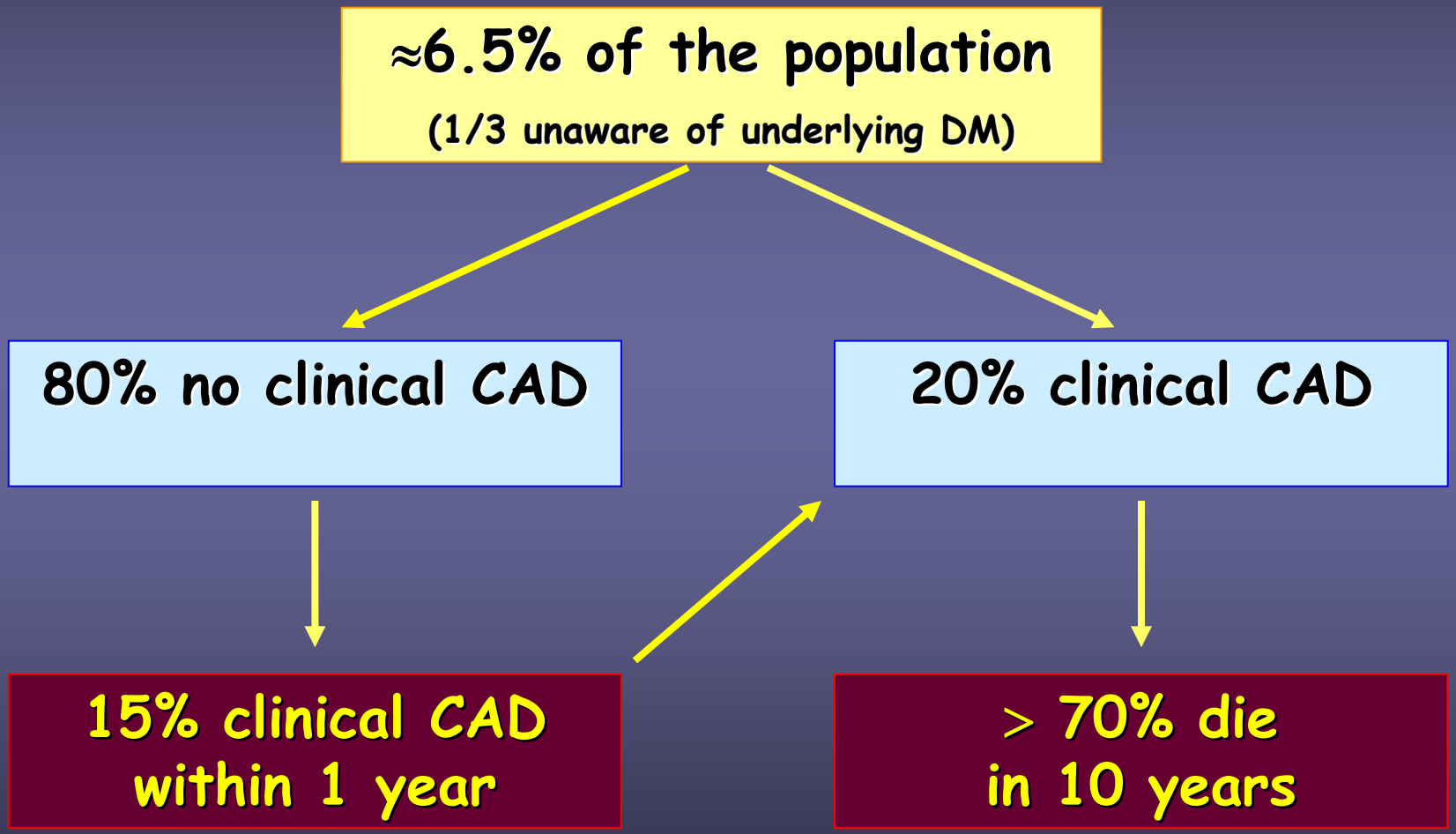
Myocardial Perfusion Imaging in Diabetic Patients

E. Moralidis

Aristotle University
AHEPA Hospital
Thessaloniki, Greece

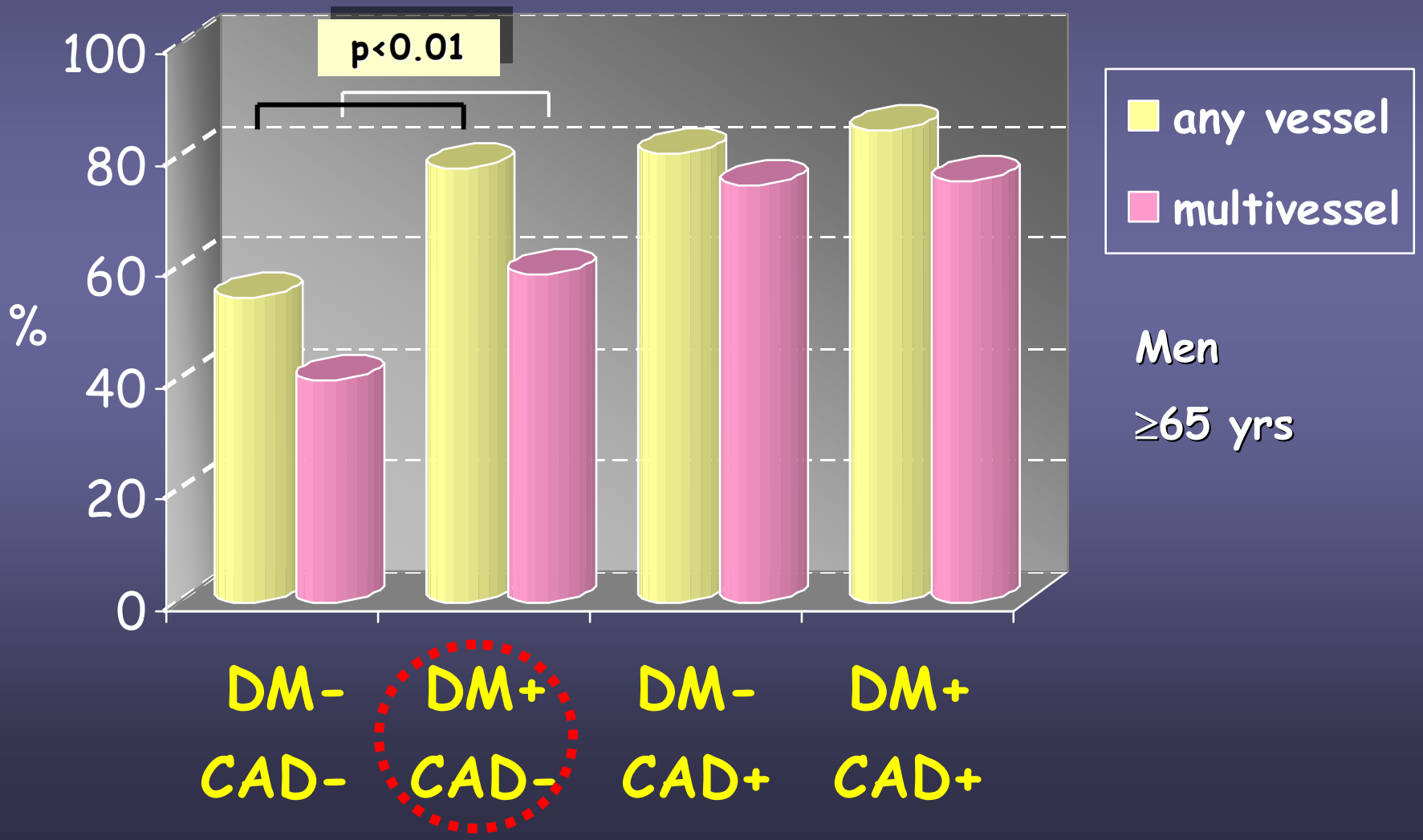
The diabetic patient



de Sutter ESC 2007

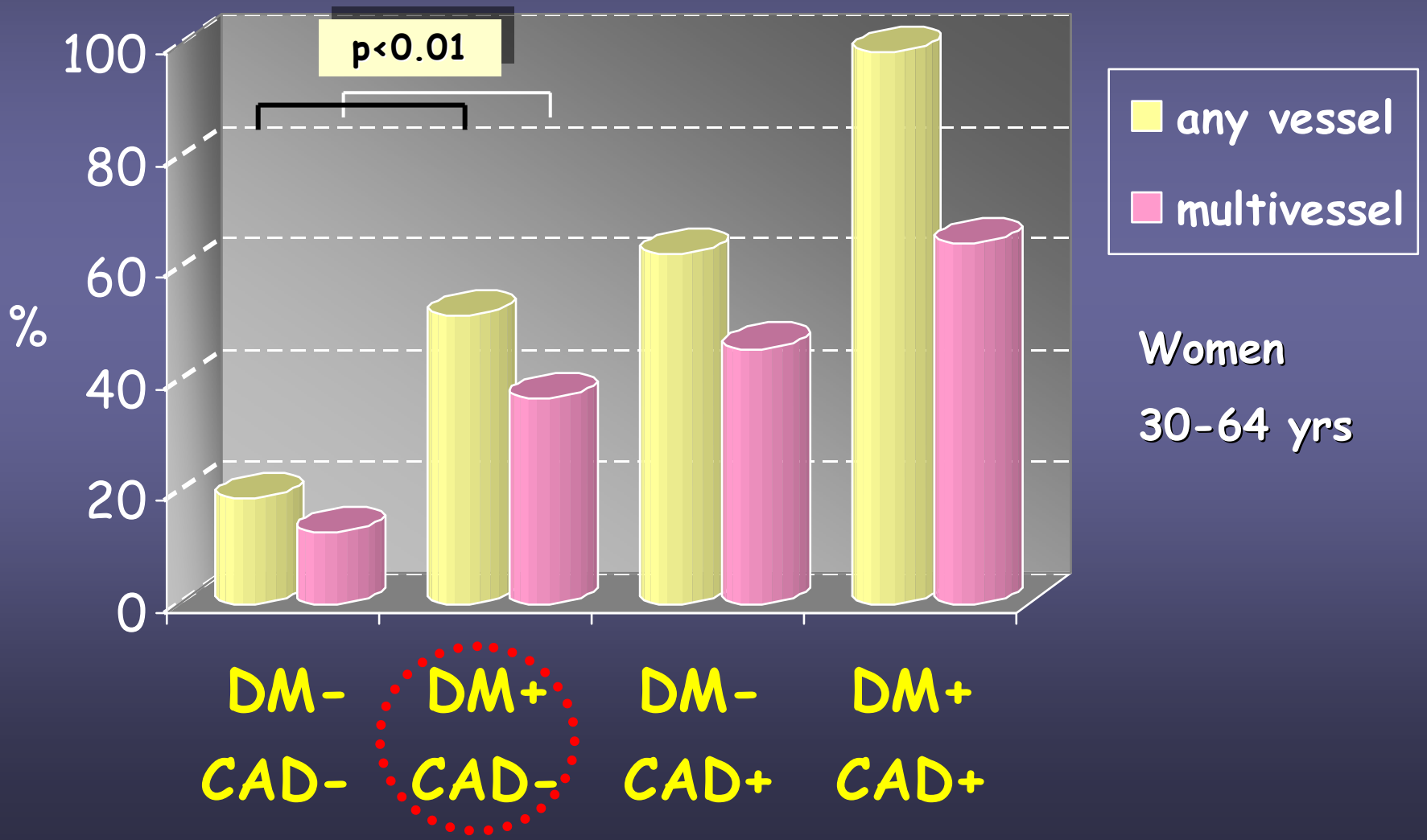
High-grade coronary atherosclerosis in autopsy

