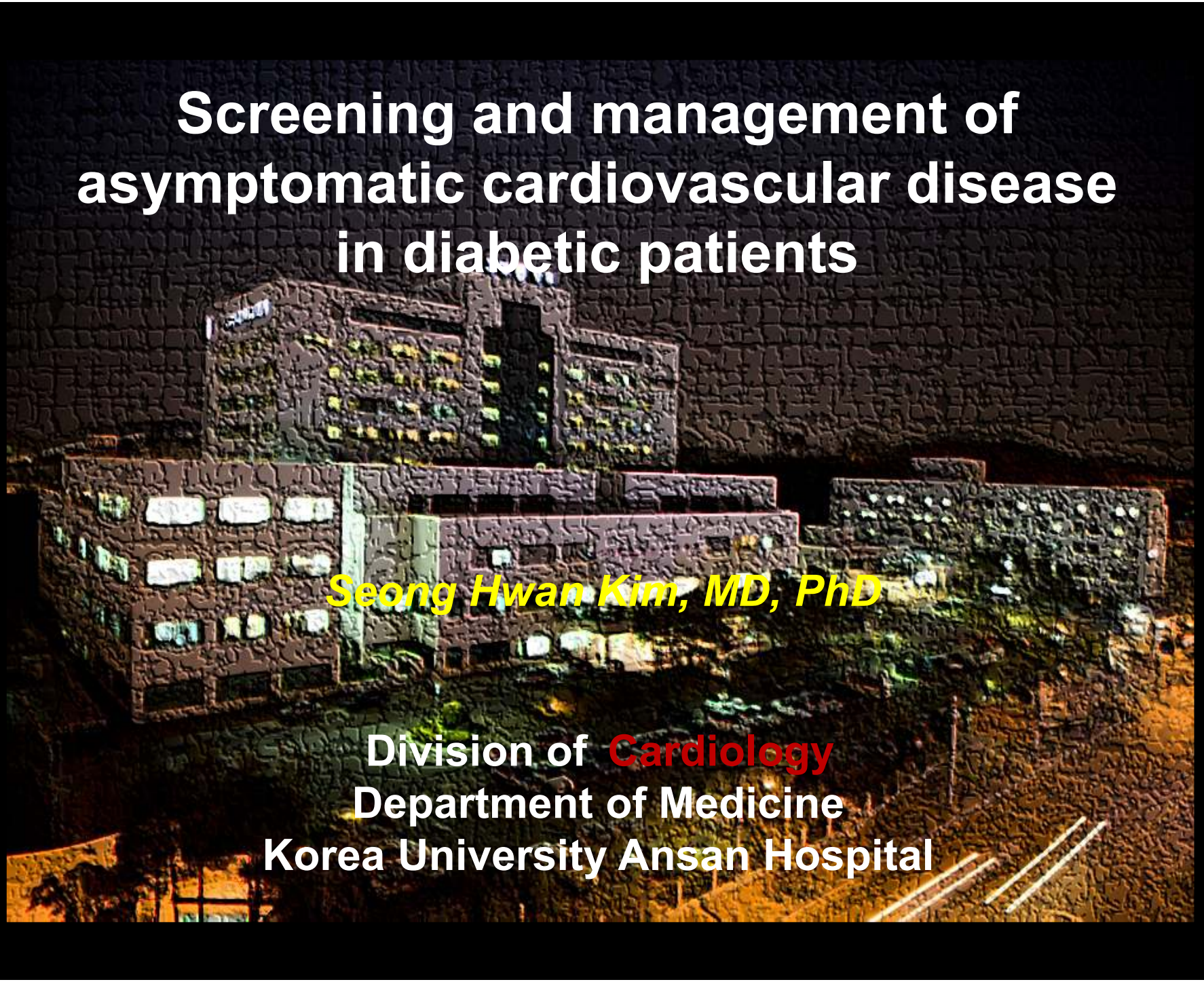
Screening and management of asymptomatic cardiovascular disease in diabetic patients



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Presenter Disclosure Information

Seong Hwan Kim, MD, PhD

Title

Screening and management of asymptomatic cardiovascular disease in diabetic patients

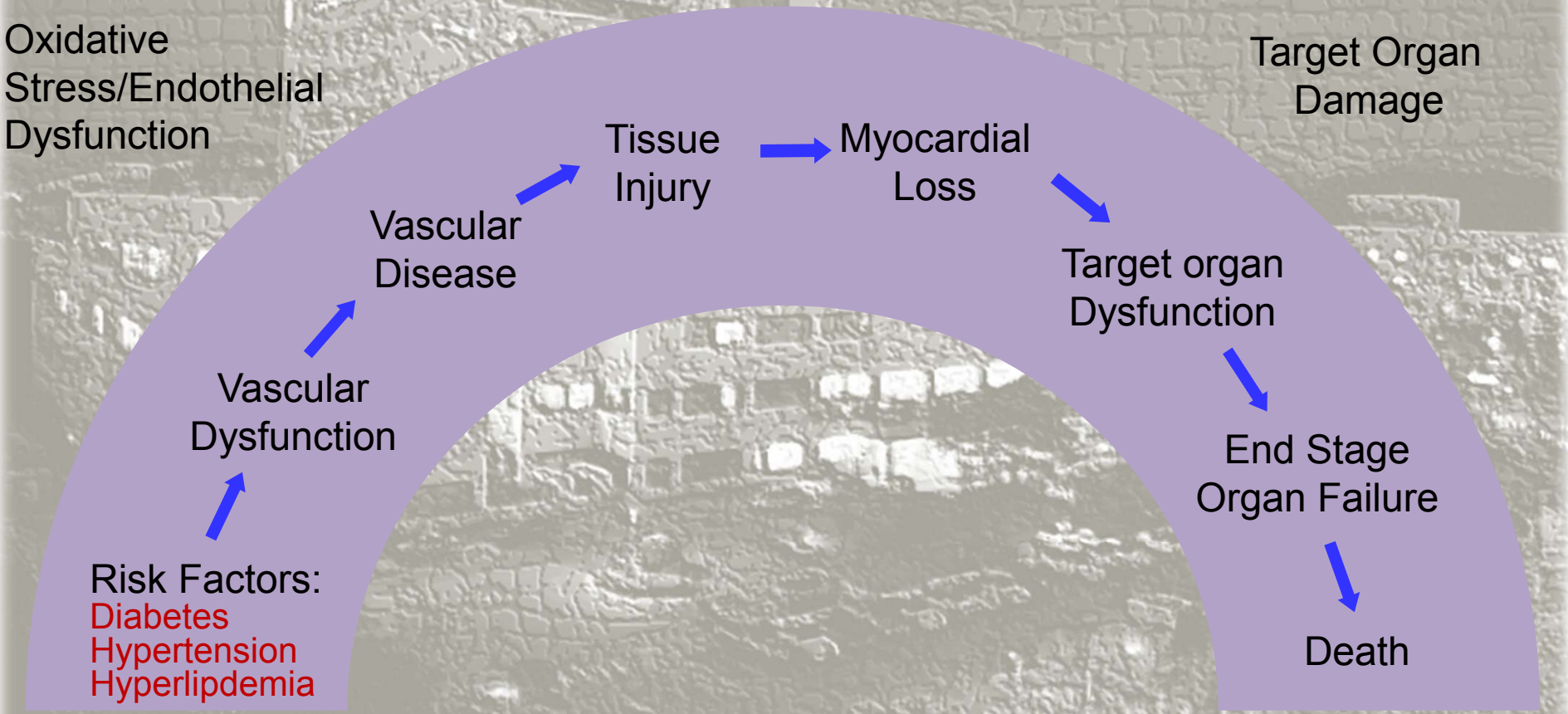
FINANTIAL DISCLOSURE:

None

UNLABELED/UNAPPROVED USES DISCLOSURE:

