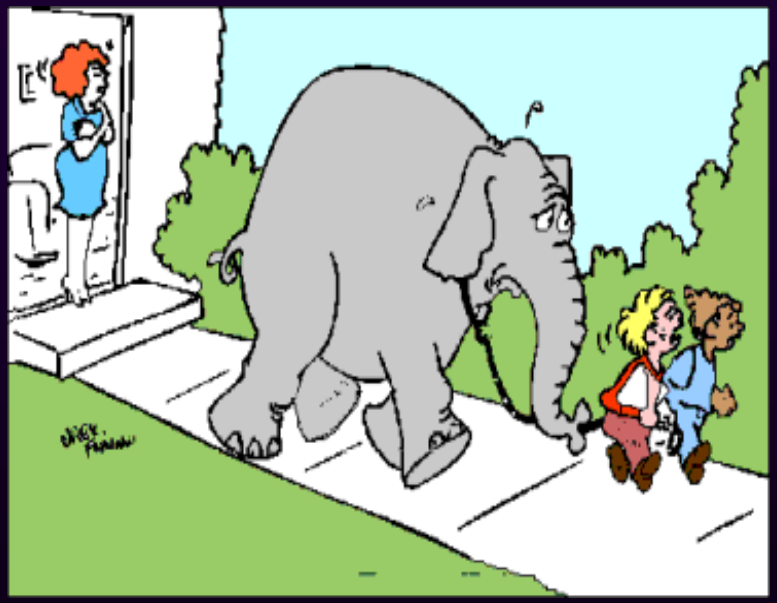
Valve Prosthesis-Patient Mismatch (PPM)

- ***Definition***: **‘‘Mismatch can be considered to be present when the effective prosthetic valve area, after insertion into the patient, is less than that of a normal human valve’’**
- ***Consequence***: **Persistence of abnormally high postoperative gradients, which is often the reason why we operate patients in the first place.**

Rahimtoola 1978



Mismatch !!!



$$\text{Gradient} = \frac{Q^2}{K \times EOA^2}$$

	Mouse	Elephant	Elephant Mismatch
Cardiac Output (mL/min)	50	50 000	50 000
EOA (cm^2)	0.1	50	0.1
Gradient (mmHg)	1	1	11 000 000 !