Goraya TY, et al. J Am Coll Cardiol 2002;40:946-953

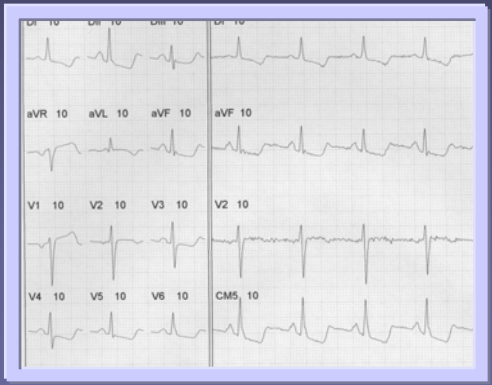


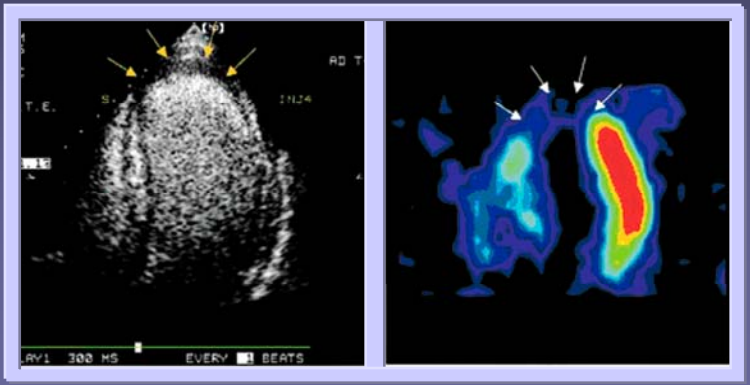
High-grade coronary atherosclerosis in autopsy

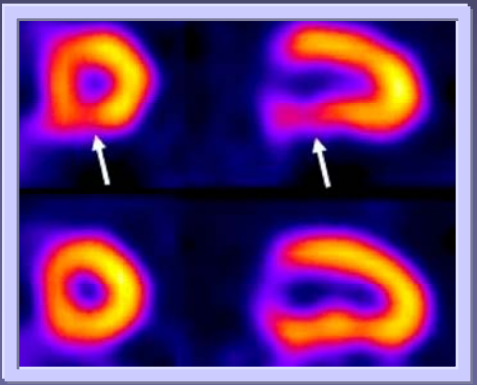
Goraya TY, et al. J Am Coll Cardiol 2002;40:946-953



Diagnostic stress testing in symptomatic DM



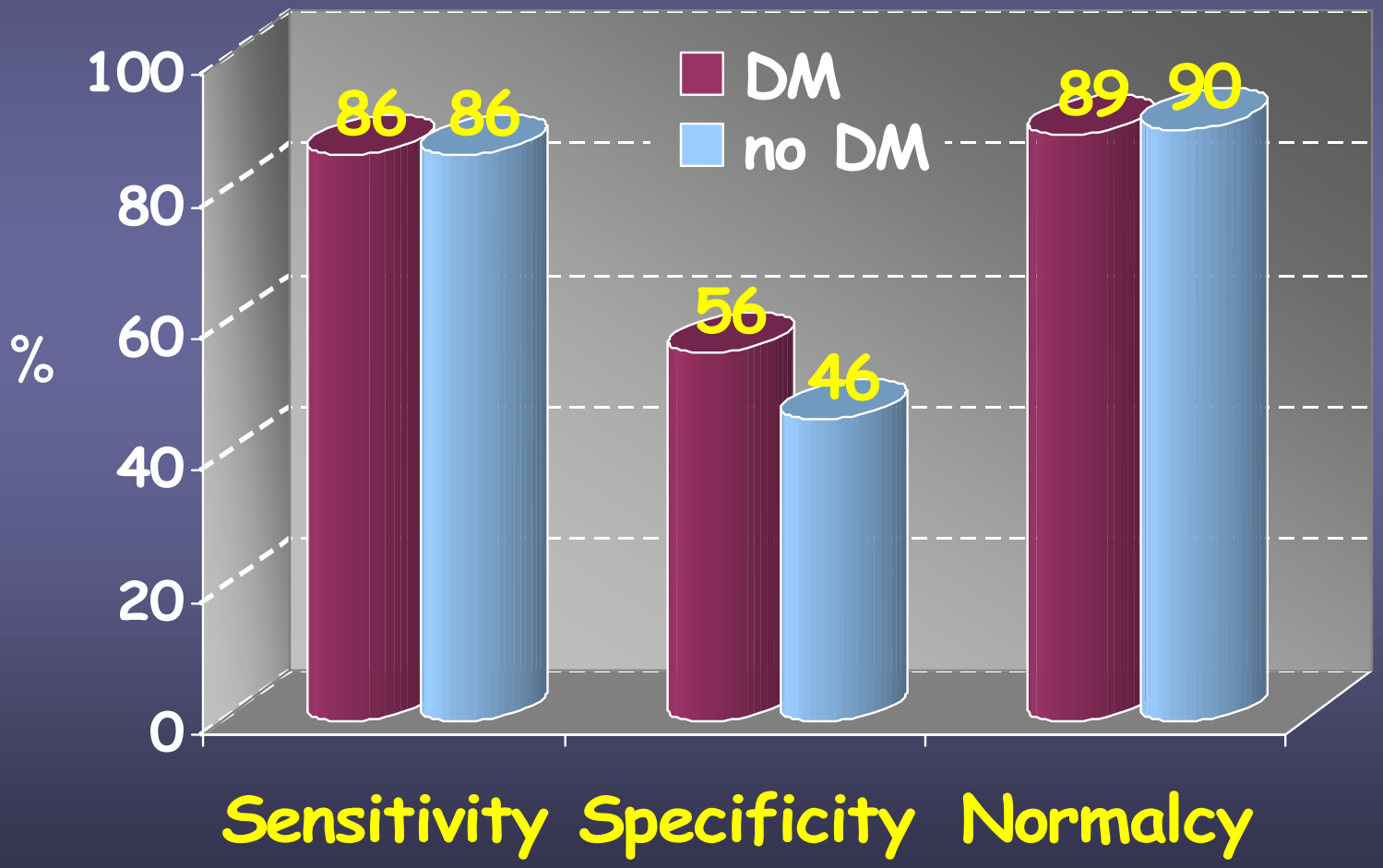




Type	Study		n	Stress	Sens	Spec
ECG	Lee	2001	190	Exercise	47%	81%
Echo	Hennessy	1997	52	Dobutamine	82%	54%
Nuclear	Kang	1999	138	Ex/Aden dual SPECT	86%	56%

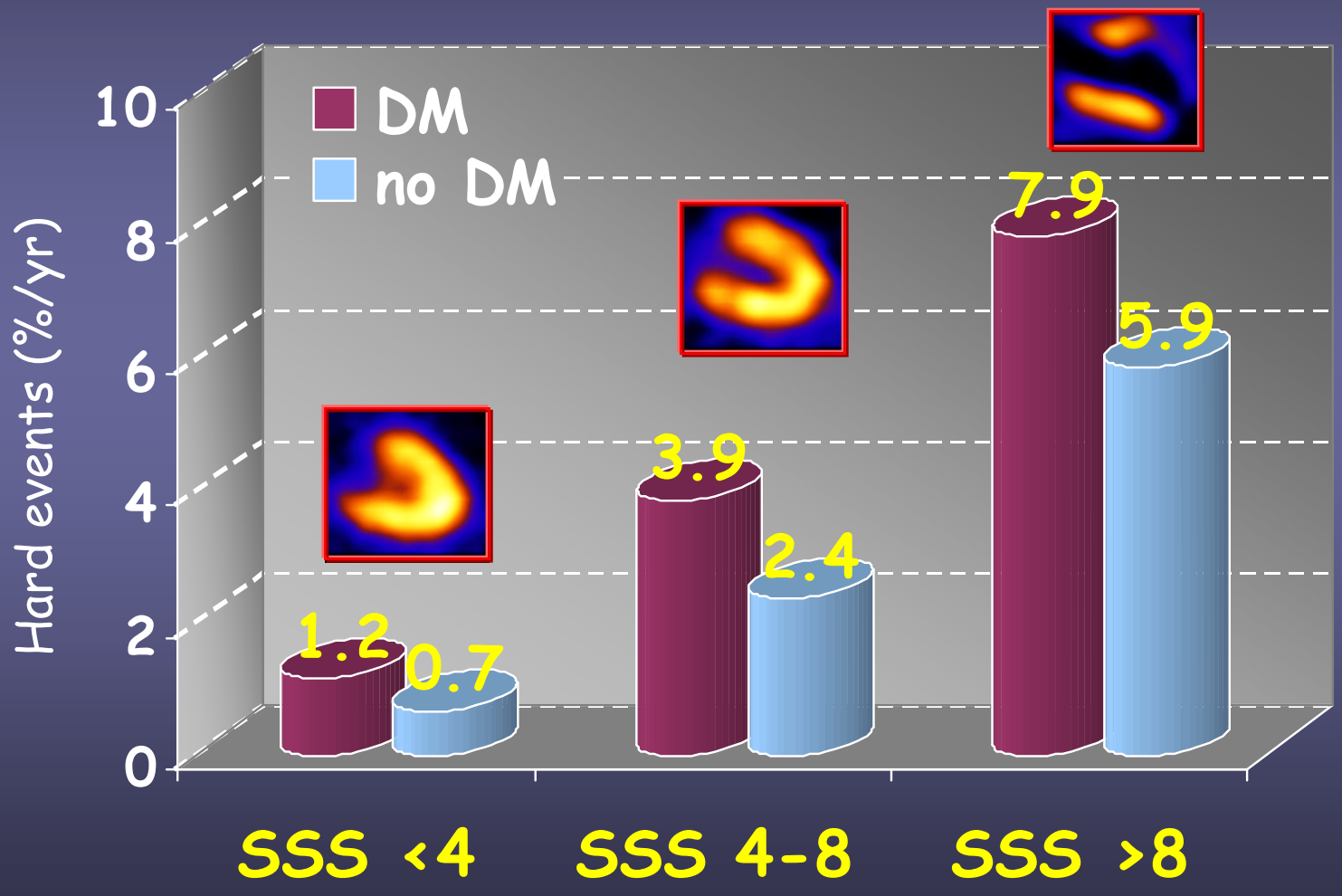
SPECT in diagnosis: diabetics vs non-diabetics