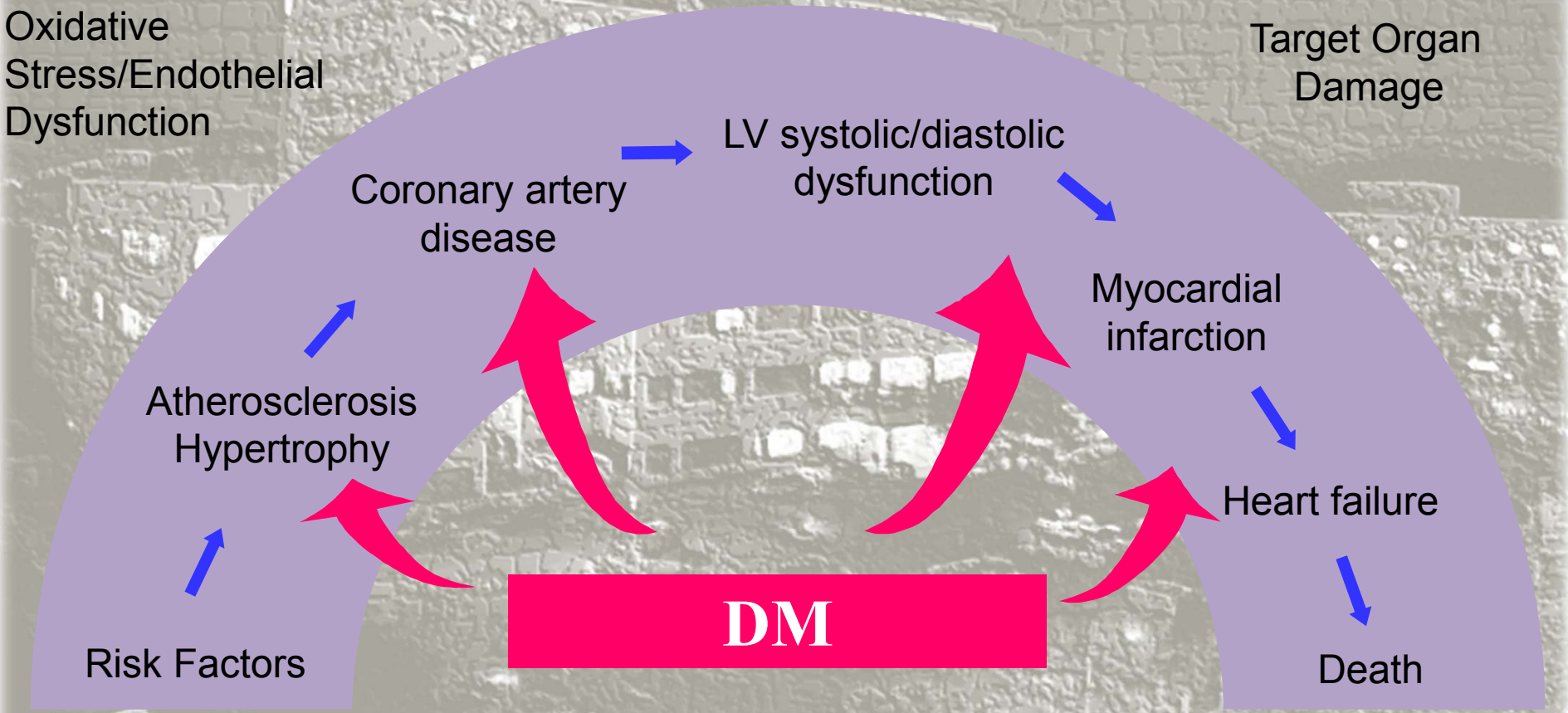
None

Cardiovascular continuum

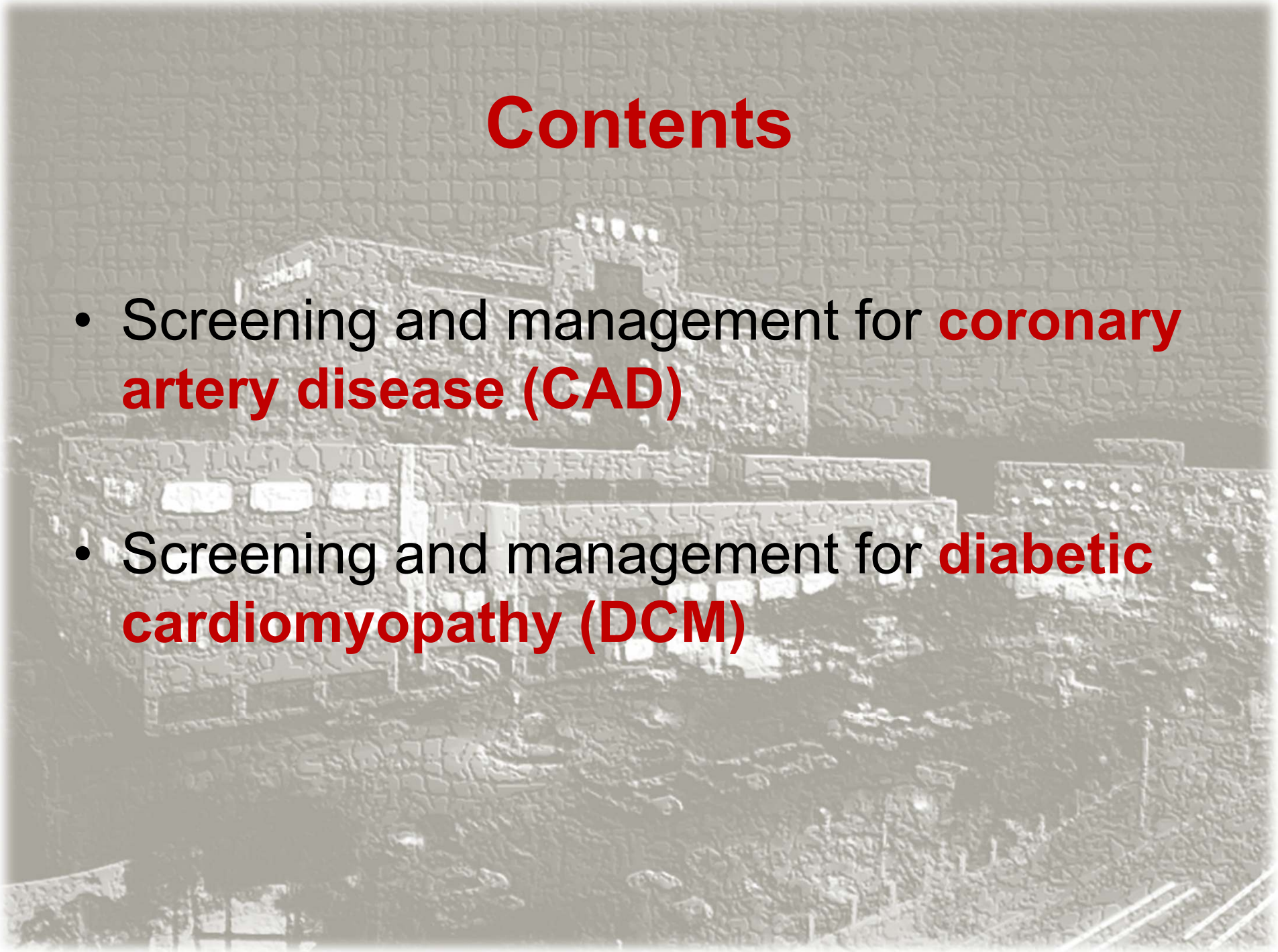


Braunwald E. *Am Heart J*. 1991;121:1244-163.

Cardiovascular continuum



Braunwald E. *Am Heart J*. 1991;121:1244-163.



Contents

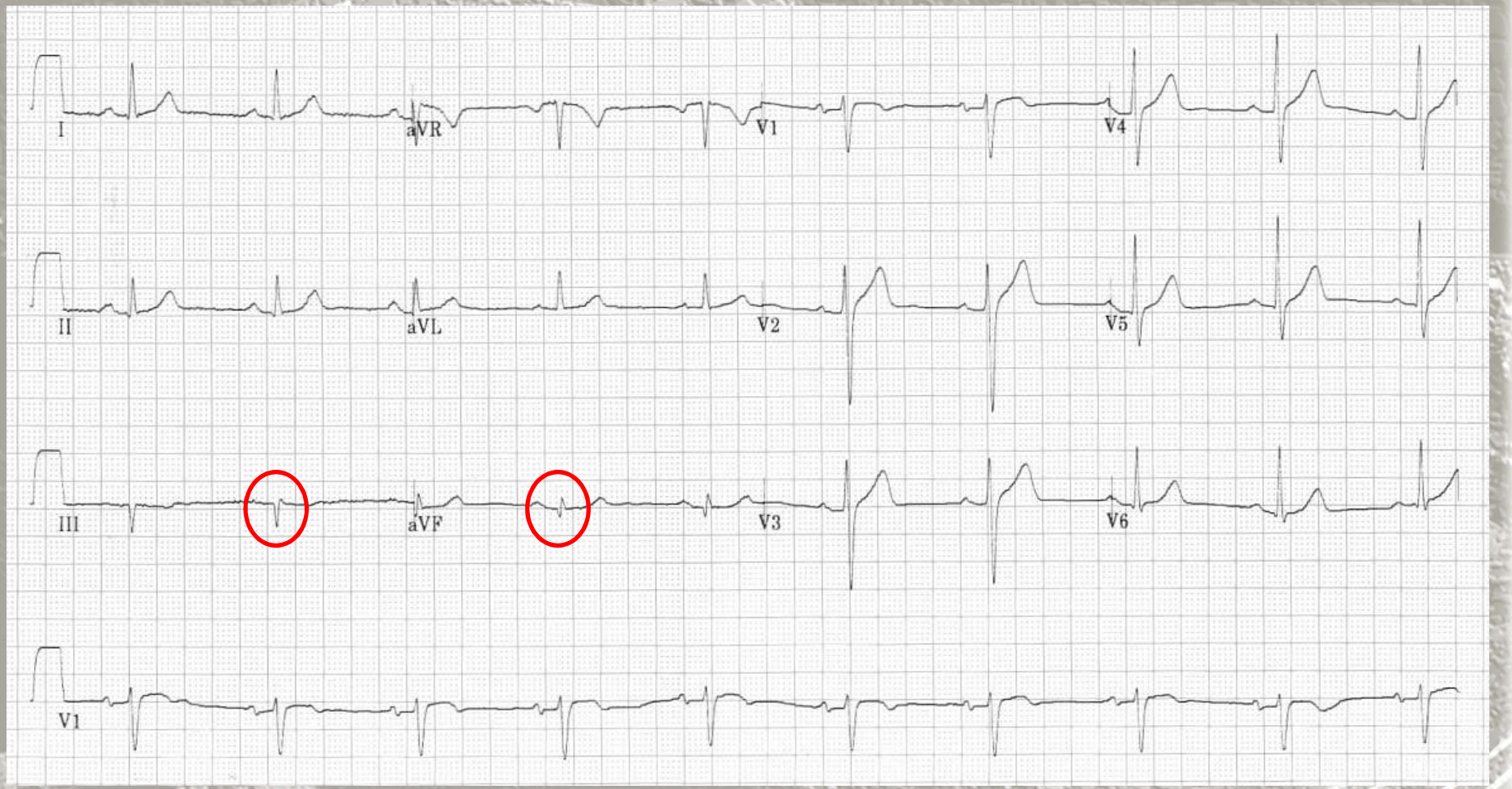
- Screening and management for **coronary artery disease (CAD)**
- Screening and management for **diabetic cardiomyopathy (DCM)**

Case

- M/60
- HTN/DM > 20 yrs
- Dyslipidemia
- DM retinopathy (-)/neuropathy (-)/ nephropathy (+)
- Chest pain (-)/dyspnea (-)