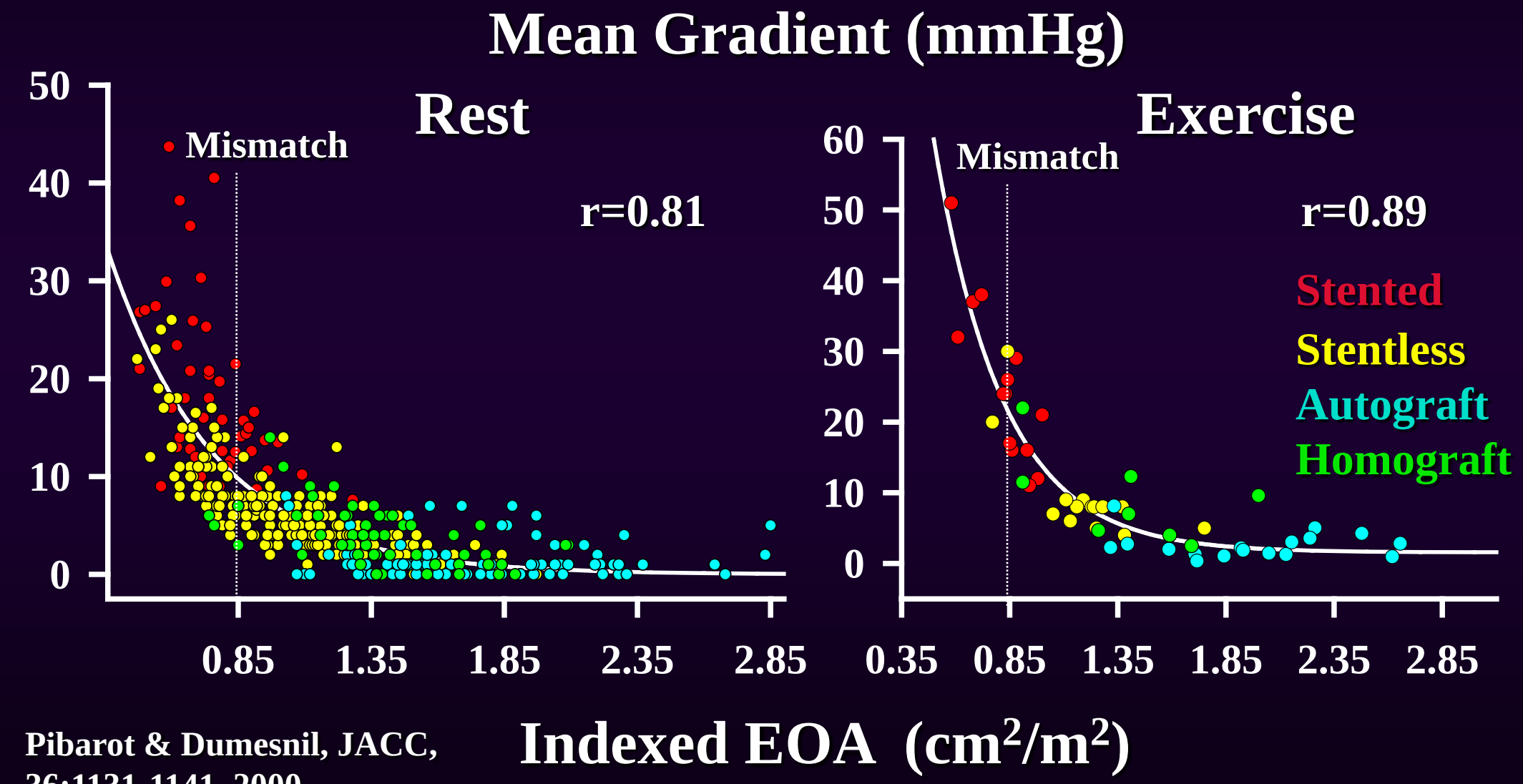
We are not created equal in terms of body size !

Comparions of transvalvular gradient in patients receiving the same prosthesis but having different BSAs

	Patient number				
	1	2	3	4	5
Body surface area (m^2)	1.5	1.75	2.0	2.25	2.5
Cardiac output (l/min)	4.5	5.25	6.0	6.75	7.5
Valve EOA (cm^2)	1.3	1.3	1.3	1.3	1.3
Mean pressure gradient (mm Hg)	13	17	22	28	35