Kang X, et al. Am Heart J 1999;137:949-957



SPECT in prognosis: diabetics vs non-diabetics

Kang X, et al. Am Heart J 1999;138:1025-1032

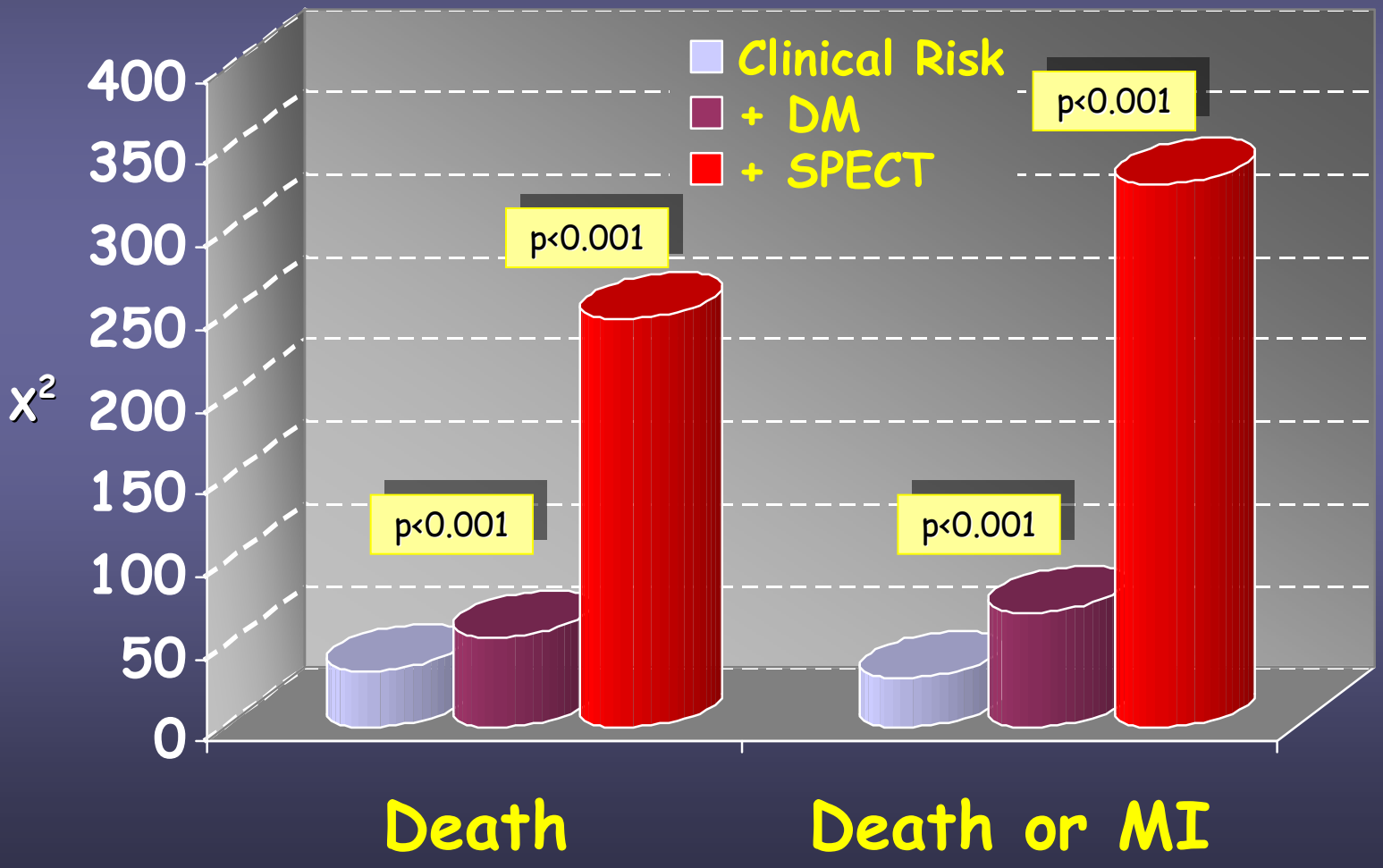


Prognostic performance of Myocadial Perfusion Imaging in diabetic patients with suspected or known CAD

Study		n	Method	Features	F-u (mo)	Annual events (%)	
						abnormal	normal
Felsher	1987	123	Ex ^{201}Tl scan	Suspected CAD	36	4.8	1.3
Vanzetto	1999	158	Ex/Dip SPECT ^{201}T	Risk factors	23	10.2	2.9
Kang	1999	1271	Ex/Aden dual SPECT	Known-susp CAD	24	3.9-7.9	1.2
Schinkel	2002	207	Dob SPECT ^{99m}Tc-MIBI	Known-susp CAD	48	6.6*	0.7
Giri	2002	929	Ex/Aden dual SPECT	Known-susp CAD	30	4.6	3.0
De Lorenzo	2002	180	Ex/Dip SPECT ^{99m}Tc-MIBI	Risk factors	36	9.0	2.0
Berman	2003	1222	Aden dual SPECT	Known-susp CAD	27	4.7-9.0*	1.8-2.5
Cosson	2004	362	Ex/Dip SPECT ^{201}Tl	Risk factors	41	9.2	1.2
Zellweger	2004	1737	Ex/Aden dual SPECT	Suspected CAD	24	3.2-13.2	2.2-7.7
Miller	2004	4736	Ex/Pharm SPECT	Suspected CAD	70	3.6-5.9	-
Pedone	2005	124	Dob SPECT ^{99m}Tc-Tetrof	Known-susp CAD	41	7.0	0.6

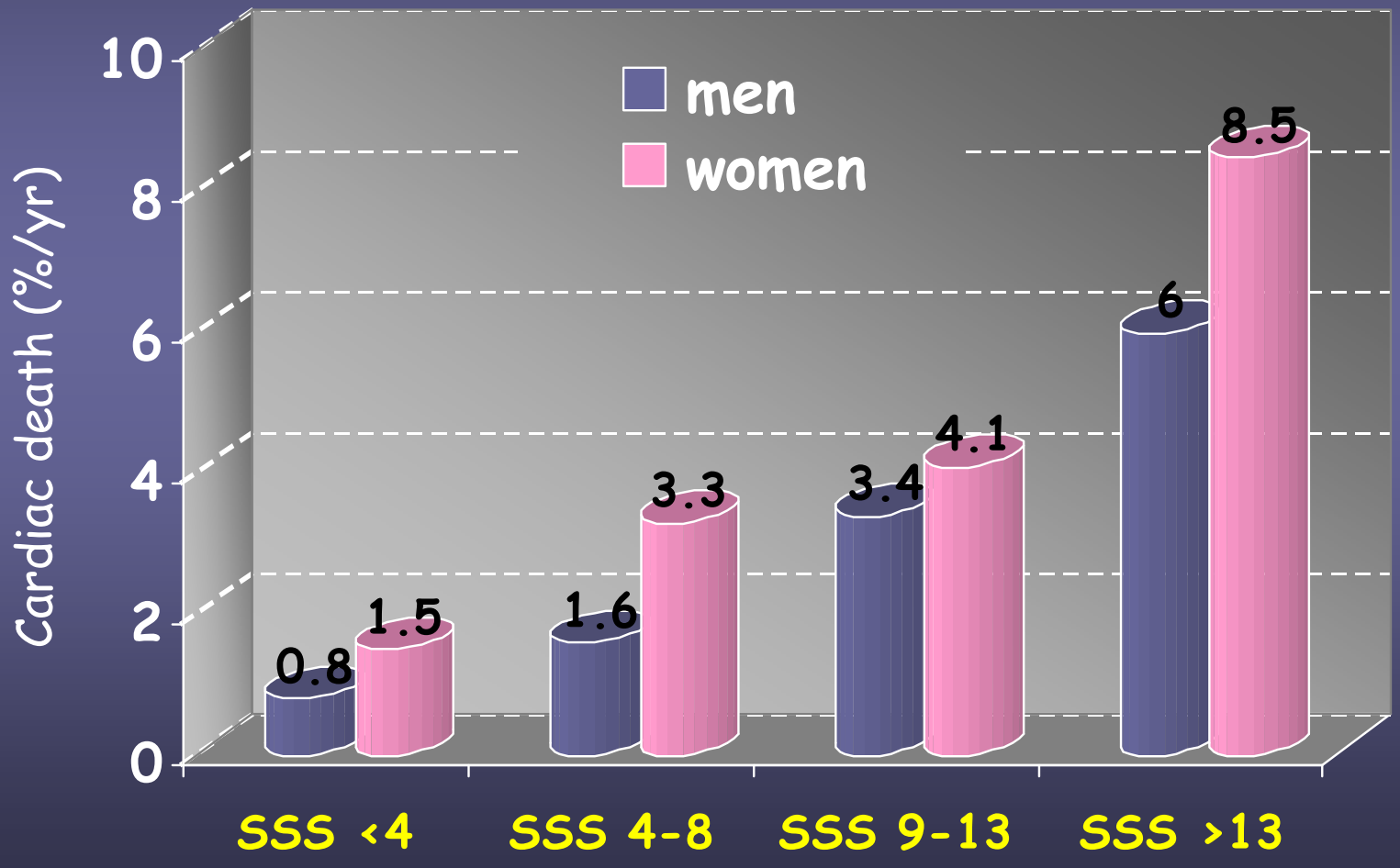
SPECT in prognosis in DM: incremental value