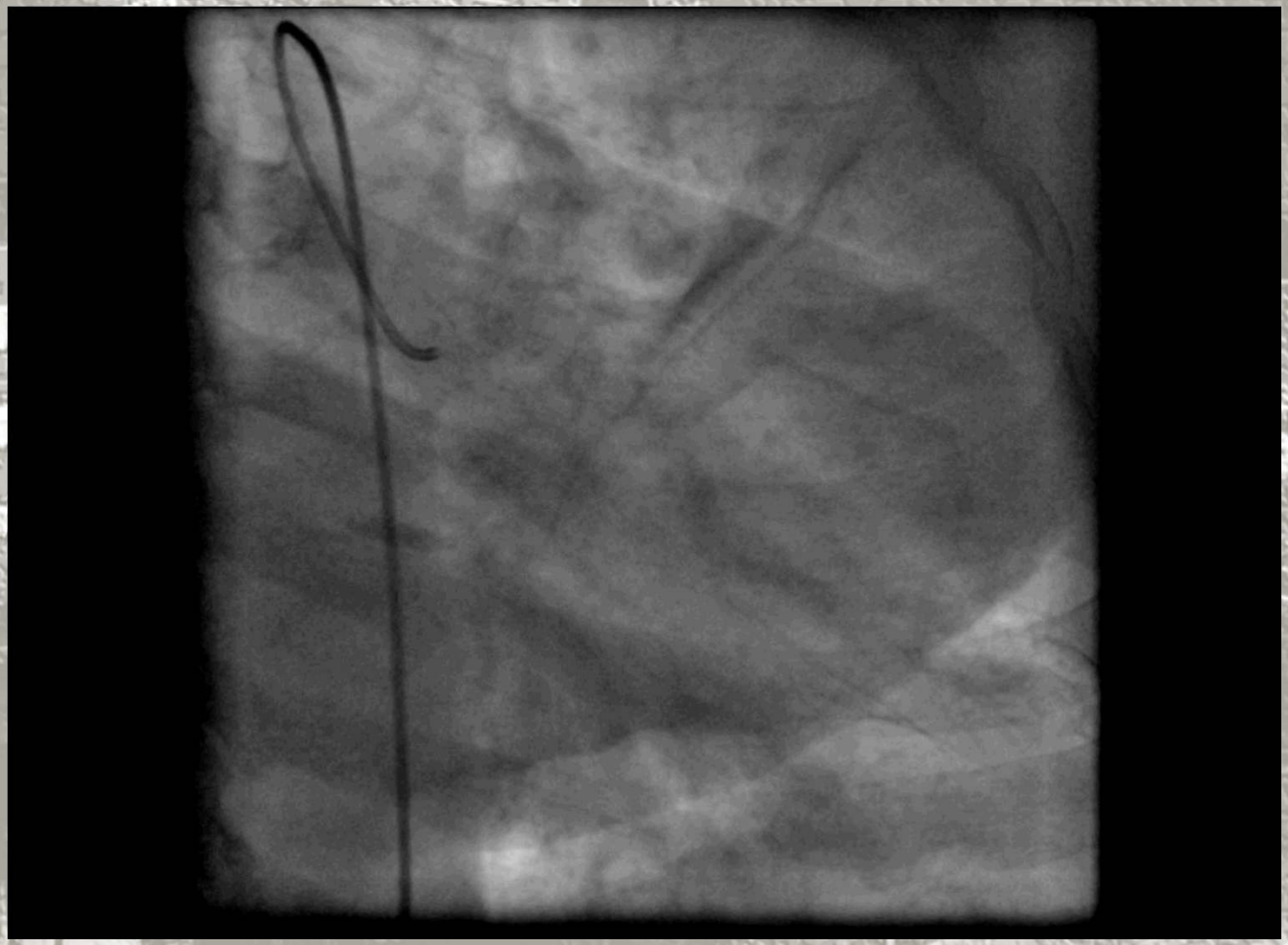
Case

Electrocardiography in regular health checkup



Case

Coronary angiogram

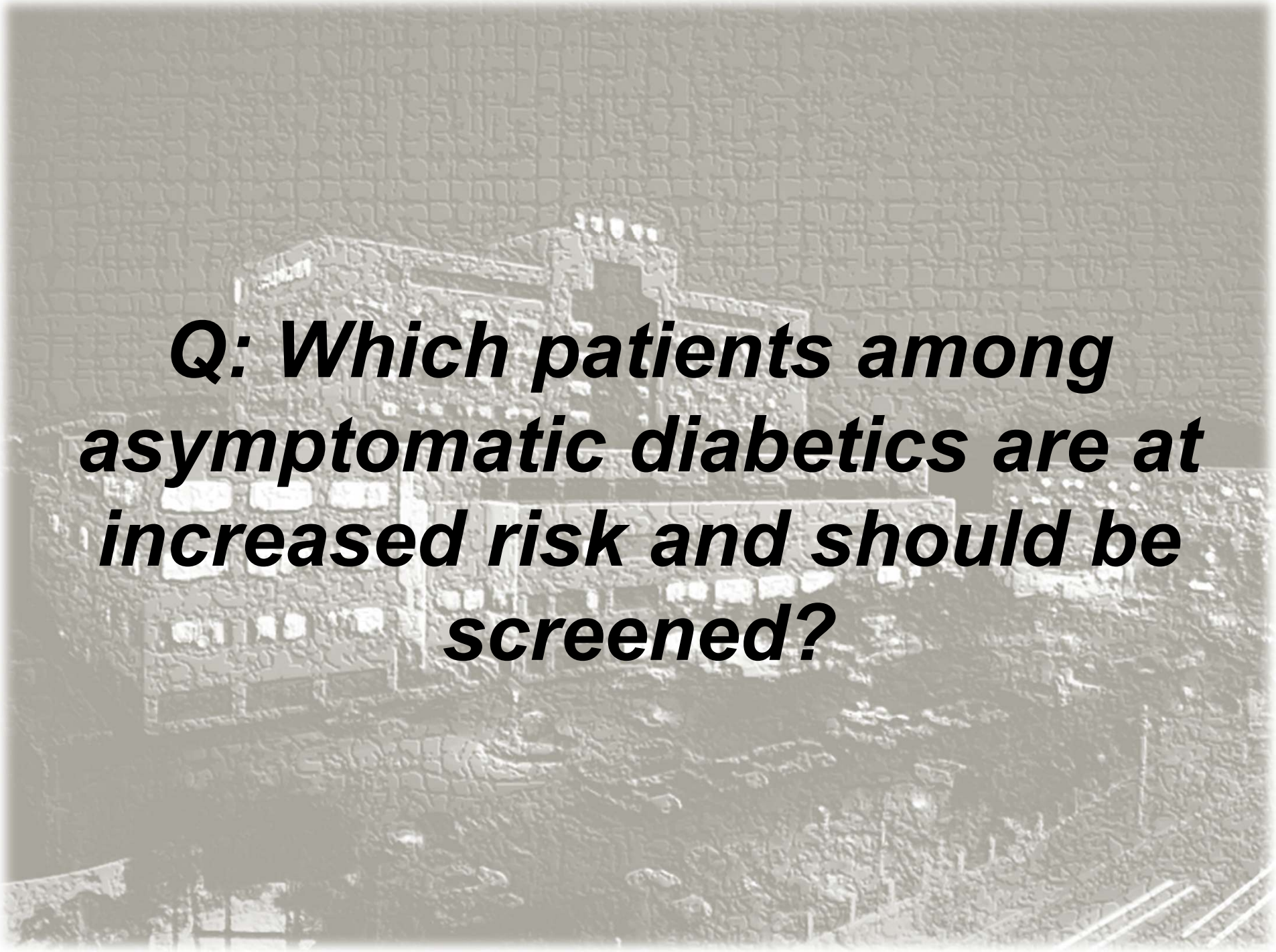


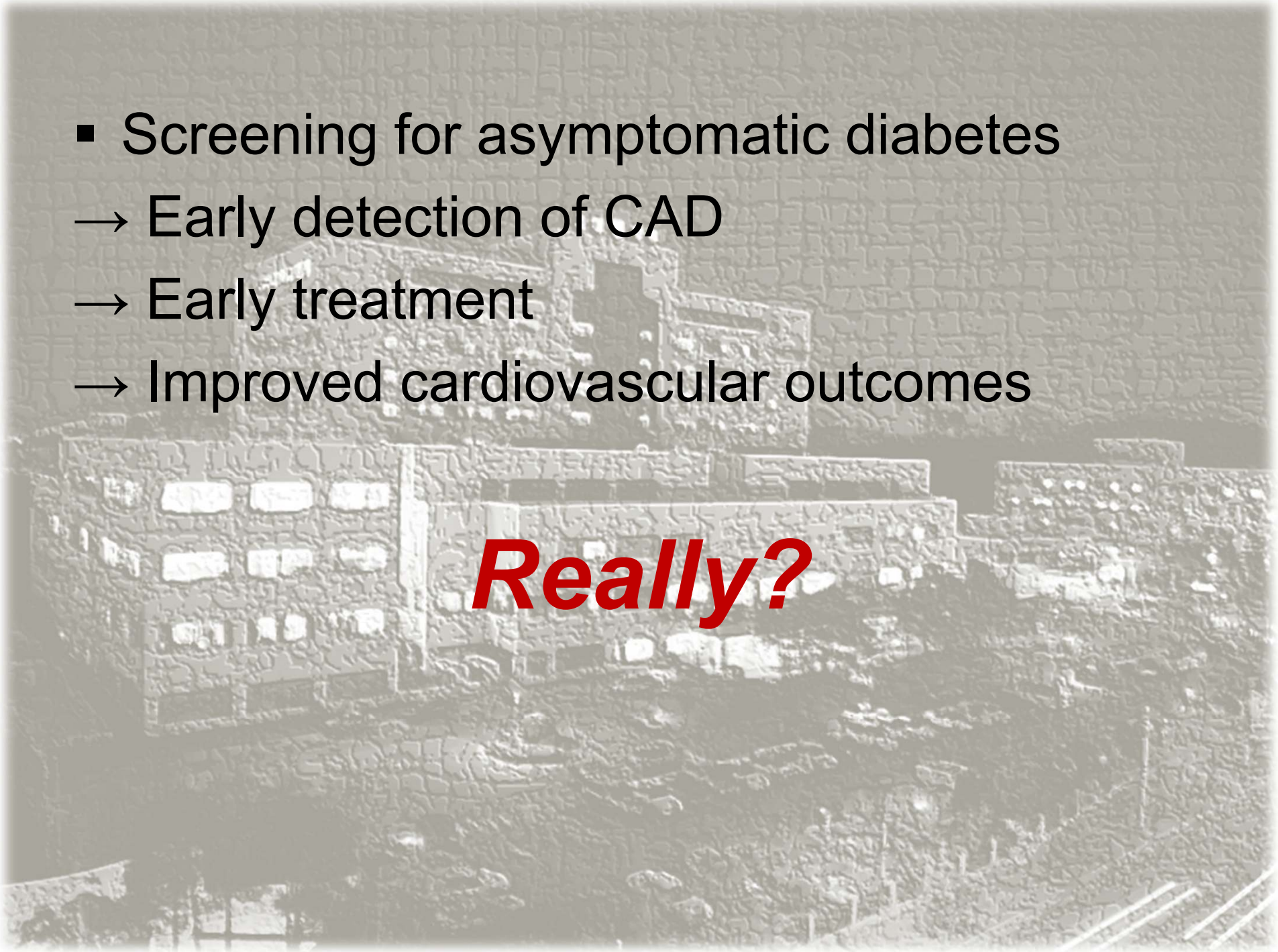
Case

Coronary angiogram

Screening and management for **coronary artery disease (CAD)**

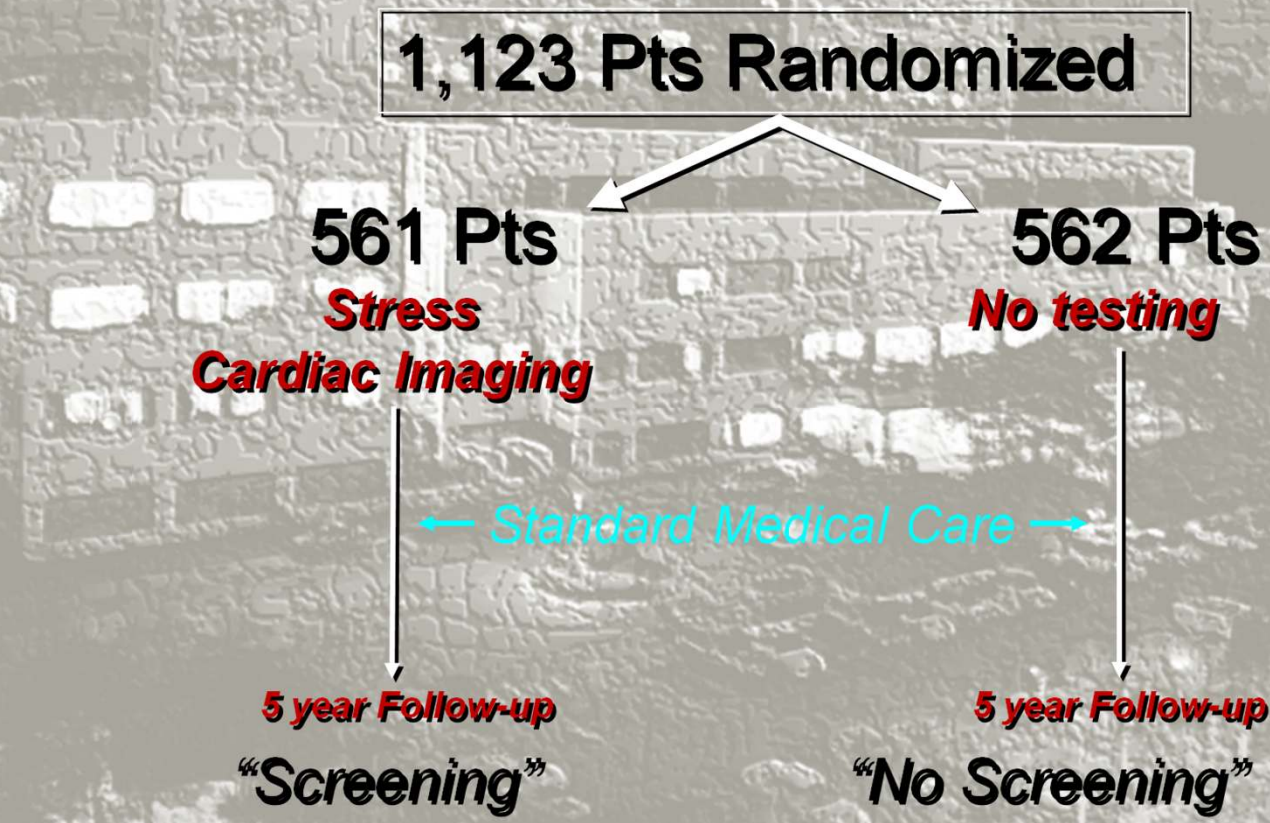
- ***Which patients among asymptomatic diabetics are at increased risk and should be screened?***
- ***What are the implications of an early diagnosis of CAD?***
- ***What tests should be considered?***


Q: Which patients among asymptomatic diabetics are at increased risk and should be screened?