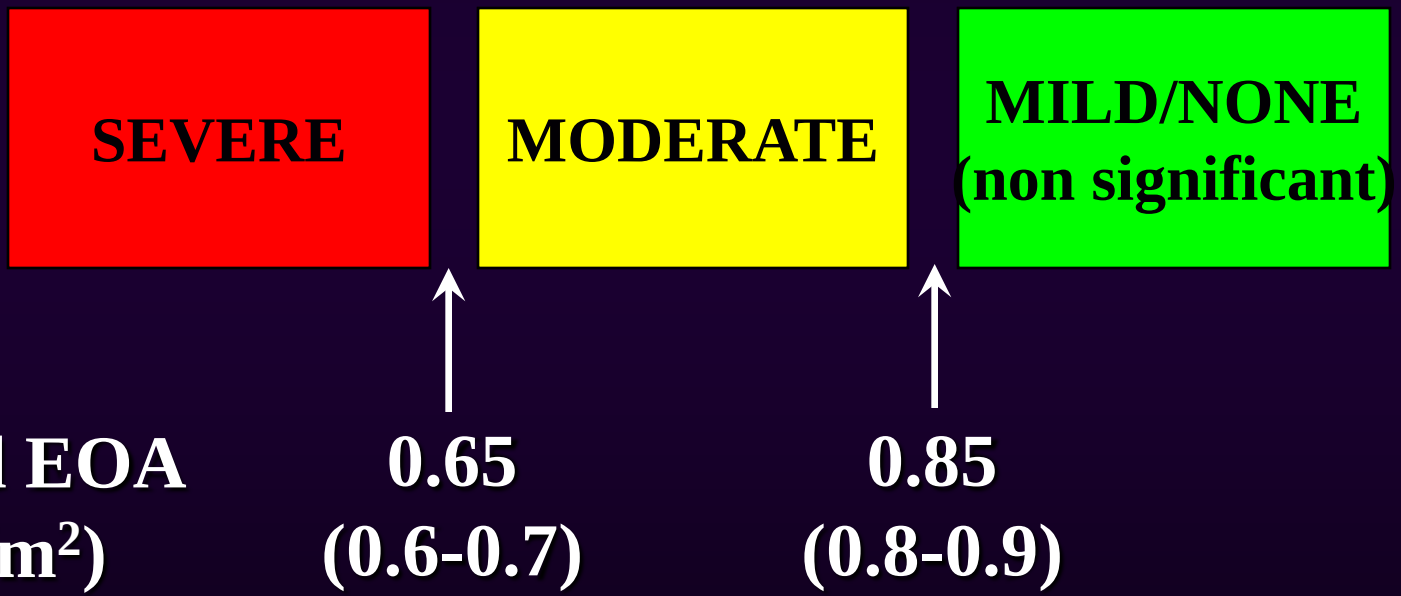
Pibarot & Dumesnil, 92:1022-9, 2006

Definition of PPM Based on Indexed EOA of Prosthesis



Pibarot & Dumesnil, JACC, 36:1131-1141, 2000.

Severity of PPM



Prevalence of PPM

- **PPM (EOAI ≤ 0.85): 20-70%**
- **Severe PPM (EOAI ≤ 0.65): 2-10%**

Pibarot & Dumesnil, 92:1022-9, 2006

Impact of PPM on Clinical Outcomes

- Less regression of LVH
- Less recovery of coronary flow reserve
- Less improvement in functional class
- Worse exercise capacity
- Increased incidence of late cardiac events
- (Increased bleeding complications ?)
- Negative impact on short- and long-term survival particularly if LV dysfunction

Pibarot & Dumesnil, JACC 2000; 36: 1131-1141
Pibarot & Dumesnil, 92:1022-9, 2006

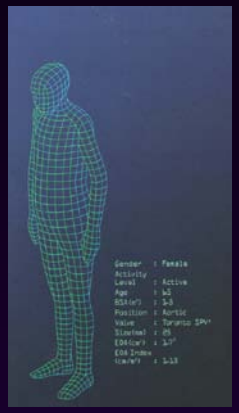
PPM is Predictive of Congestive Heart Failure after AVR

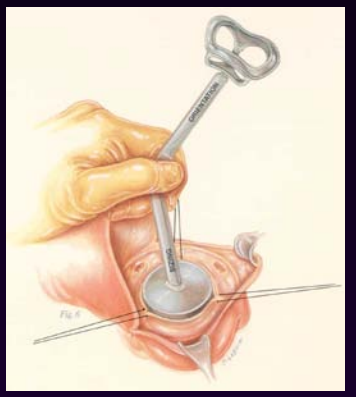
1681 patients, mean follow-up 4.4 years

Independent predictors of CHF (NYHA 3-4 or CHF death):

- **Age**
- **Preop. NYHA class**
- **Elevated diastolic pulmonary arterial pressures**
- **Atrial fibrillation**
- **Coronary artery disease**
- **Smoking**
- **Redo status**
- **PPM (EOAI $\leq$ 0.80 cm^2/m^2): 60% increase in the risk of CHF**

Ruel et al, JTCVS; 127:149-159, 2003





Impact of Valve Prosthesis-Patient Mismatch on Short-Term Mortality After Aortic Valve Replacement with Stentless Bioprostheses

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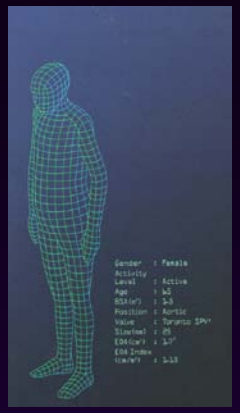
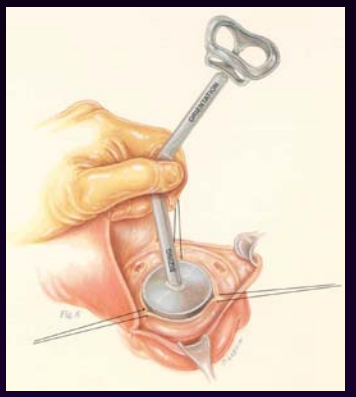




Now the Good News :
PPM can be Prevented !