Giri S, et al. Circulation 2002;105:32-40



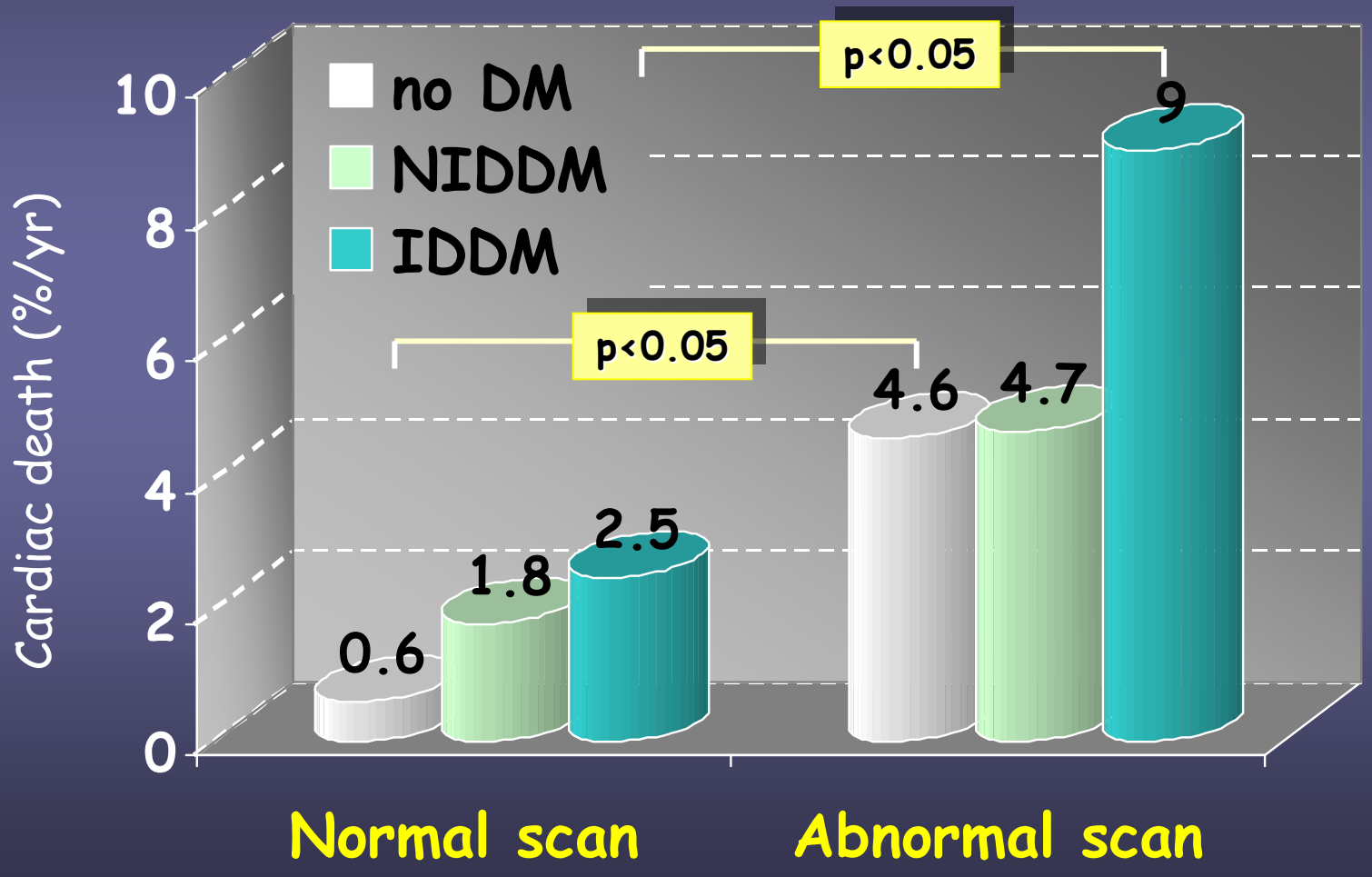
SPECT prognosis in DM: men vs women

Berman DS, et al. J Am Coll Cardiol 2003;41:1125-1133



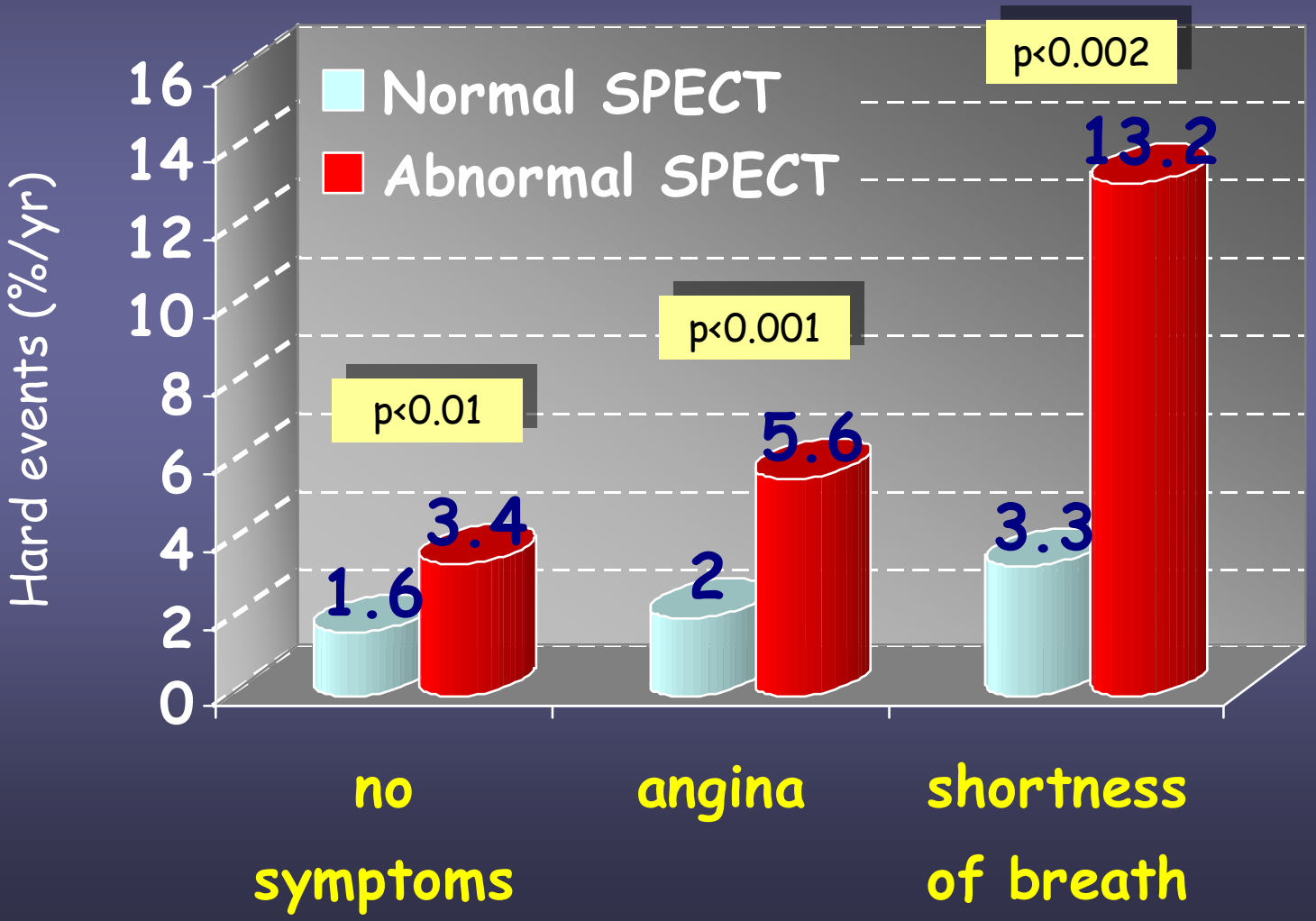
SPECT prognosis in NIDDM vs IDDM

Berman DS, et al. J Am Coll Cardiol 2003;41:1125-1133

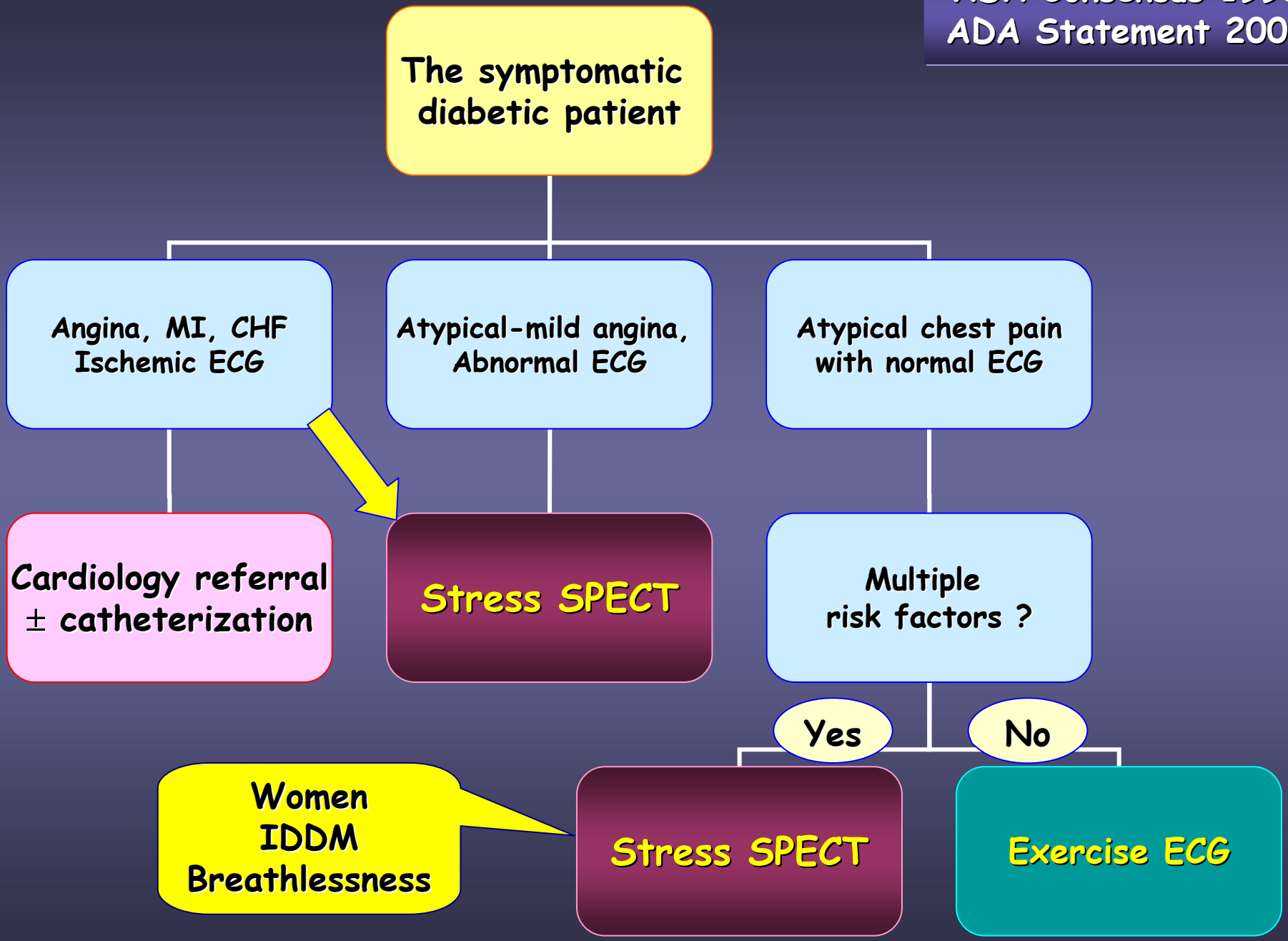


SPECT prognosis in DM and symptomatic status

Zellweger MJ, et al. Eur Heart J 2004;25:543-550



ADA Consensus 1998
ADA Statement 2006



Indications for cardiac testing in diabetics

ADA Consensus 1998, ADA Position Statement 2006

- Typical or atypical cardiac symptoms
- Abnormal resting ECG
- Peripheral arterial disease
- Sedentary lifestyle, age ≥ 35 yrs, begin a vigorous exercise program
- ≥ 2 risk factors in addition to DM
  - Total cholesterol ≥240mg/dl, LCL-cholesterol ≥160mg/dl or HDL-cholesterol <35mg/dl
  - Blood pressure >140/90 mmHg
  - Smoking
  - Family history of premature CAD
  - Micro/macroalbuminuria

Prevalence of stress-induced ischemia

Asymptomatic diabetics - Retrospective databases

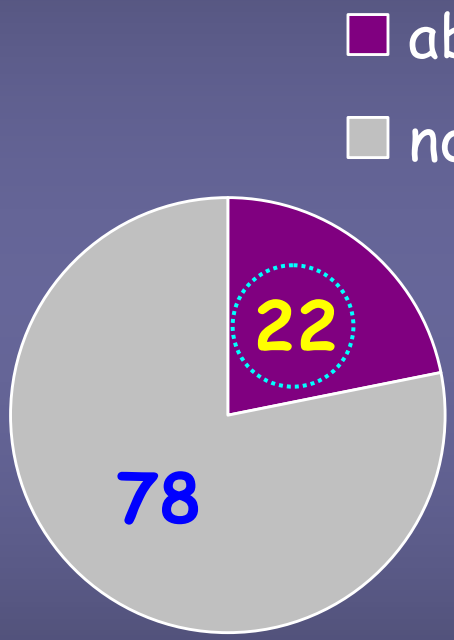
Study		n	Method	Features	Abnormal MPI	Extensive ischemia
Abevanoli	1981	12	Ex Planar ^{201}Tl	Middle-aged	42%	-
Nesto	1990	30	Dip Planar ^{201}Tl	PVD	57%	-
De Lorenzo	2002	180	Ex/Dip SPECT ^{99m}Tc-MIBI	Risk factors	26%	-
Zellweger	2004	826	Ex/Aden dual SPECT	Risk factors	39%	-
Miller	2004	1738	Ex/Pharm SPECT ^{201}Tl/ ^{99m}Tc-MIBI	Risk factors	59%	-
Sorajja	2005	826	Ex/Pharm SPECT ^{201}Tl/ ^{99m}Tc-MIBI	Abnormal MPI	-	32%
Rajagopalan	2005	1427	Ex/Pharm SPECT ^{201}Tl/ ^{99m}Tc-MIBI	Risk factors	58%	18%
DeLuca	2006	189	Ex ^{99m}Tc-MIBI	Preoperative	33%	-