▪ Screening for asymptomatic diabetes
→ Early detection of CAD
→ Early treatment
→ Improved cardiovascular outcomes
Really?

Cardiac outcomes after screening for asymptomatic coronary artery disease in patients with type 2 diabetes: the *DIAD* study

A randomized controlled trial

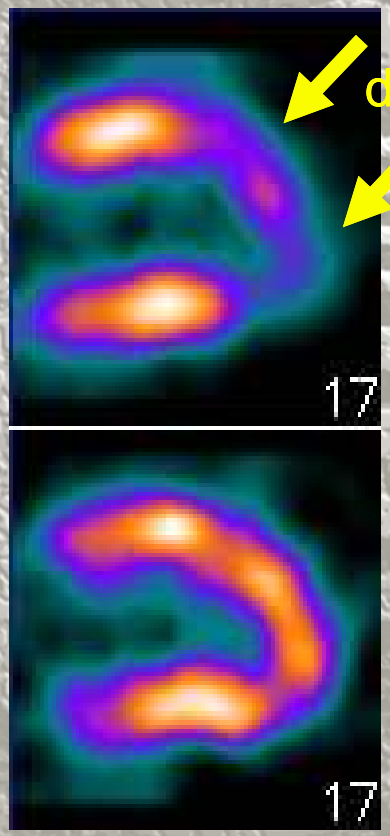


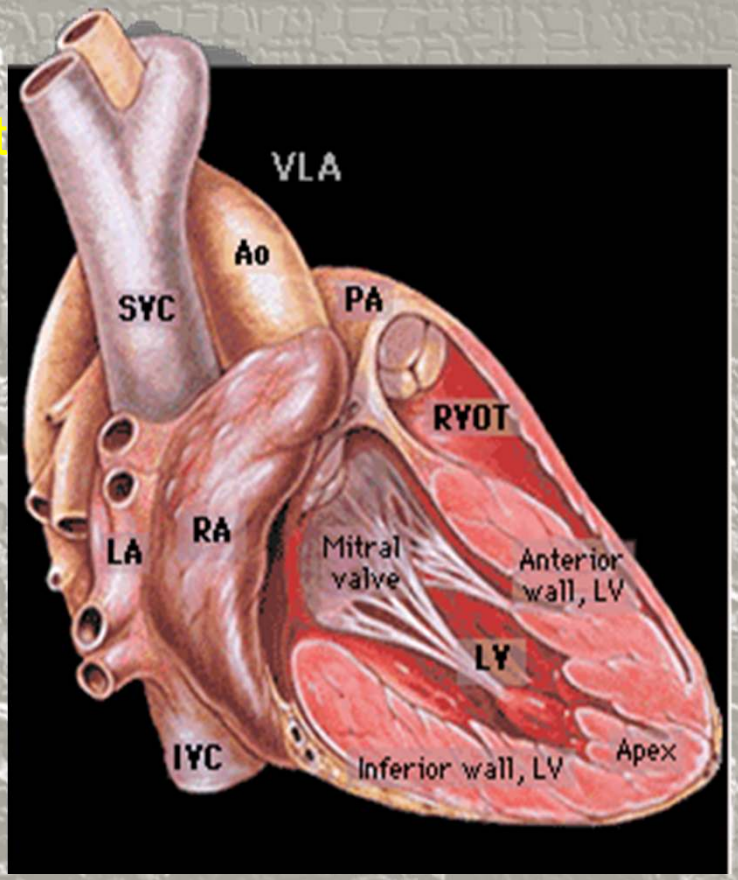
JAMA 2009

Adenosine Stress Perfusion Imaging

Stress

Rest

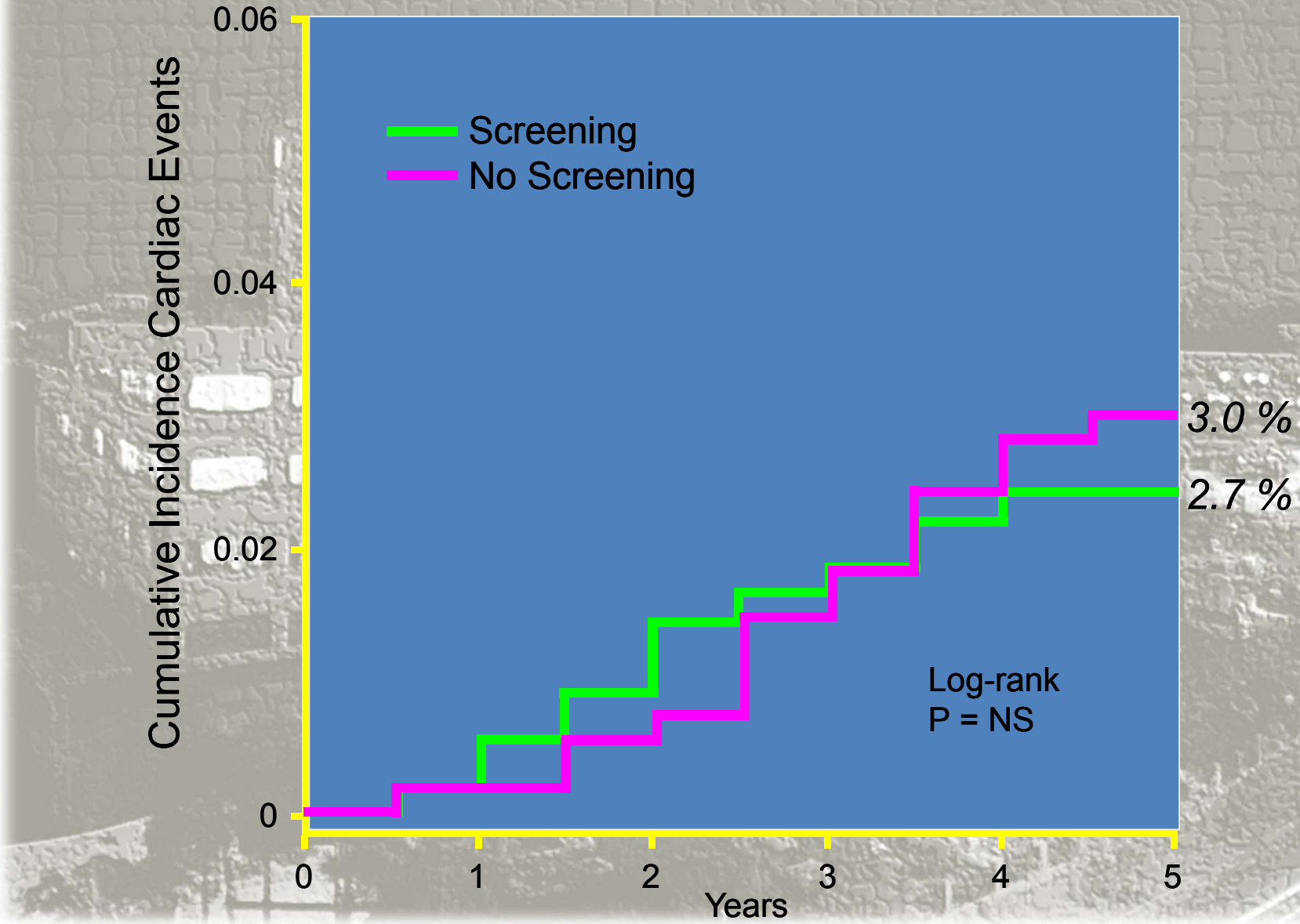




CAD → *Ischemic ECG Changes*

Primary End Point

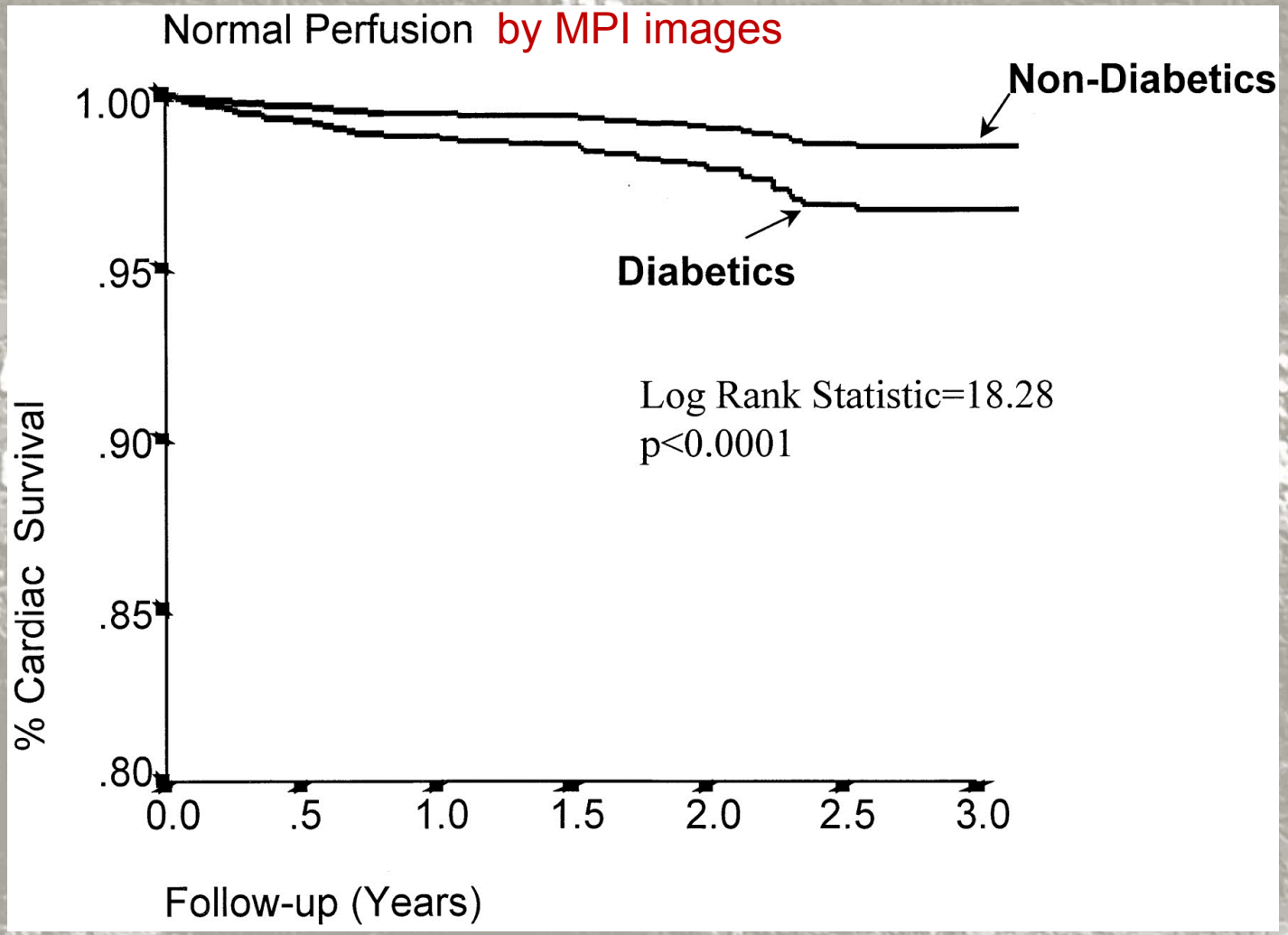
- Cardiac Death and Heart Attacks -



Secondary End Points

	Screening	No Screening	
	n = 561	*n = 562*	*p*
Unstable Angina	4 (0.7%)	3 (0.5%)	*ns*
Heart Failure	7 (1.2%)	7 (1.2%)	*ns*
Stroke	10 (1.8%)	5 (0.9%)	*ns*
Revascularization	31 (5.5%)	44 (7.8%)	*ns*