Hypothetical Prosthesis Model XXX

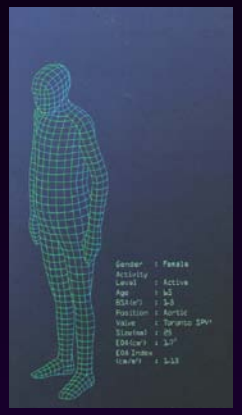
	EOAi by Prosthesis size (mm)					
Prosthesis size (mm)	**19**	**21**	**23**	**25**	**27**	**29**
Average EOA (cm^2)	1.1	1.3	1.5	1.8	2.3	2.7
BSA (m^2)						
0.6	1.83	2.17	2.50	3.00	3.83	4.50
0.7	1.57	1.86	2.14	2.57	3.29	3.86
0.8	1.38	1.63	1.88	2.25	2.88	3.38
0.9	1.22	1.44	1.67	2.00	2.56	3.00
1	1.10	1.30	1.50	1.80	2.30	2.70
1.1	1.00	1.18	1.36	1.64	2.09	2.45
1.2	0.92	1.08	1.25	1.50	1.92	2.25
1.3	0.85	1.00	1.15	1.38	1.77	2.08
1.4	0.79	0.93	1.07	1.29	1.64	1.93
1.5	0.73	0.87	1.00	1.20	1.53	1.80
1.6	0.49	0.88	0.88	0.88	0.88	1.69
1.7	0.65	0.76	0.88	1.06	1.35	1.59
1.8	0.61	0.72	0.83	1.00	1.28	1.50
1.9	0.58	0.68	0.79	0.95	1.21	1.42
2	0.55	0.65	0.75	0.90	1.15	1.35
2.1	0.52	0.62	0.71	0.86	1.10	1.29
2.2	0.50	0.59	0.68	0.82	1.05	1.23
2.3	0.48	0.57	0.65	0.78	1.00	1.17
2.4	0.46	0.54	0.63	0.75	0.96	1.13
2.5	0.44	0.52	0.60	0.72	0.92	1.08

Pibarot & Dumesnil, 92:1022-9, 2006

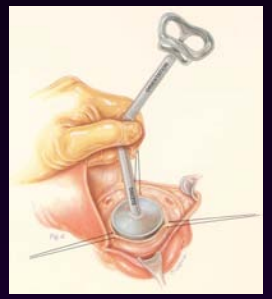
Surgical Options if Anticipating PPM

- **Use of better performing prosthesis**
  - **Newer generation supra-annular bioprosthesis**
  - **Stentless bioprosthesis**
  - **Newer generation mechanical prosthesis**
  - **Homografts**
  - **Ross operation**
- **Aortic root enlargement**
- **Acceptance of PPM in light of other clinical factors**

mortderire.com



Avoiding Aortic PPM Why and How ?