Asymptomatic diabetics - Prospective databases

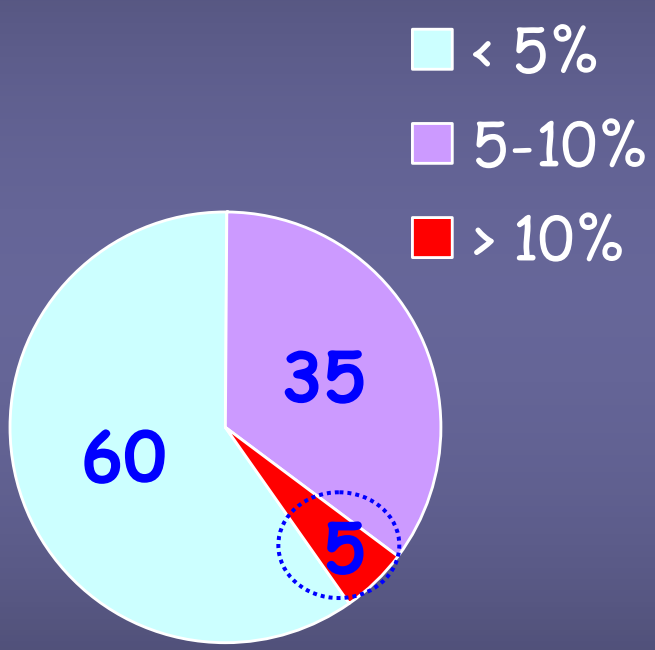
Study		n	Method	Features	Abnormal MPI	Extensive ischemia
Koistinen	1990	136	Ex SPECT ^{201}Tl	Middle-aged	24%	-
Langer	1991	58	Ex SPECT ^{201}Tl	Ex ECG – Holter (+)	17%	-
Janand-Delenne	1999	105	Ex/Dip ^{201}Tl	Inderm. Ex ECG Risk factors	19%	-
Inoguchi	2000	93	Dip Planar ^{201}Tl	Elderly, Inderm. Ex ECG	42%	-
Castells	2000	112	Dip SPECT ^{201}Tl	Middle-aged	37%	-
Penformis	2001	56	Ex SPECT ^{201}Tl	Risk factors	21%	-
Valensi	2001	107	Dip ^{201}Tl	Risk factors	16%	-
Faglia	2002	97	Ex SPECT ^{201}Tl	Ex ECG (+)	59%	-
Cosson	2003	362	Ex/Dip SPECT ^{201}Tl	Risk factors	33%	-
Sultan	2004	135	Dip SPECT ^{99m}Tc-MIBI	Risk factors	22%	-
Cosson	2004	262	Ex ^{201}Tl	Exercise ability	21%	-
Wackers	2004	522	Aden SPECT ^{99m}Tc-MIBI	Multicentre study	16%	1%
Prior	2005	75	Ex/Dip ^{201}Tl/^{99m}Tc-MIBI	Risk factors	36%	12%
Sultan	2006	419	Dip SPECT ^{99m}Tc-MIBI	Risk factors	17%	-
Anand	2006	180	Ex/Dip SPECT ^{99m}Tc-MIBI	Coronary calcium	32%	-
Vanzetto	2007	235	Ex/Dip ^{201}Tl	High risk	26%	16%

Stress-induced ischemia in asymptomatic DM

Wackers FJT, et al. Diabetes Care 2004;27:1954-1961



patients

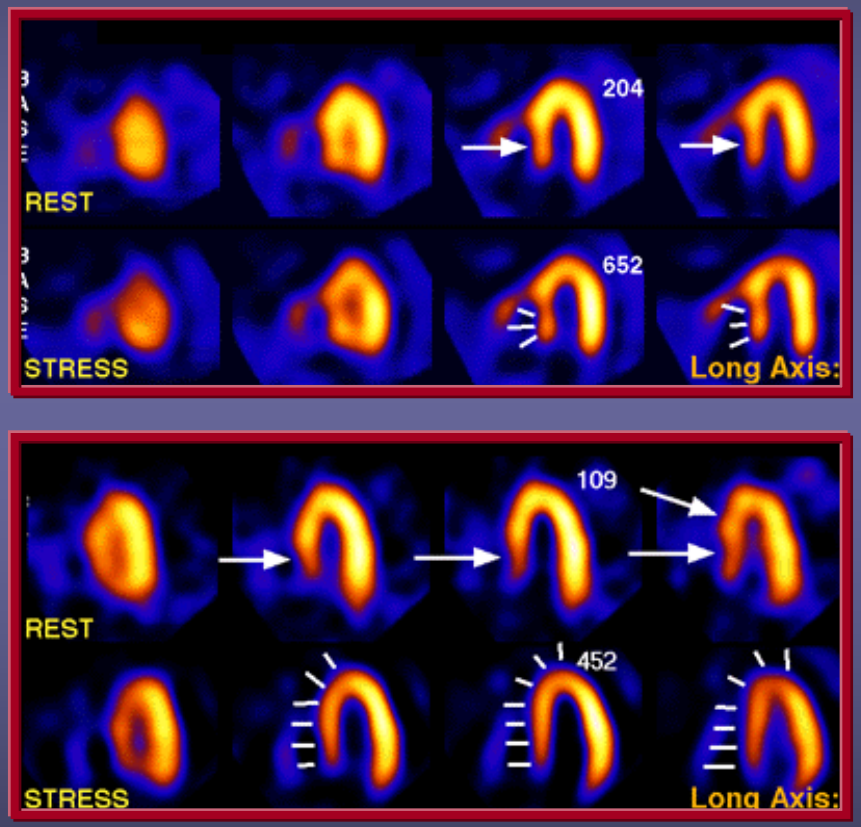


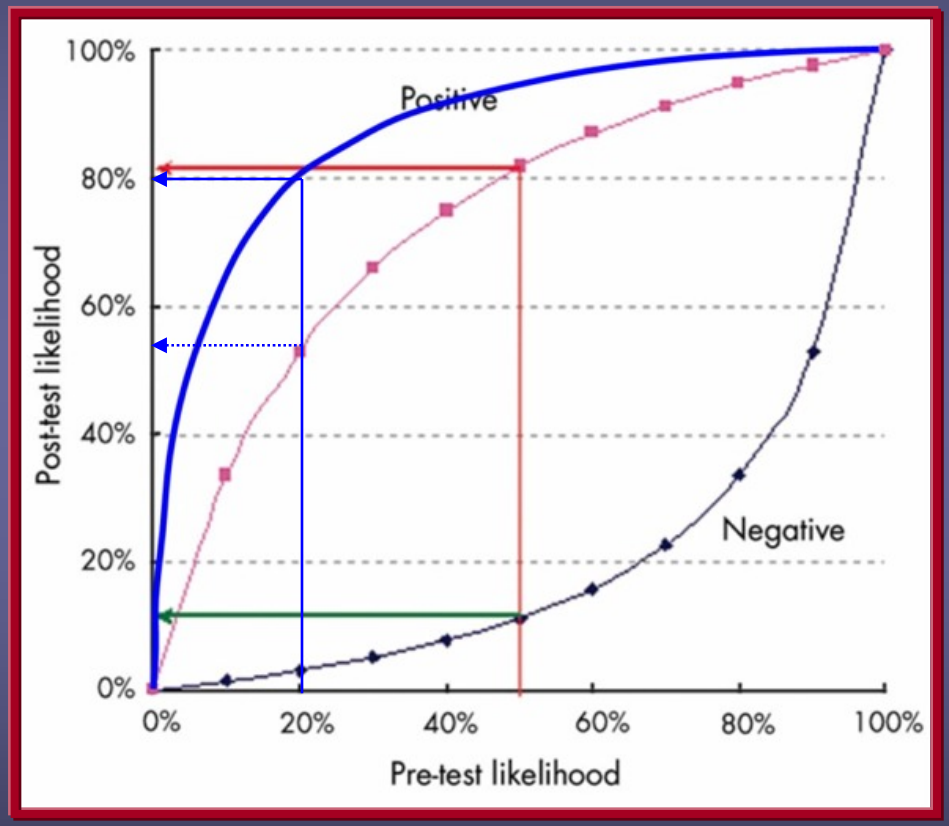
defects

Diagnostic performance of Myocardial Perfusion Imaging in asymptomatic diabetic patients with unknown CAD

Study		n	Method	Features	Sens	Spec	PPV	NPV
Symptomatic and asymptomatic diabetics								
Kang	**1999**	138	Ex/Pharm dual SPECT	51% no symptom	**86%**	**56%**	-	-
Asymptomatic diabetics only								
Koistinen	**1990**	33	Ex SPECT ^{201}Tl	Middle-aged	**77%**	**15%**	59%	50%
Cosson	**2004**	76	Ex ^{201}Tl	Exerc. ability	**68%**	**50%**	52%	66%
Sultan	**2004**	73	Dip SPECT ^{99m}Tc-MIBI	Risk factors	**74%**	**48%**	76%	46%
Rajagopalan	**2005**	212	Ex/Pharm SPECT ^{201}Tl	High risk	**92%**	**32%**	89%	40%

The Bayesian approach





Prognostic performance of Myocardial Perfusion Imaging in asymptomatic diabetic patients with unknown CAD

Study		n	Method	Features	F-u (mo)	Annual events (%)	
						abnormal	normal
Hard events (cardiac death, non-fatal myocardial infarction)							
De Lorenzo	2002	180	Ex/Dip SPECT ^{99m}Tc-MIBI	Risk factors	36	9.0	2.0
Zellweger	2004	701	Ex/Aden dual SPECT	Risk factors	12-102	3.4	1.6
Cosson	2004	262	Ex/Pharm SPECT ^{201}Tl	Risk factors	48	3.4	0.8
Rajagopalan	2005	1427	Ex/Pharm SPECT ^{99m}Tc-MIBI	Risk factors	70	3.6-5.9	1.6-2.9
Valensi	2005	370	Ex/Dip SPECT ^{201}Tl	Risk factors	38	5.2	2.1
Hard and soft events (angina, revascularization, heart failure, stroke)							
Faglia	2002	735	Ex SPECT ^{201}Tl	Middle-aged	60	3.9	0.4
Sultan	2004	419	Dip SPECT ^{99m}Tc-MIBI	Risk factors	25	4.0	1.1
Anand	2006	180	Ex+Dip SPECT ^{99m}Tc-MIBI	Coron. calcium	26	6.4	1.7

High-risk asymptomatic diabetic patients candidates for screening with SPECT imaging