Impact of Diabetes on the Risk Stratification Using Stress Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging in Patients With Symptoms Suggestive of Coronary Artery Disease

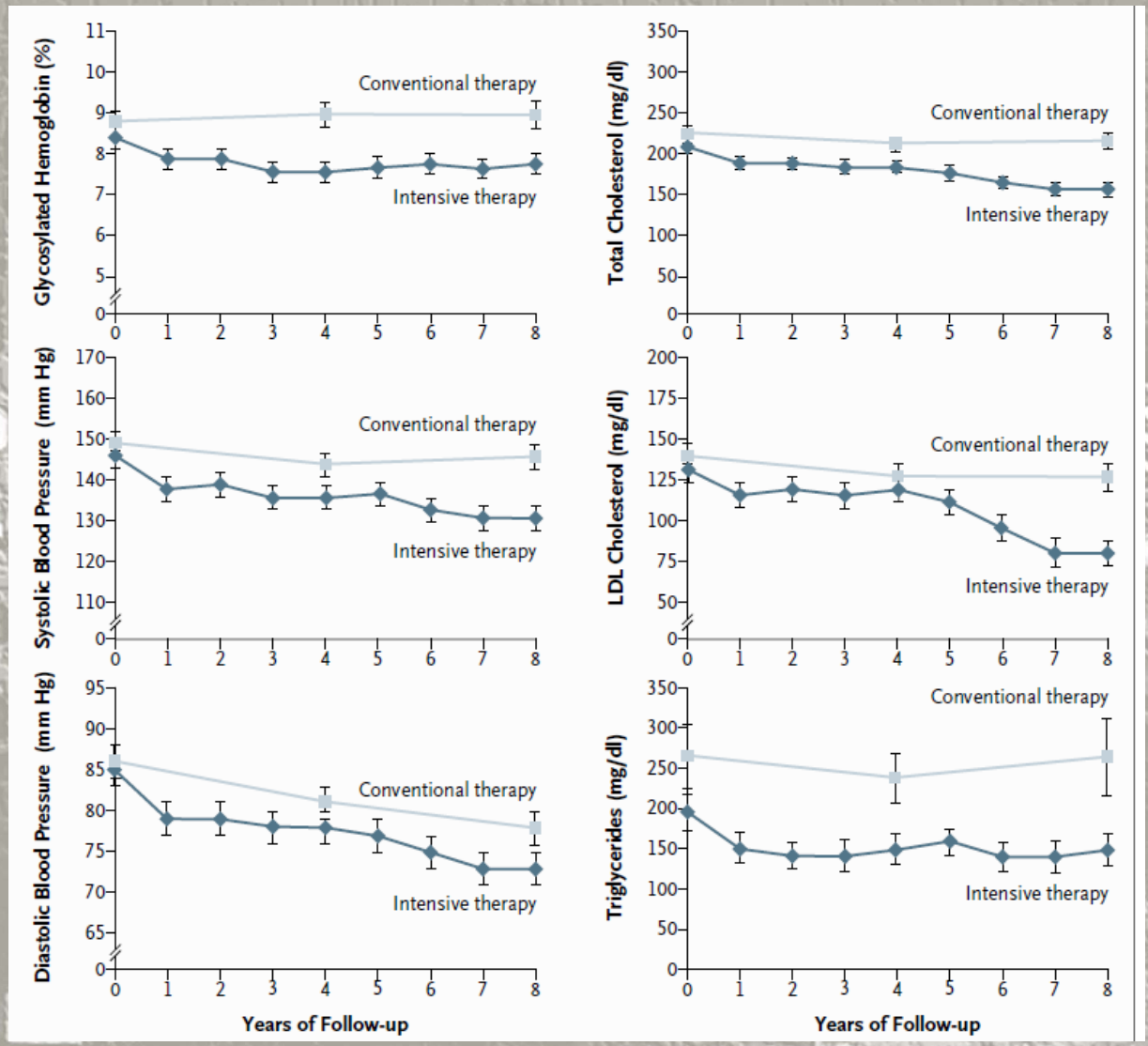


Circulation 2002

Clinical clues identifying diabetic patients with increased risk for CV death

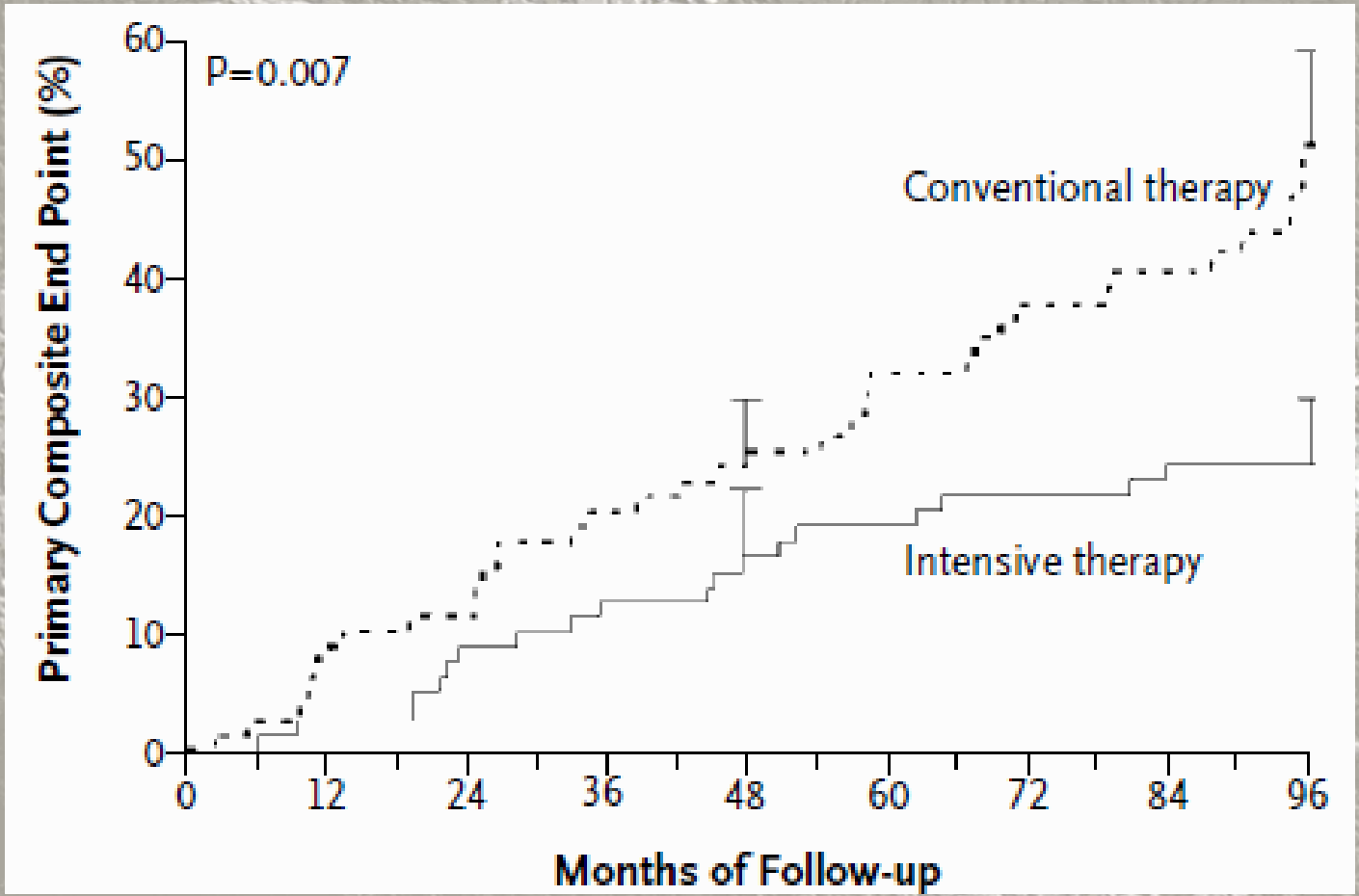
- Atherosclerotic vascular disease
- Renal disease
- Abnormal ECG findings
- Diabetic complications (autonomic neuropathy and retinopathy)
- Hyperglycemia
- Age (>65 y in type 2 diabetes) and sex (male)
- Unexplained dyspnea
- Multiple cardiac risk factors (HTN, dyslipidemia, smoking, obesity, etc.)

Multiple cardiac risk factors in type 2 diabetes increase the CV risk.



NEJM 2003

Multiple cardiac risk factors in type 2 diabetes increase the CV risk.



NEJM 2003

Multiple cardiac risk factors in type 2 diabetes are not associated with inducible ischemia.

Detection of Silent Myocardial Ischemia in Asymptomatic Diabetic Subjects

The DIAD study

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RAYMOND TAILLEFER, MD[5]
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SAMUEL ENGEL, MD[9]
ROBERT E. RATNER, MD[10]
AMI E. ISKANDRIAN, MD[11]
FOR THE DETECTION OF ISCHEMIA IN ASYMPTOMATIC DIABETICS (DIAD)

Traditional and emerging cardiac risk factors were not associated with abnormal stress tests.

OBJECTIVE — To assess the prevalence and clinical predictors of silent myocardial ischemia in asymptomatic patients with type 2 diabetes and to test the effectiveness of current American Diabetes Association screening guidelines.

RESEARCH DESIGN AND METHODS — In the Detection of Ischemia in Asymptomatic Diabetics (DIAD) study, 1,123 patients with type 2 diabetes, aged 50–75 years, with no known or suspected coronary artery disease, were randomly assigned to either stress testing and 5-year clinical follow-up or to follow-up only. The prevalence of ischemia in 522 patients randomized to stress testing was assessed by adenosine technetium-99m sestamibi single-photon emission–computed tomography myocardial perfusion imaging.