Why

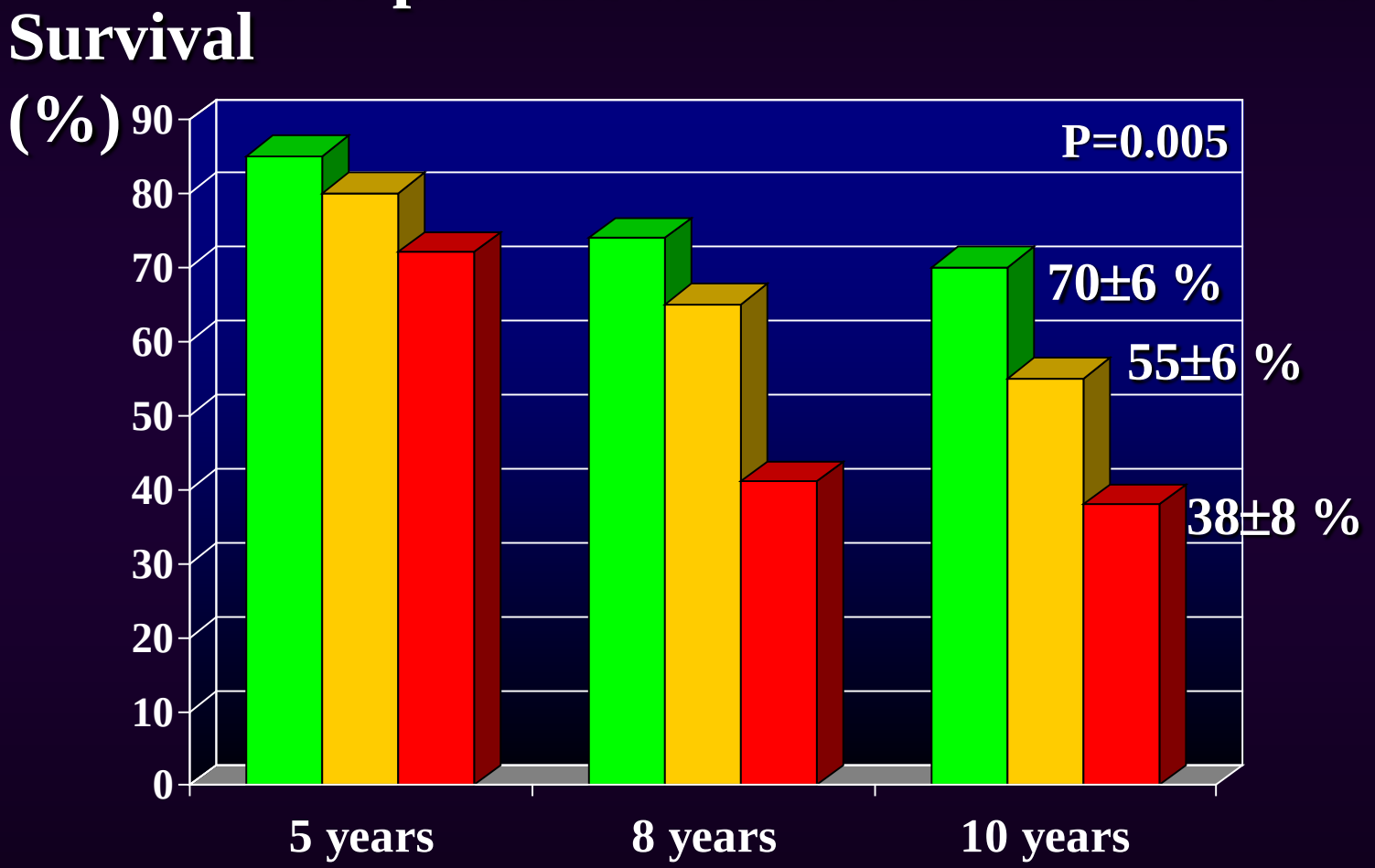
- **PPM is a frequent and modifiable risk factor leading to worse hemodynamics and coronary flow reserve, more cardiac events, and lesser survival.**

How

- **Use charts to project postoperative indexed EOA.**
- **If anticipating PPM, consider alternative options in light of patient's clinical condition and risk-benefit ratio.**