Rajagopalan N, et al. *JACC* 2005;45:43-49

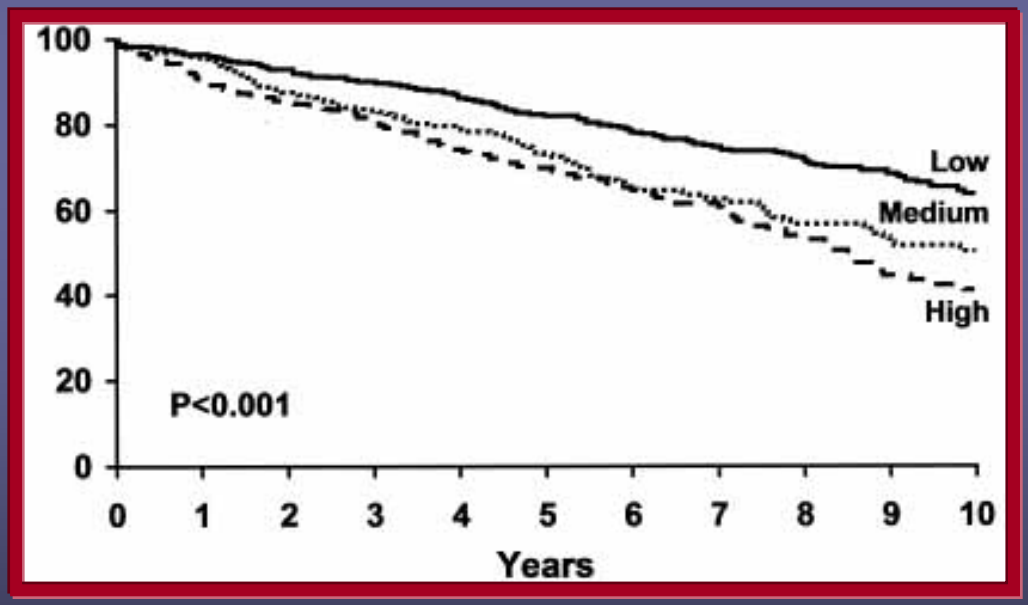
1,427 pts with suspected CAD

18% High-Risk SPECT

➢Predictors

- Q-waves
- Peripheral Artery Disease

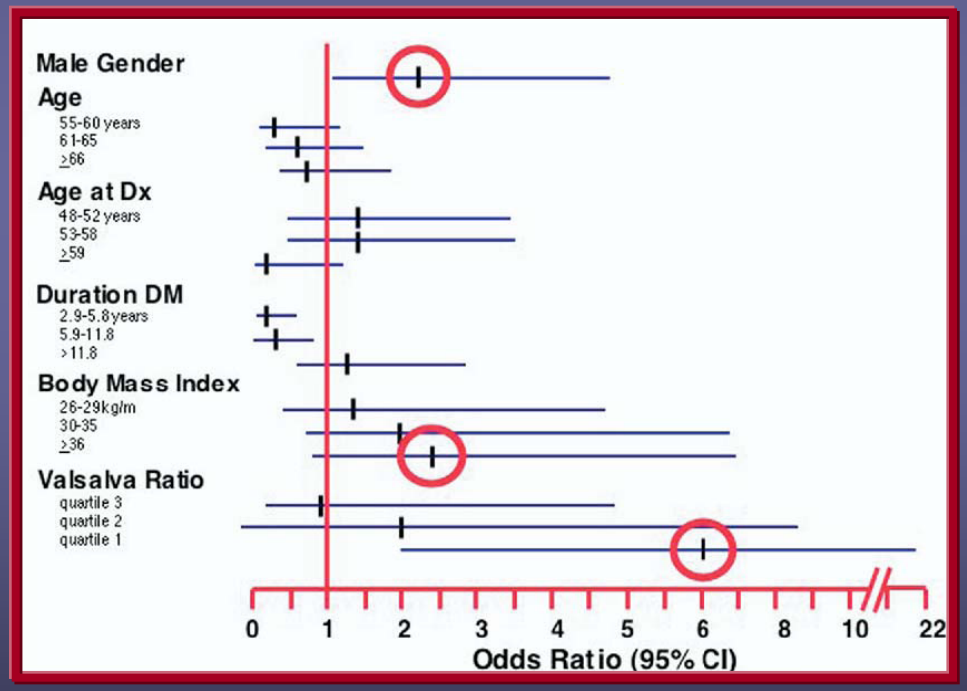
SPECT risk and survival



SPECT in DM: silent ischemia and risk factors

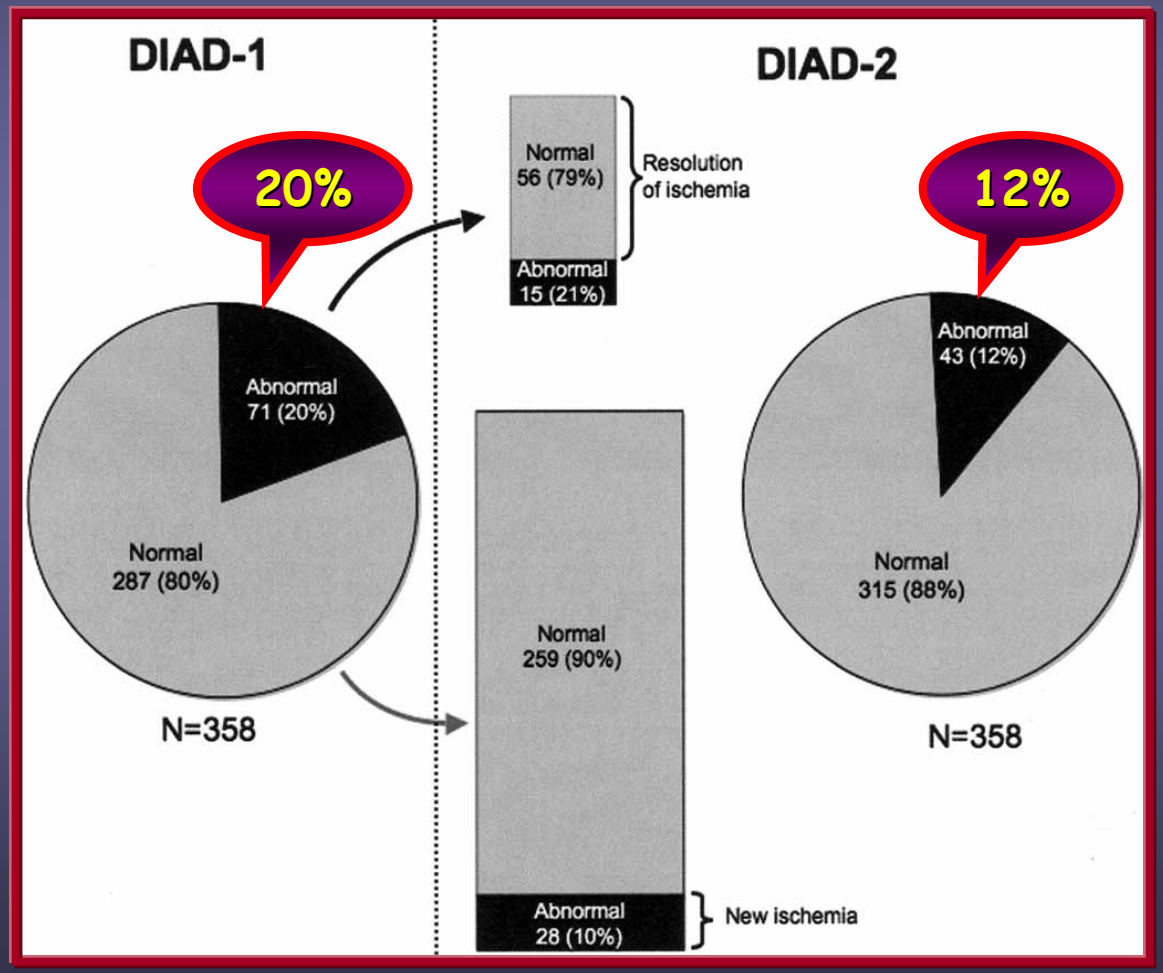
Wackers FJT, et al. Diabetes Care 2004;27:1954-1961

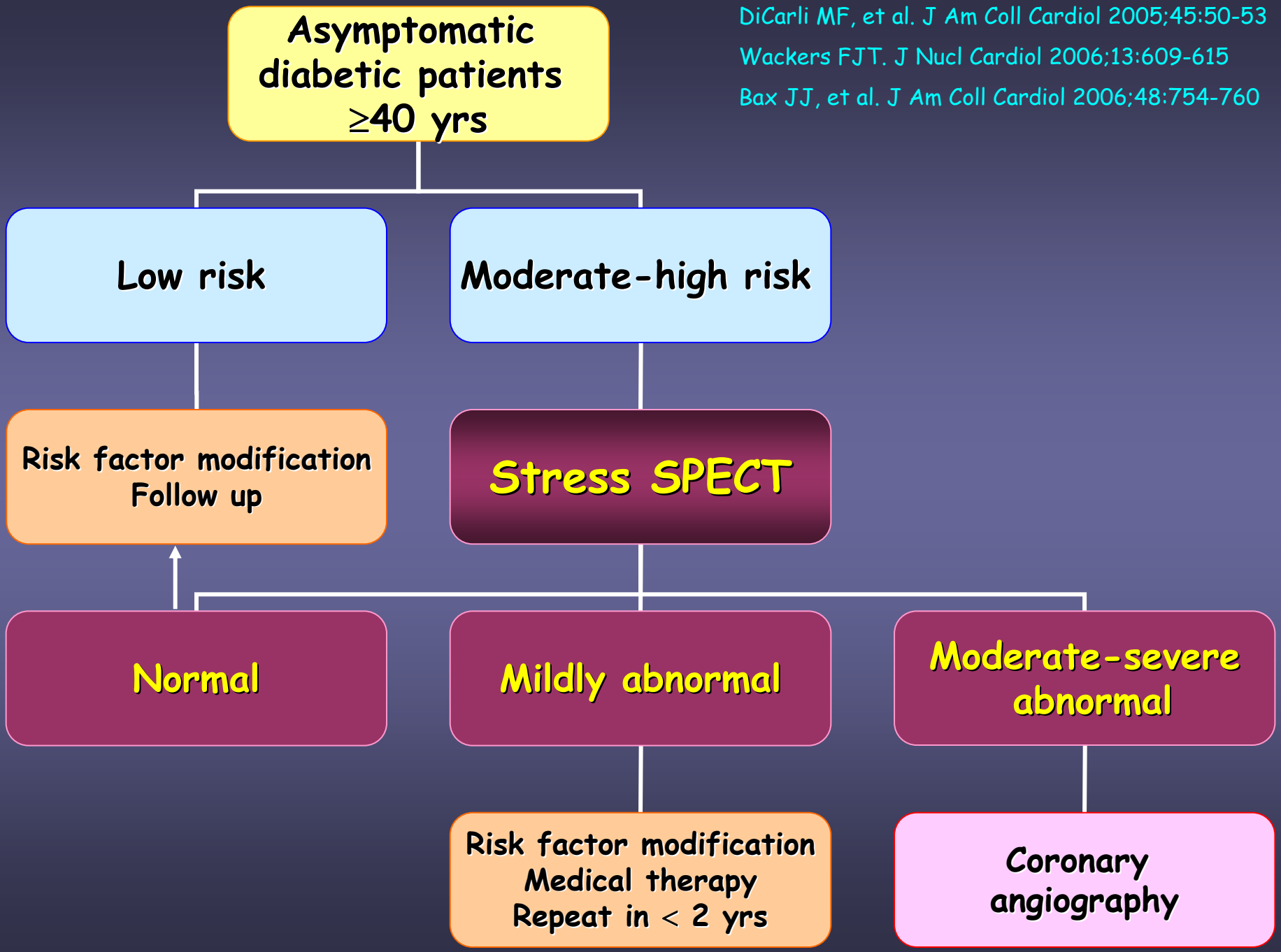
Risk factors	Ischemia (n=510)
≥ 2	22% (66/306)
0-1	22% (45/204)
p	ns



Stress-induced ischemia in asymptomatic DM

Wackers FJT, et al. Diabetes Care 2007;30:2892-2898





DiCarli MF, et al. J Am Coll Cardiol 2005;45:50-53
Wackers FJT. J Nucl Cardiol 2006;13:609-615
Bax JJ, et al. J Am Coll Cardiol 2006;48:754-760