RESULTS — A total of 113 patients (22%) had silent ischemia, including 83 with regional myocardial perfusion abnormalities and 30 with normal perfusion but other abnormalities (i.e., adenosine-induced ST-segment depression, ventricular dilation, or rest ventricular dysfunction). Moderate or large perfusion defects were present in 33 patients. The strongest predictors for abnormal tests were abnormal Valsalva (odds ratio [OR] 5.6), male sex (2.5), and diabetes duration (5.2). Other traditional cardiac risk factors or inflammatory and prothrombotic markers were not predictive. Ischemic adenosine-induced ST-segment depression with normal perfusion ($n = 21$) was

CONCLUSIONS — Silent myocardial ischemia occurs in greater than one in five asymptomatic patients with type 2 diabetes. Traditional and emerging cardiac risk factors were not associated with abnormal stress tests, although cardiac autonomic dysfunction was a strong predictor of ischemia.

Diabetes Care 27:1954–1961, 2004

Coronary artery disease (CAD) is the leading cause of death in patients with diabetes (1). Myocardial isch-

Diabetes Care 2004

Q: Which asymptomatic diabetes should be screened for occult CAD?

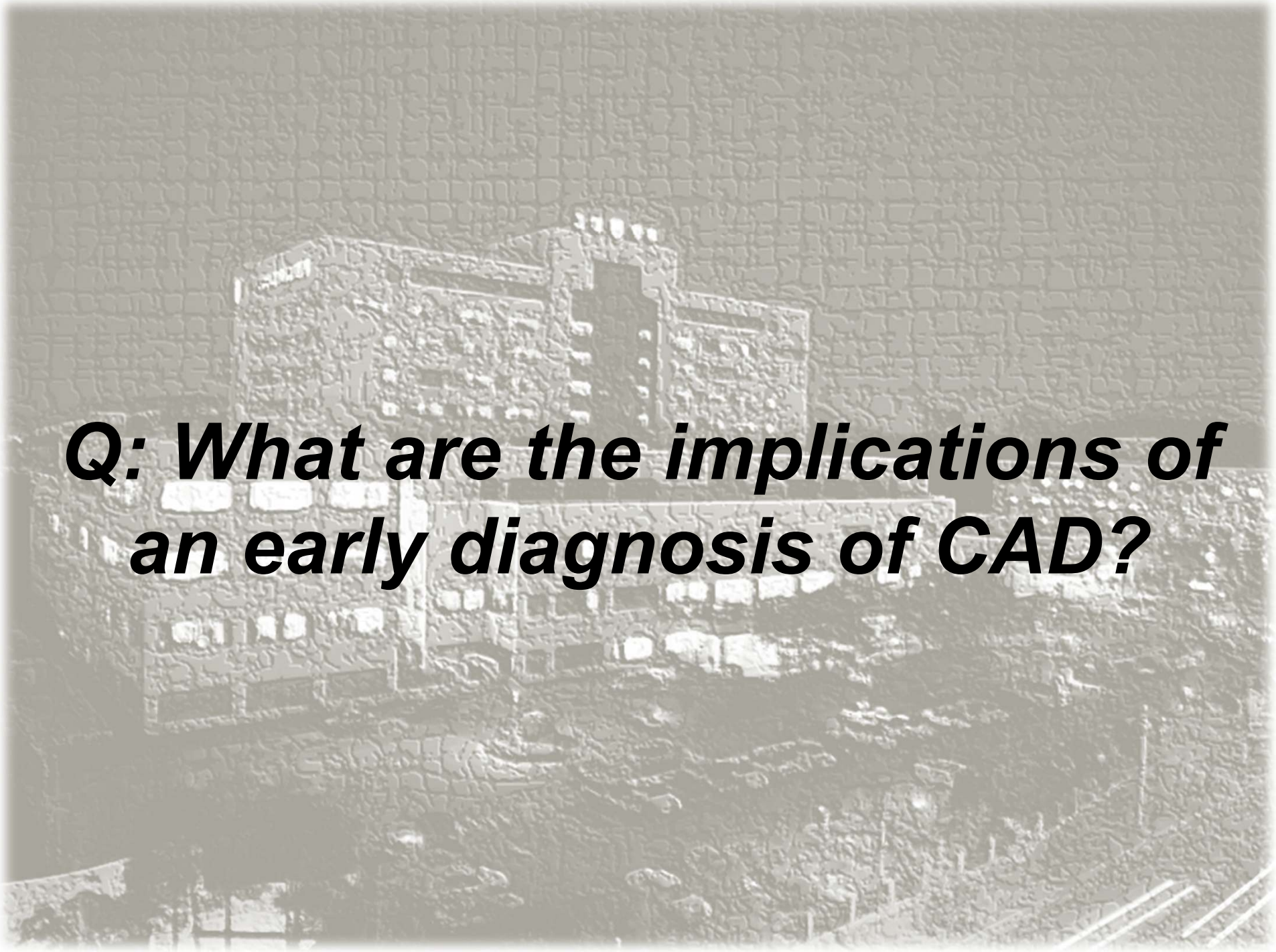
A: "Challenging!"

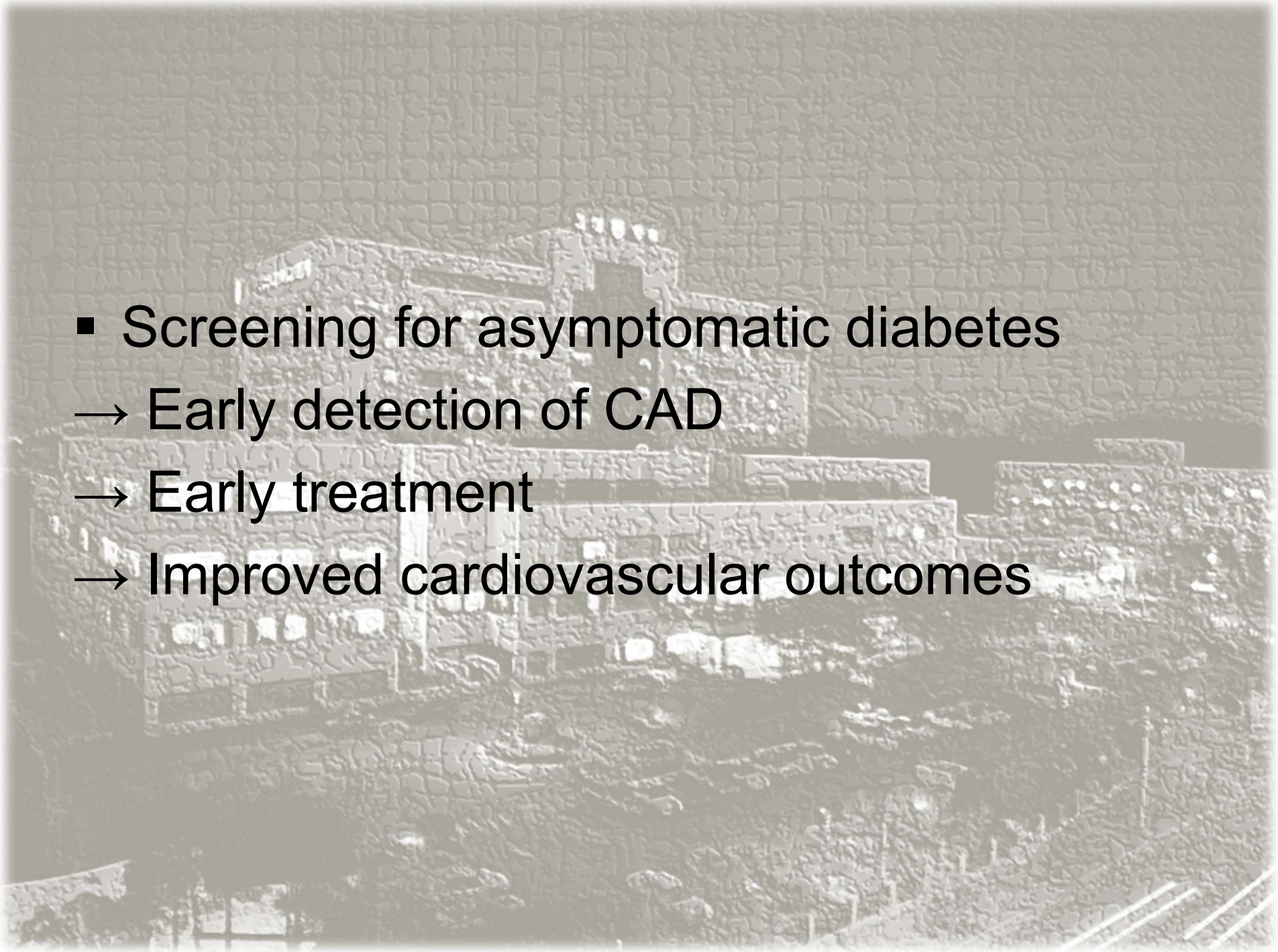
Greater likelihood of CAD in asymptomatic diabetes includes

- ✓ Evidence of PAD
- ✓ DM complications
- ✓ Abnormal ECG
- ✓ Symptoms of dyspnea

2011 ADA recommendation in CAD screening

"In asymptomatic patients, routine screening for CAD is not recommended, as it does not improve outcomes as long as CVD risk factors are treated. (A)"


Q: What are the implications of an early diagnosis of CAD?



- Screening for asymptomatic diabetes

→ Early detection of CAD

→ Early treatment

→ Improved cardiovascular outcomes

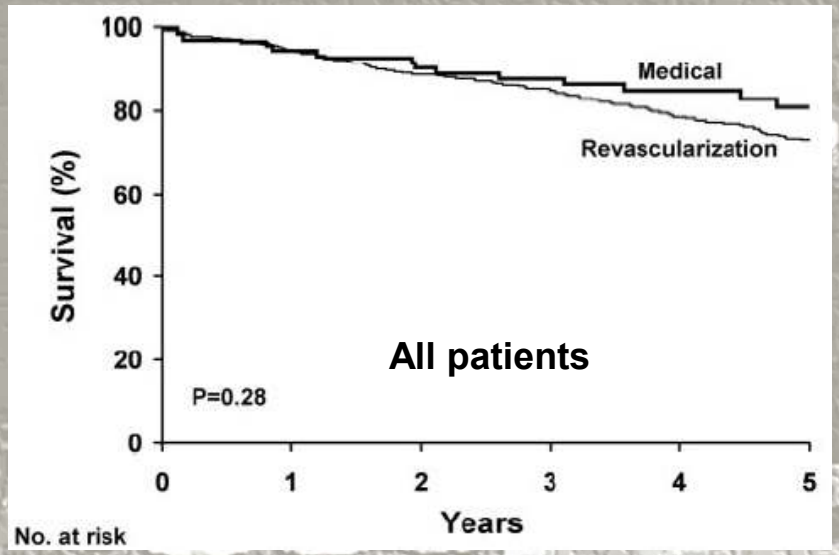
"In all patients with diabetes, cardiovascular risk factors should be assessed at least annually. These risk factors include dyslipidemia, hypertension, smoking, a positive family history of premature coronary disease, and the presence of micro- or macroalbuminuria. Abnormal risk factors should be treated as described elsewhere in these guidelines. Patients at increased CHD risk should receive aspirin and a statin and ACE inhibitor or ARB therapy if hypertensive, unless there are contraindications to a particular drug class."