Impact of severe PPM on Long-term Survival

388 patients with 19 or 21 mm St-Jude Standard



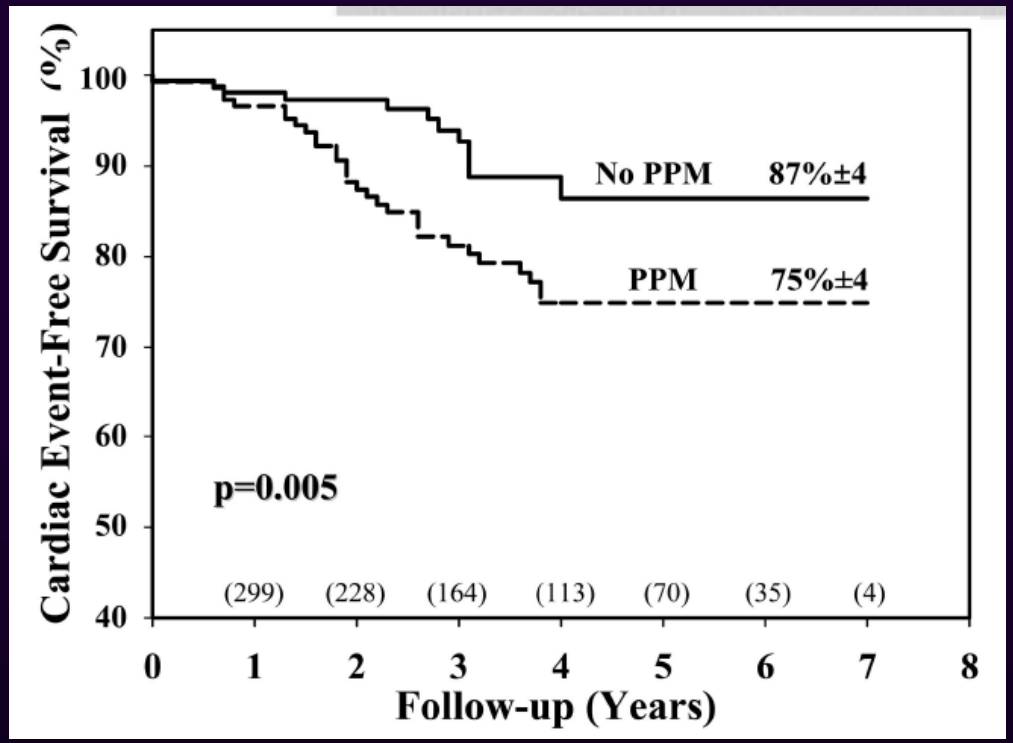
- Severe PPM IEOA ≤ 0.6 cm^2/m^2 (n=66;17%)
- Moderate PPM IEOA ≤ 0.9 cm^2/m^2 (n=168;43%)
- No PPM IEOA > 0.9 cm^2/m^2 (n=154;40%)

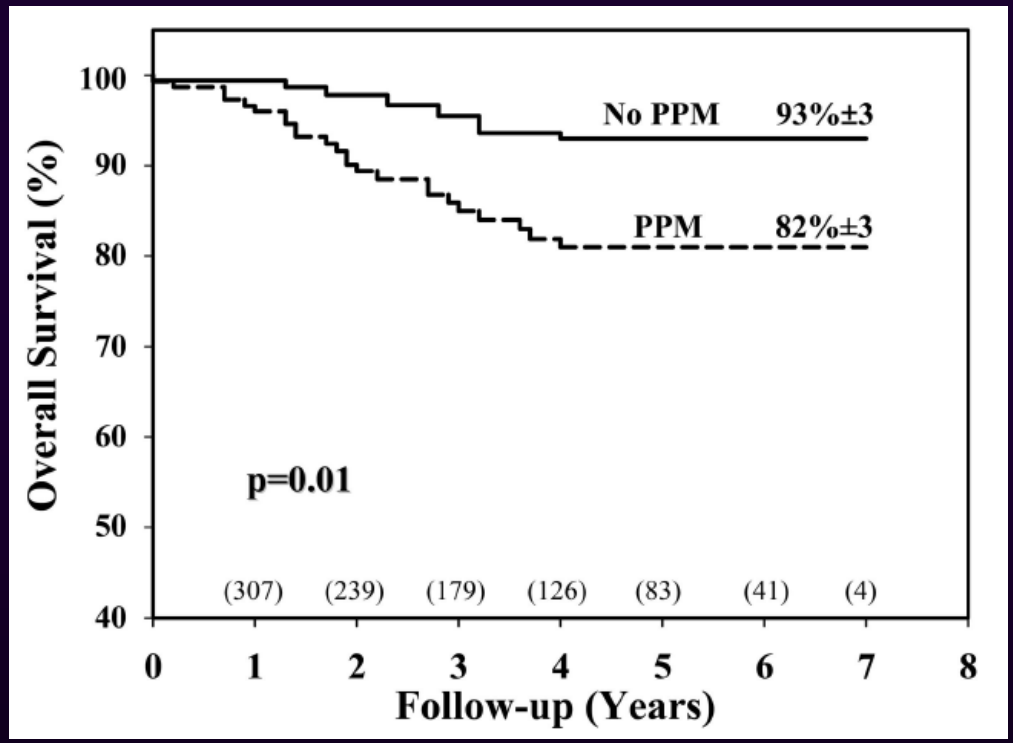
Mohty D et al., Circulation, 113:420-426,2006