ACC/AHA/ASNC 2003 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging

www.acc.org

Myocardial perfusion imaging in asymptomatic patients

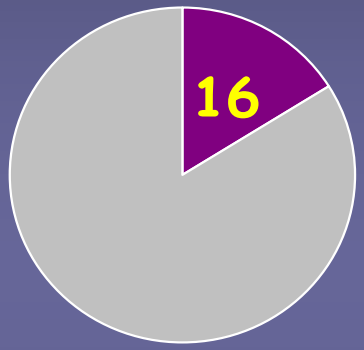
- Initial diagnostic test in patients considered to be at high-risk (diabetes or more than 20% 10-year risk of CHD event)

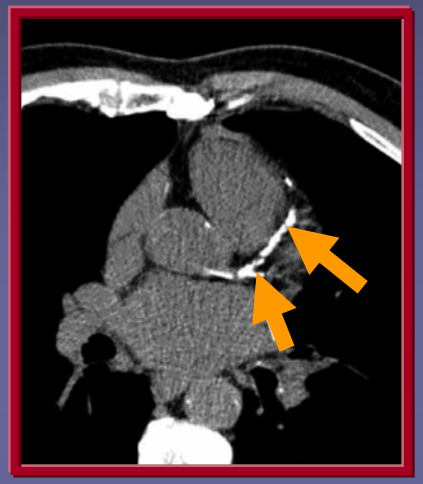
  (Class IIa, LE: B)

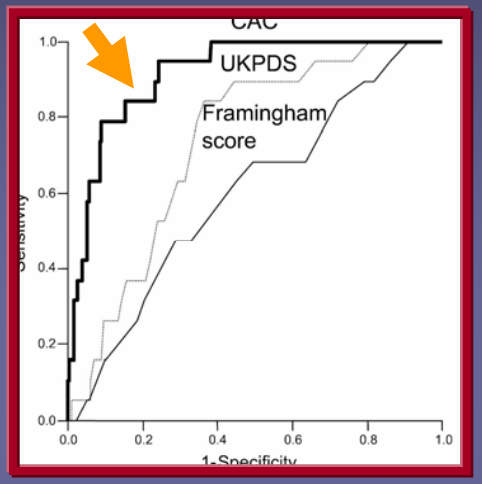
Coronary calcium & SPECT in asymptomatic DM

Wackers FJT, et al. Diabetes Care 2004;27:1954-1961

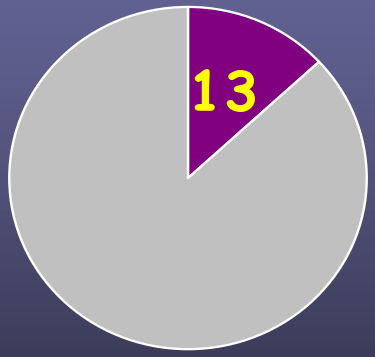
abnormal SPECT
normal SPECT



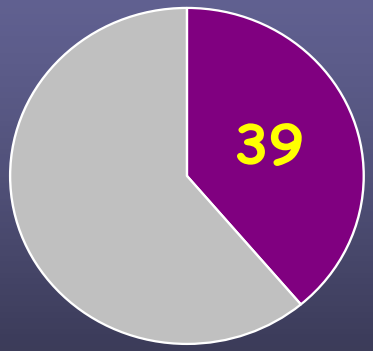




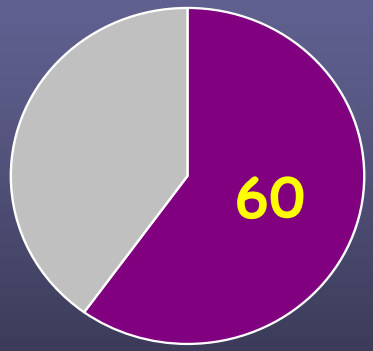
Anand DV, et al. Eur Heart J 2006;27:713-721



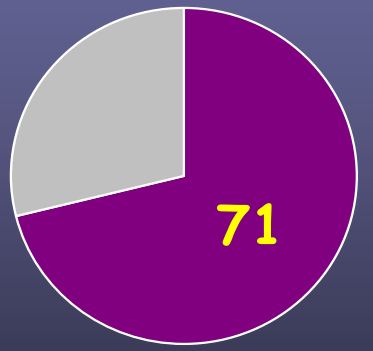
CAC 0-100



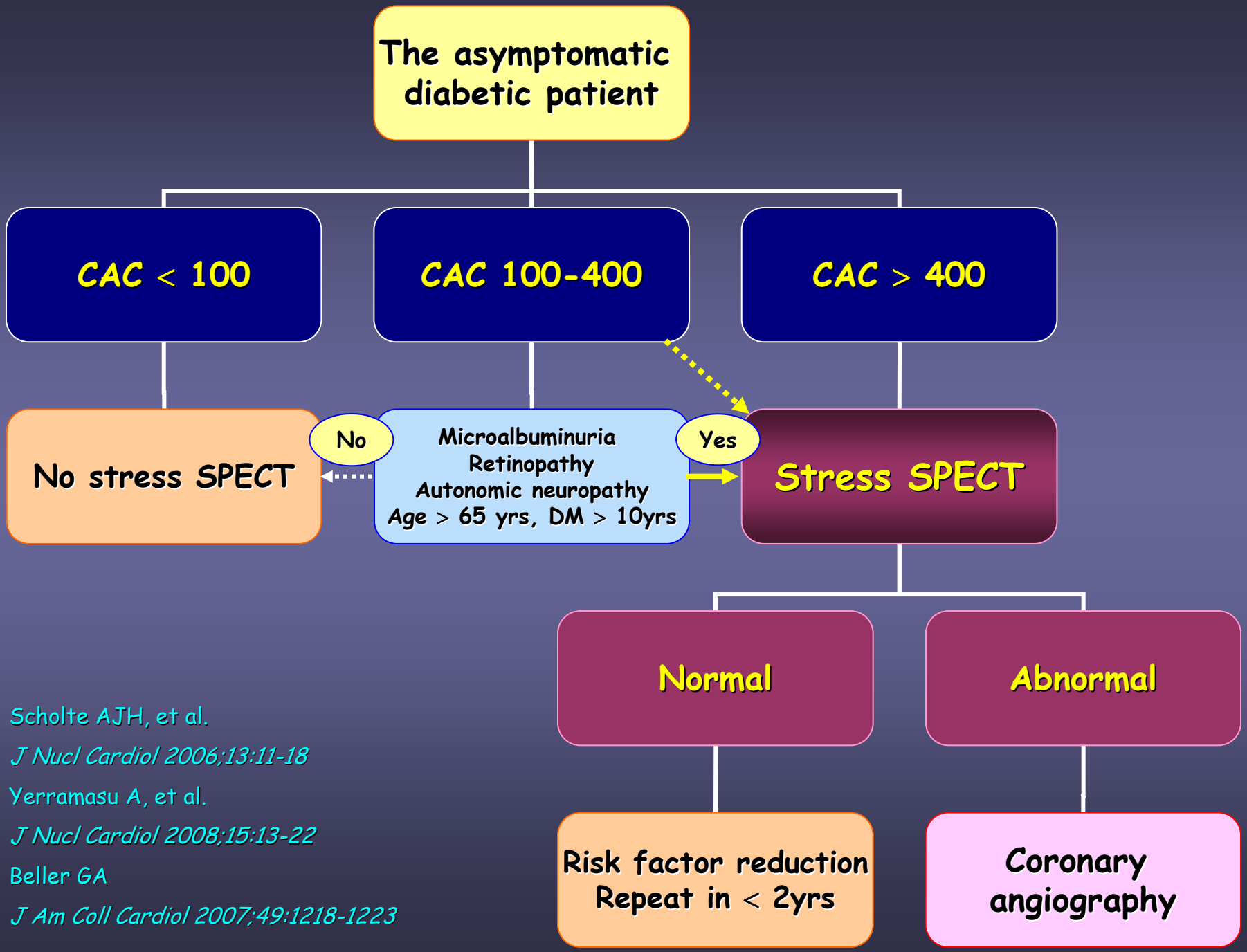
CAC > 100



CAC > 400



CAC > 1000



Scholte AJH, et al.
J Nucl Cardiol 2006;13:11-18
Yerramasu A, et al.
J Nucl Cardiol 2008;15:13-22
Beller GA
J Am Coll Cardiol 2007;49:1218-1223

SPECT logistics in screening asymptomatic DM

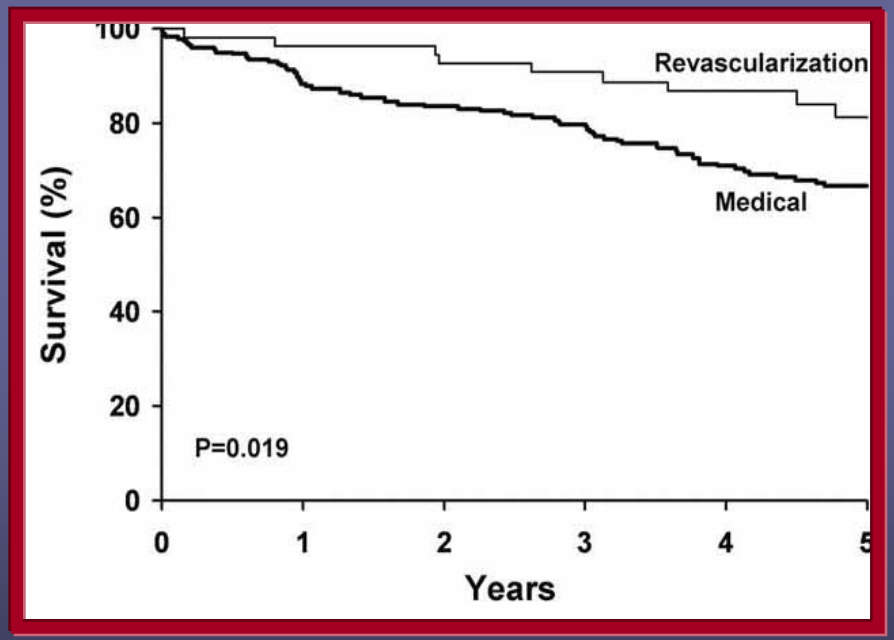
Diamond GA, et al. J Am Coll Cardiol 2007;49:1915-1917

	Statin treatment	
Metric	Test no one Treat all	Test → Treat
Target population	14,000,000	14,000,000
Test population	0	14,000,000
Treatment population	14,000,000	2,800,000
Expected events	**280,000**	**224,000**
Testing cost	$ 0	$ 11,300,000,000
Treatment cost	$ 10,100,000,000	$ 2,000,000,000
Total cost	$ 10,100,000,000	$ 13,300,000,000
Prevented events	**84,000**	**67,200**
Cost/prevented event	**$ 120,238**	**$ 197,917**
Cost/life-year	**$ 9,249**	**$ 15,224**