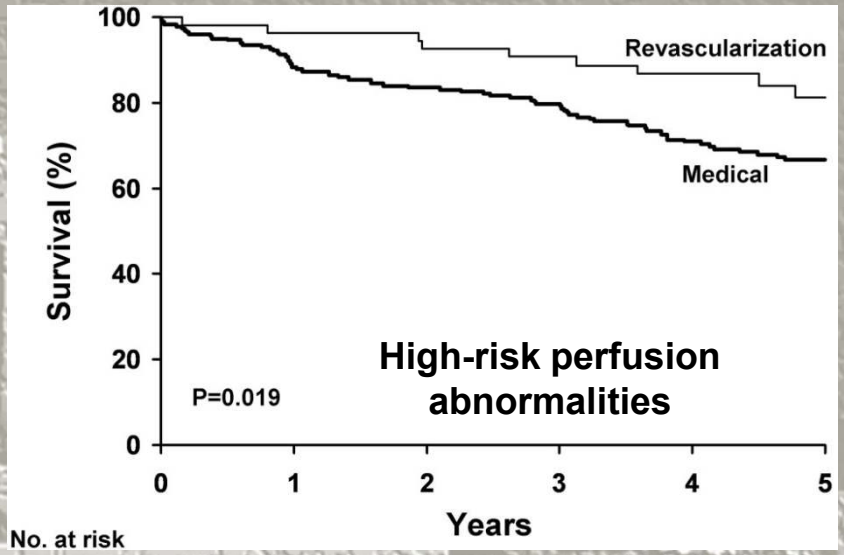
2011 ADA recommendations

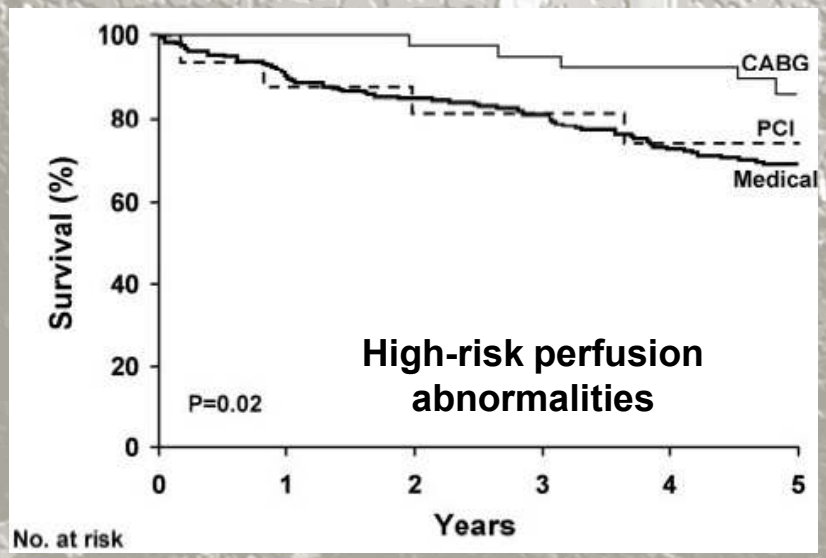
↓

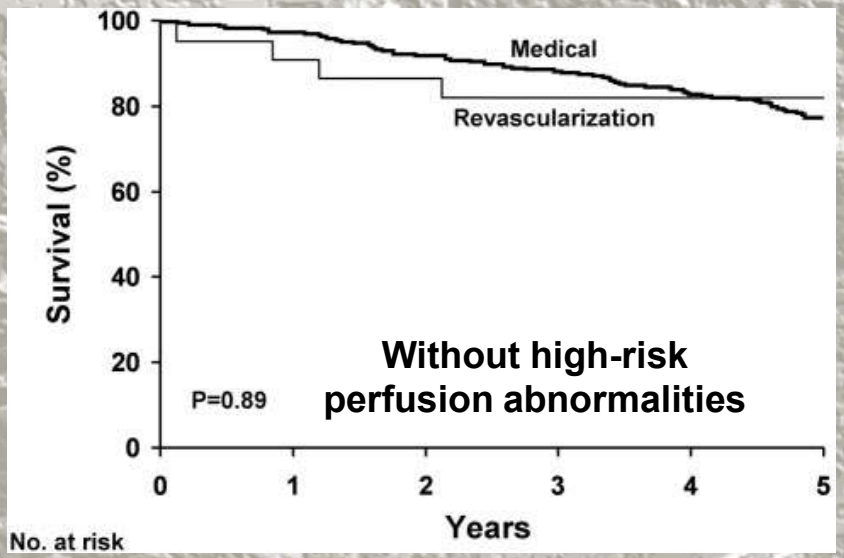
심혈관계 무증상 당뇨환자도 이미
위험인자에 따른 적극적인
약물치료를 받고 있다.

Improved Survival in Asymptomatic Diabetic Patients With High-Risk SPECT Imaging Treated With Coronary Artery Bypass Grafting



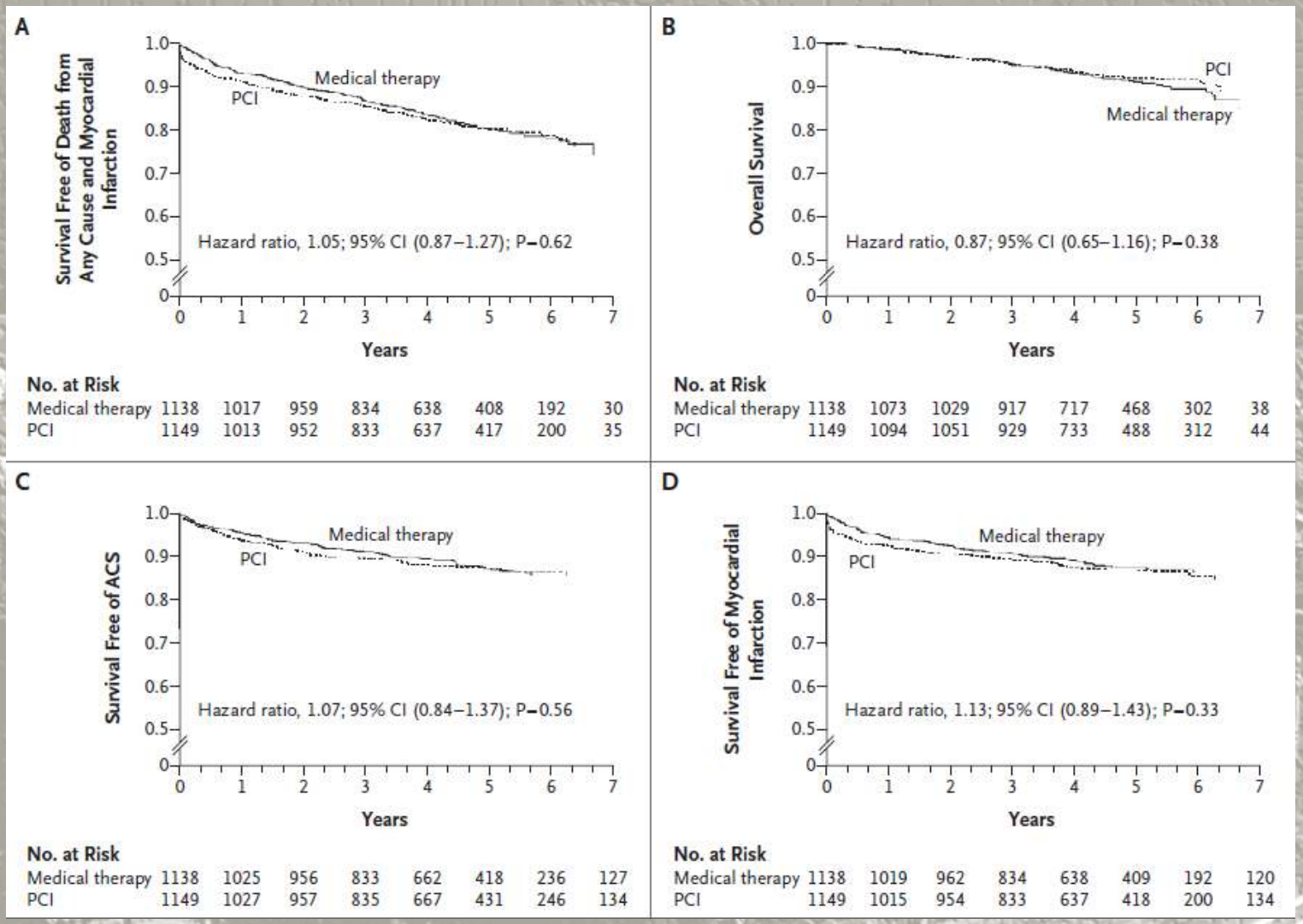






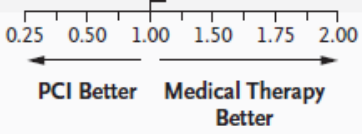
Circulation 2005

Optimal Medical Therapy with or without PCI for Stable Coronary Disease: (COURAGE) trial
- Multivessel or proximal LAD disease -



NEJM 2007

Baseline Characteristics	No. of Patients	Hazard Ratio (95% CI)	Event Rate for the Primary Outcome		P Value
			PCI	Medical Therapy	
Overall	2287	1.05 (0.87–1.27)	0.19	0.19	
Sex					0.03
Male	1947	1.15 (0.93–1.42)	0.19	0.18	
Female	338	0.65 (0.40–1.06)	0.18	0.26	
Myocardial infarction					0.15
Yes	876	0.91 (0.69–1.21)	0.23	0.25	
No	1371	1.22 (0.93–1.60)	0.17	0.14	
Extent of CAD					0.65
Multivessel disease	1581	1.04 (0.84–1.30)	0.21	0.21	
Single-vessel disease	700	1.17 (0.76–1.80)	0.15	0.12	
Smoking					0.71
Current	653	1.00 (0.71–1.41)	0.20	0.21	
Not current	1631	1.08 (0.86–1.36)	0.19	0.18	
Diabetes					0.33
Yes	766	0.99 (0.73–1.32)	0.25	0.24	
No	1468	1.20 (0.92–1.56)	0.17	0.15	
CCS angina class					0.73
0 or I	964	1.01 (0.75–1.38)	0.17	0.20	
II or III	1371	1.09 (0.85–1.40)	0.20	0.18	
Ejection fraction					0.72
≤50%	406	1.14 (0.77–1.70)	0.28	0.26	
>50%	1848	1.05 (0.84–1.32)	0.17	0.16	
Age					0.62
>65 yr	904	1.10 (0.83–1.46)	0.24	0.22	
≤65 yr	1381	1.00 (0.77–1.32)	0.16	0.16	
Previous CABG					0.81
No	2039	1.04 (0.84–1.29)	0.17	0.17	
Yes	248	0.98 (0.52–1.82)	0.34	0.29	
Race					0.43
White	1963	1.08 (0.87–1.34)	0.19	0.18	
Nonwhite	322	0.87 (0.54–1.42)	0.19	0.24	
Health care system					0.17
Canadian	932	1.27 (0.90–1.78)	0.17	0.14	
U.S. non-VA	387	0.71 (0.44–1.14)	0.15	0.21	
U.S. VA	968	1.06 (0.80–1.38)	0.22	0.22	