After adjusting for other risk factors, severe PPM was associated with higher mortality: HR: 2.2 [1.24-2.7] (p=0.007)

Impact of PPM on Cardiac Events and Survival

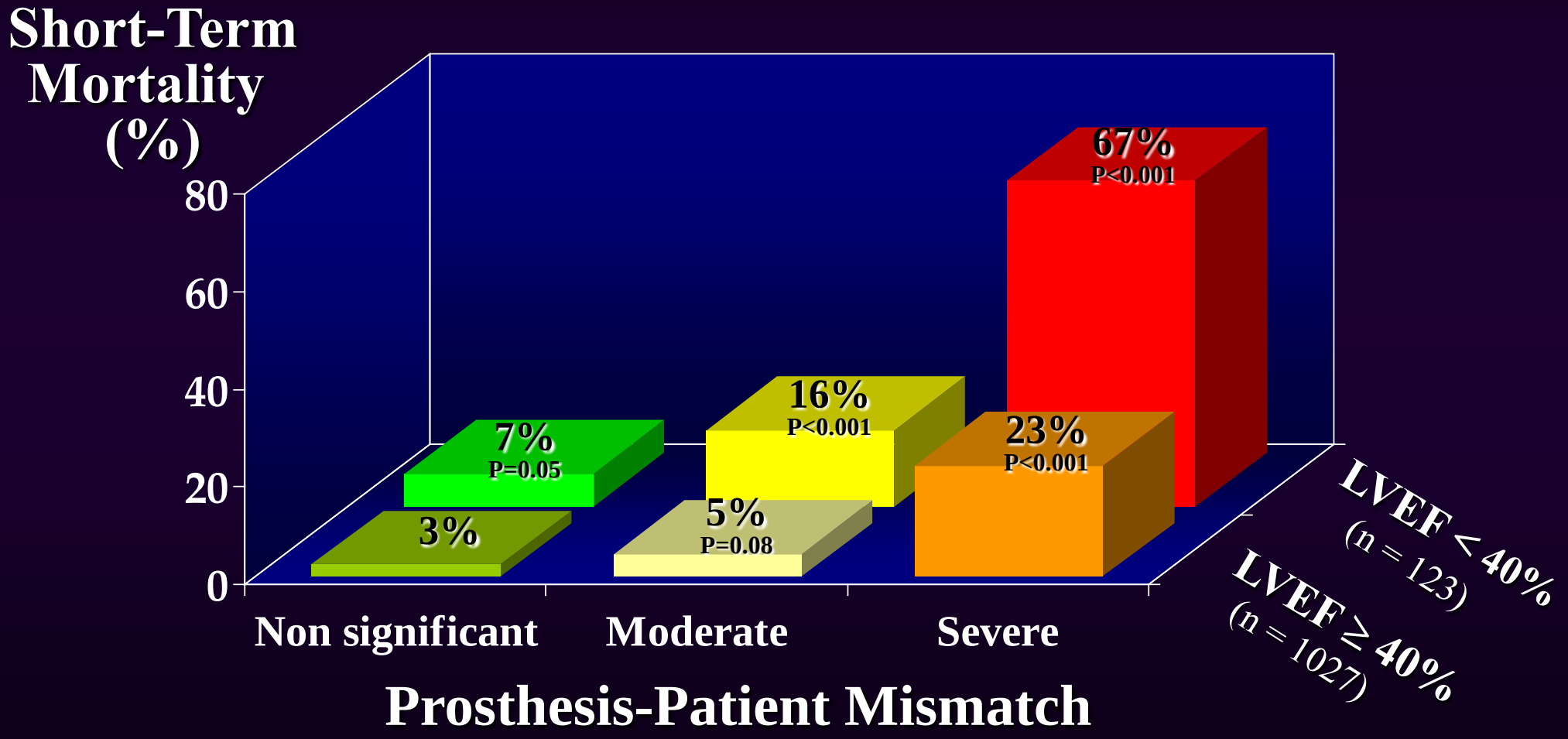
315 consecutive patients with pure AS; PPM: EOAI ≤ 0.8 cm^2/m^2