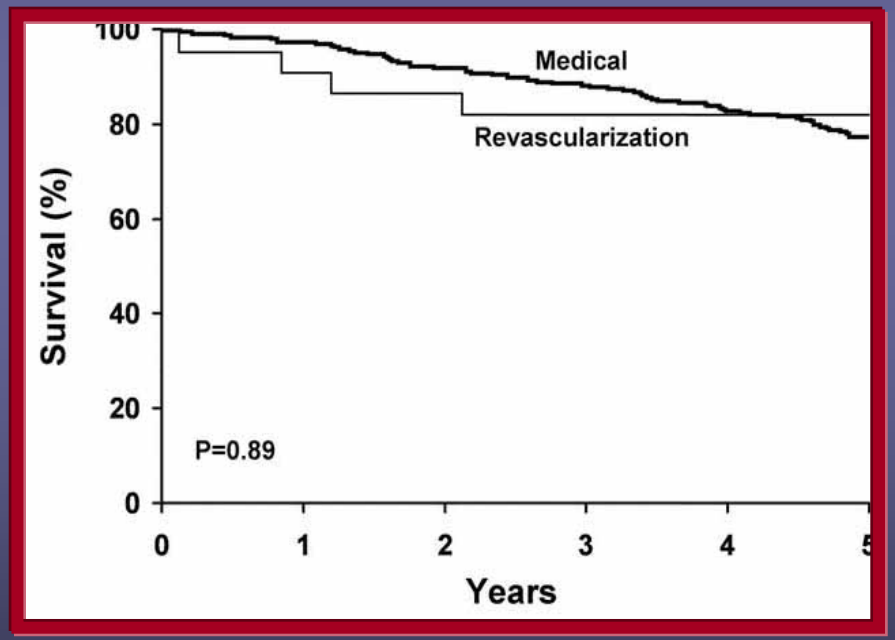
Survival of asymptomatic diabetic patients with high-risk SPECT imaging

Sorajja P, et al. Circulation 2005;112:I-131-I-316

High-risk SPECT



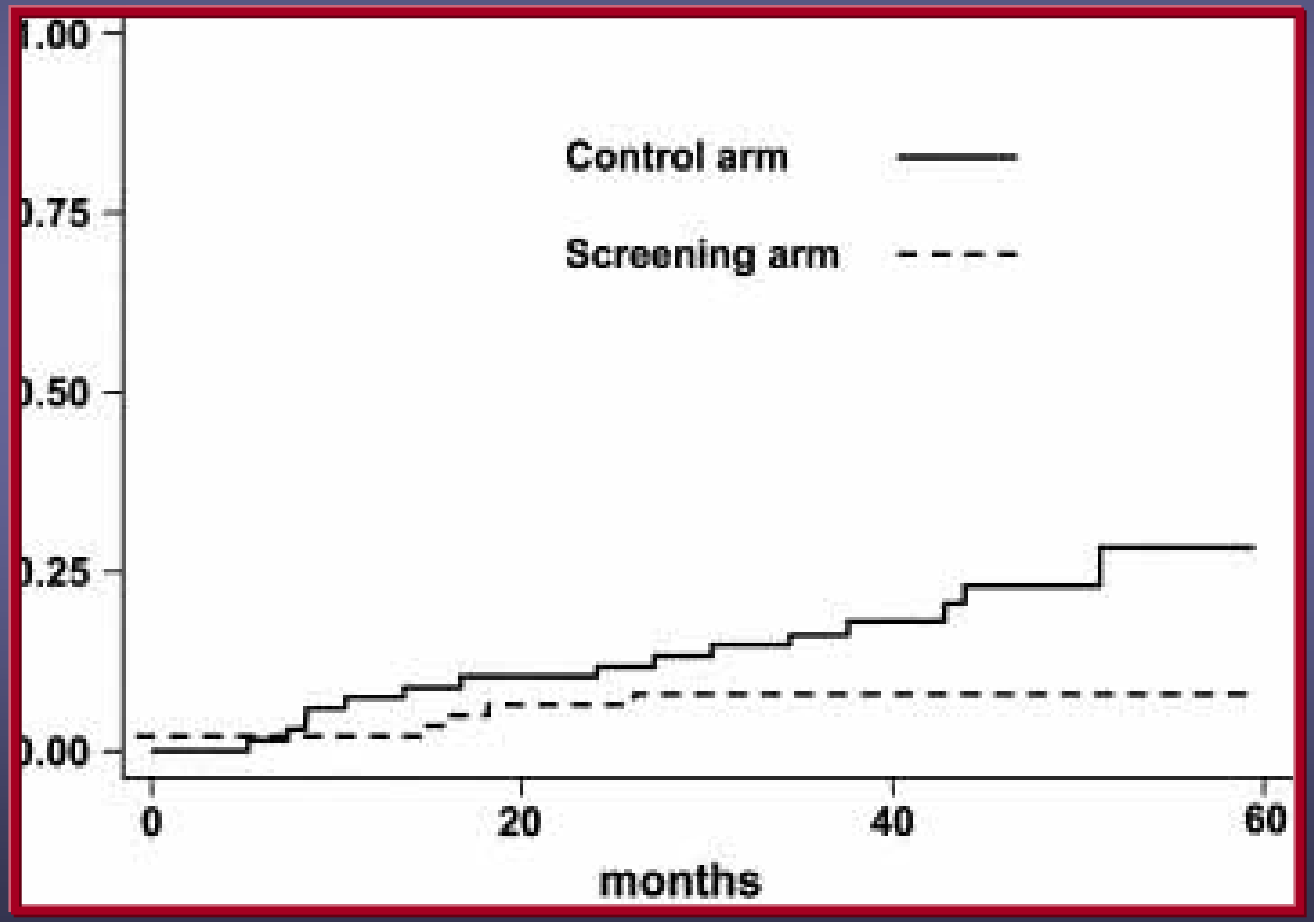
No high-risk SPECT



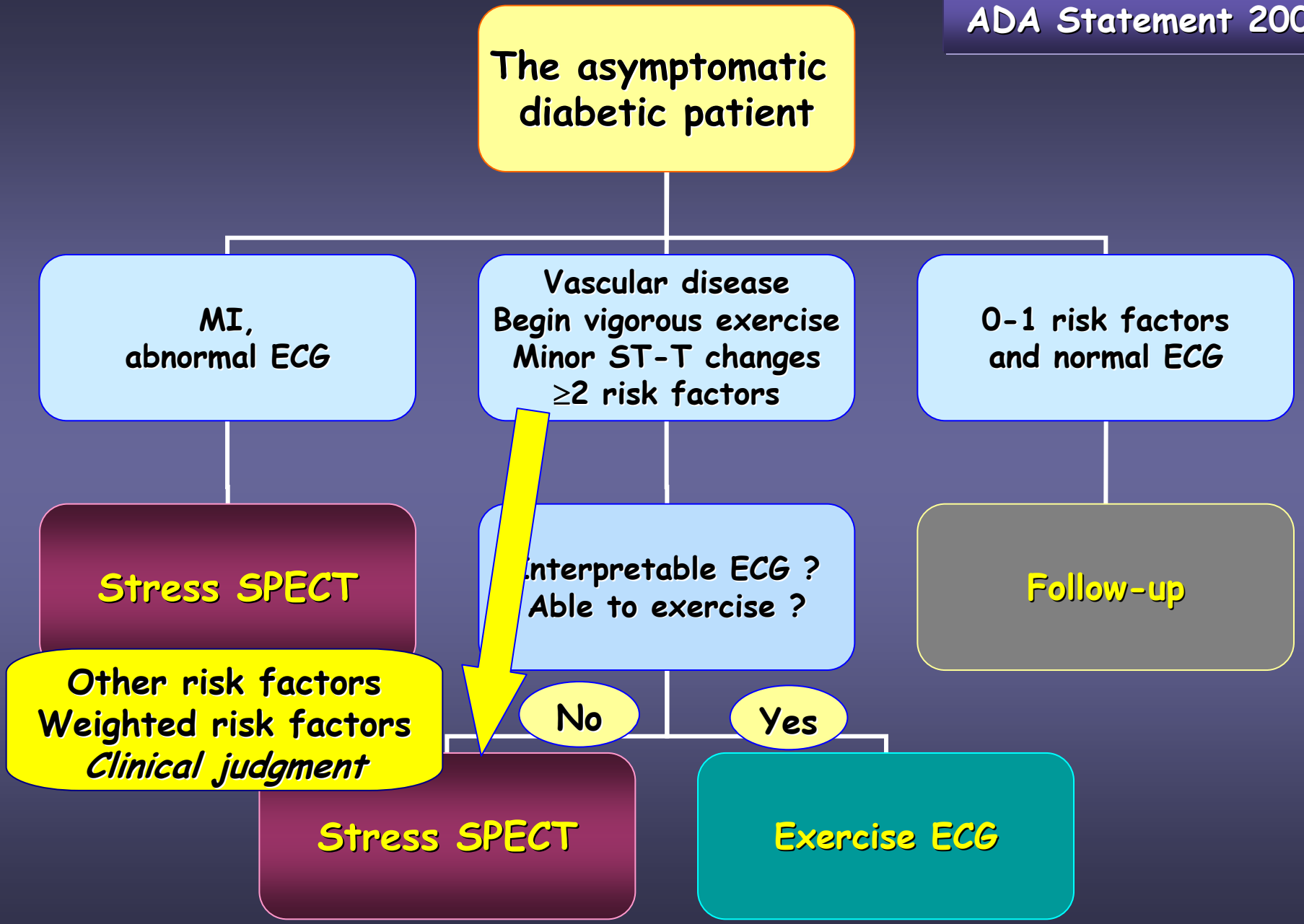
826 patients

Risk reduction in asymptomatic diabetics with non-invasive testing

Faglia E, et al. Am Heart J 2005;149:283.e1-283.e6



ADA Consensus 1998
ADA Statement 2006



Myocardial Perfusion Imaging in diabetic patients

- **Myocardial perfusion imaging** is:
  - a strong diagnostic and prognostic tool
  - endorsed by international guidelines
  - suitable for all patients

- Proposed criteria for imaging:
  - are inadequate
  - clinical judgment required

- In asymptomatic diabetic patients with suspected CAD the best management option is largely unclear

Clinical CAD

Occult CAD

Thank you for your attention

Prognostic assessment in symptomatic DM

Kamalesh M, et al. Am J Cardiol 2007;99:1016-1019

Table 1
Cardiac event rates in diabetic subjects with normal stress imaging study

Year First Author	No. of Patients	Normal Results (%)	Age (yrs)	Follow-Up (mo)	Type of Stress	Event Rate (Myocardial Infarction ± Death)
Stress echocardiography						
2001 Elhendy	563	40	64	60	Exercise	1.5%
2001 Bigi	259	58	64	24	Dob/dip	3%
2002 Kamalesh	89	100	64	25	Exercise/dob	6%*
2002 Marwick	937	60	59	47	Exercise/dob	4%
2003 Sozzi	396	18	61	36	Dob	4.8%†
2005 Garrido	214	34	63	44	Exercise	1.6%
2006 Chaowalit	2,349	57	67	96	Dob	6%*†
2006 Cortigiani	749	28	64	31	Dip/dob	4.6%
Stress perfusion						
1987 Felsher	123	44	56	21	Exercise	2%
1999 Vanzetto	158	44	63	23	Exercise/dip	2.9%
1999 Kang	108	41	67	24	Exercise/aden	1.9
2002 Schinkel	206	33	61	49	Dob	0.7*
2002 Giri	929	52	65	30	Exercise/aden	3%
2002 DeLorenzo	180	74	61	36	Exercise/dip	2%‡
2003 Hachamovitch	181	100	61	22	Exercise/aden	1.0%–1.8%§
2005 Pedone	125	37	61	40	Dob	1.3%#

* Baseline wall motion abnormalties included.
† Death only.
‡ Asymptomatic diabetics only.
§ 1.0% in men and 1.8% in women.
# Tetrofosmin tracer.
Aden = adenosine; dip = dipyridamole; dob = dobutamine.

SPECT prognosis in DM: exercise vs adenosine

Kang X, et al. Am Heart J 1999;138:1025-1032