Tasca et al. Circulation, 113:570-6, 2006

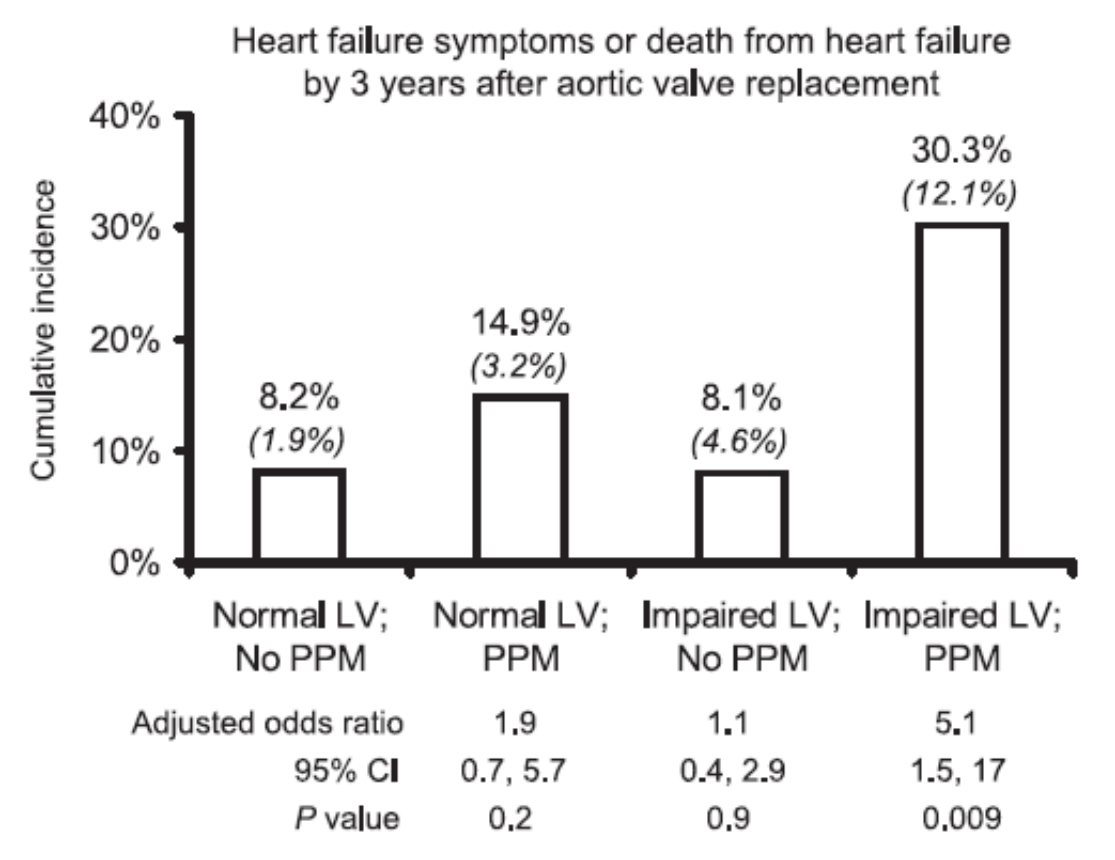
Combined Impact of PPM and LV Dysfunction on Short-term Mortality



Blais et al, Circulation,108:983-988, 2003

Prosthesis–patient mismatch after aortic valve replacement predominantly affects patients with preexisting left ventricular dysfunction: Effect on survival, freedom from heart failure, and left ventricular mass regression

Marc Ruel, MD, MPH,[a,b] Hussam Al-Faleh, MD,[c] Alexander Kulik, MD,[a] Kwan L. Chan, MD,[c] Thierry G. Mesana, MD, PhD,[a] and Ian G. Burwash, MD[c]



Ruel et al, JTCVS; 131:1036-44, 2006