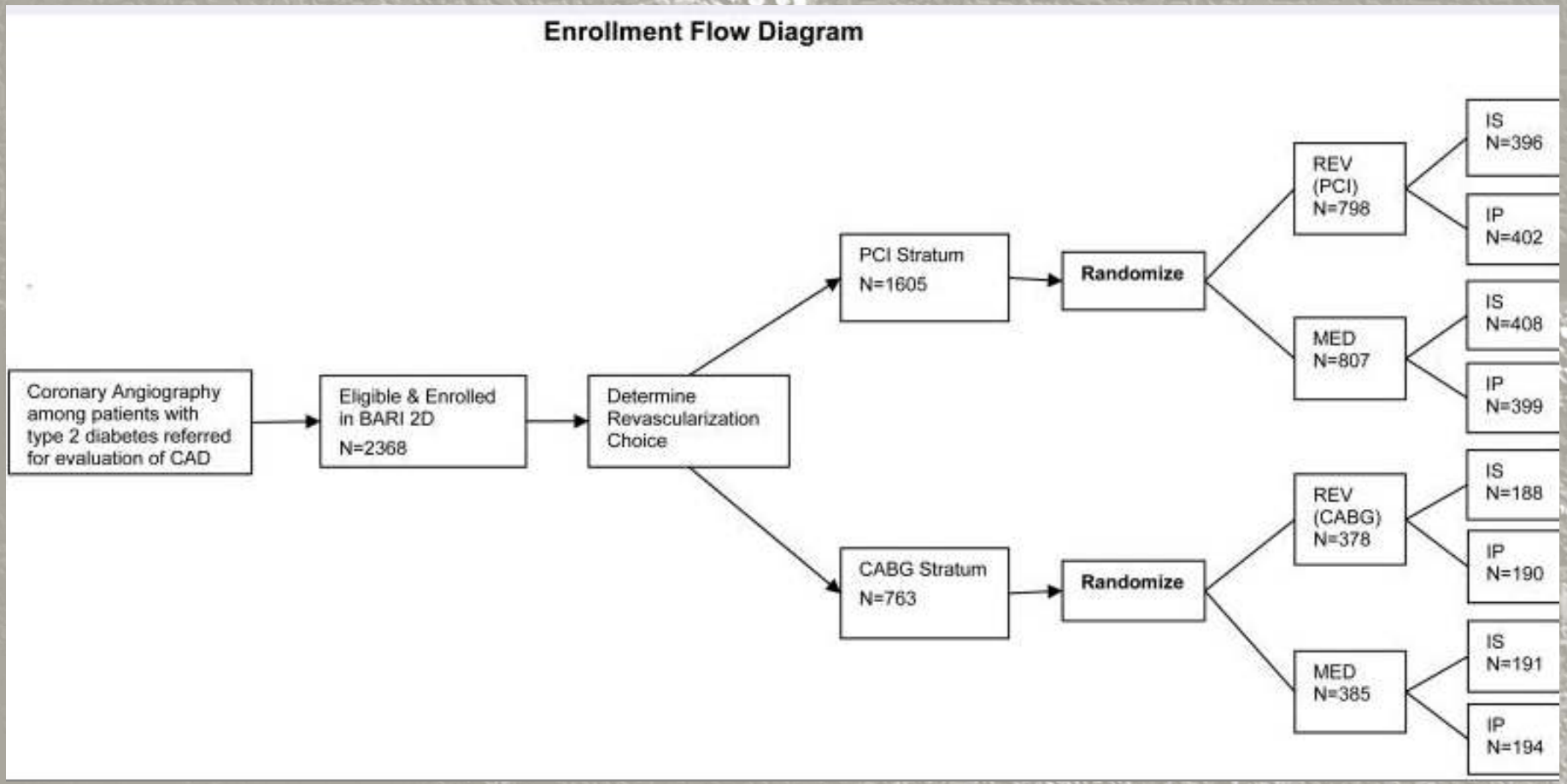
NEJM 2007

Q: What are the implications of an early diagnosis of CAD?

Before the era of BARI 2D trial results

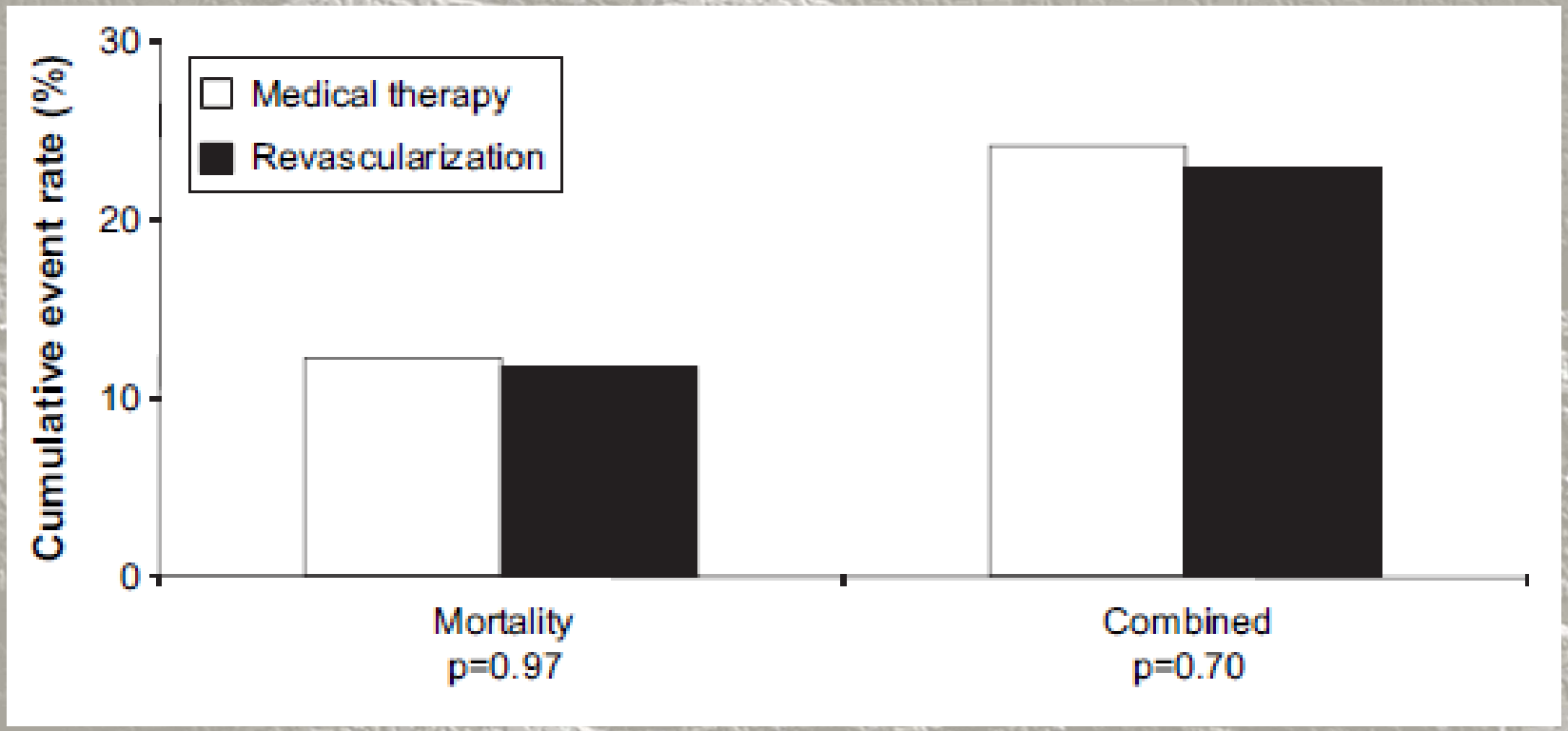
A: It is likely that asymptomatic diabetes with very high CAD risk may benefit from screening and early revascularization.

A randomized trial of therapies for type 2 diabetes and coronary artery disease : BARI 2D trial



NEJM 2009

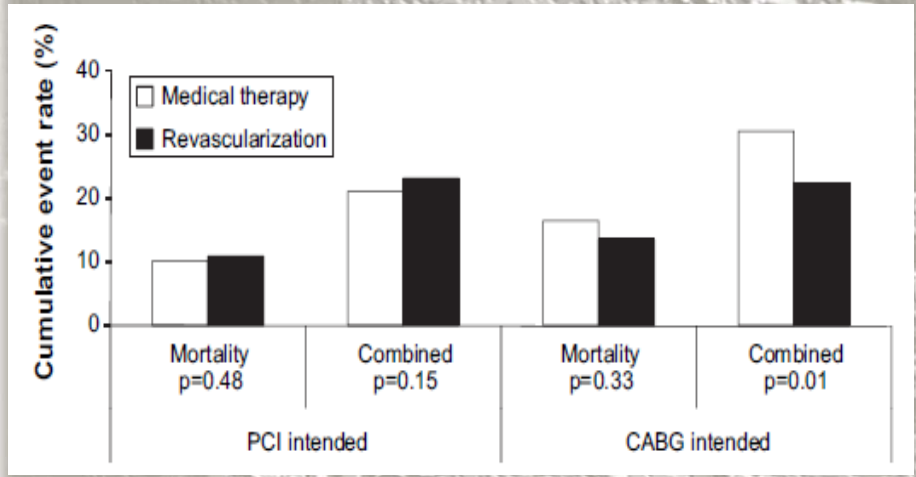
A randomized trial of therapies for type 2 diabetes and coronary artery disease : BARI 2D trial



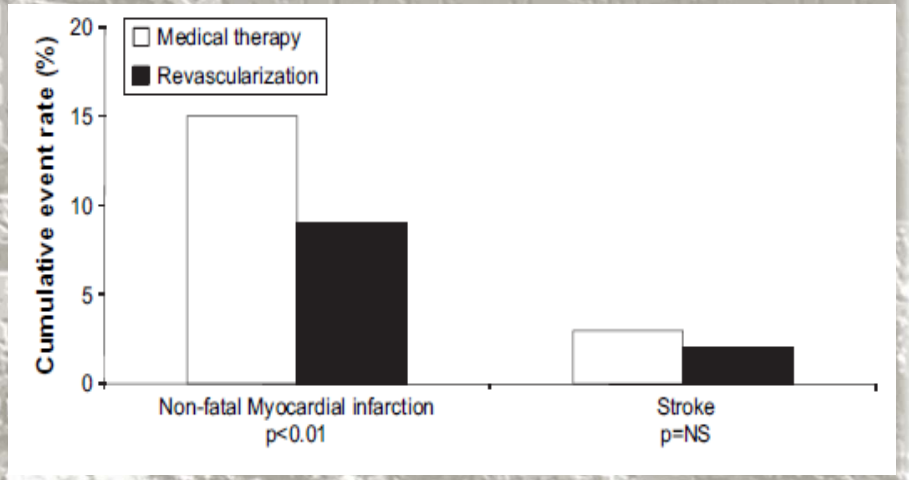
5-year rates of mortality or the combined outcome of death/myocardial infarction/stroke in prompt revascularisation and medical therapy groups

NEJM 2009
Heart 2012

A randomized trial of therapies for type 2 diabetes and coronary artery disease : BARI 2D trial



5-year rates of mortality or the combined outcome of death/ myocardial infarction/stroke in PCI (lower risk) and CABG (higher risk)



Cardiovascular event rates in CABG revascularisation or medical therapy allocation.

NEJM 2009
Heart 2012

A randomized trial of therapies for type 2 diabetes and coronary artery disease : BARI 2D trial

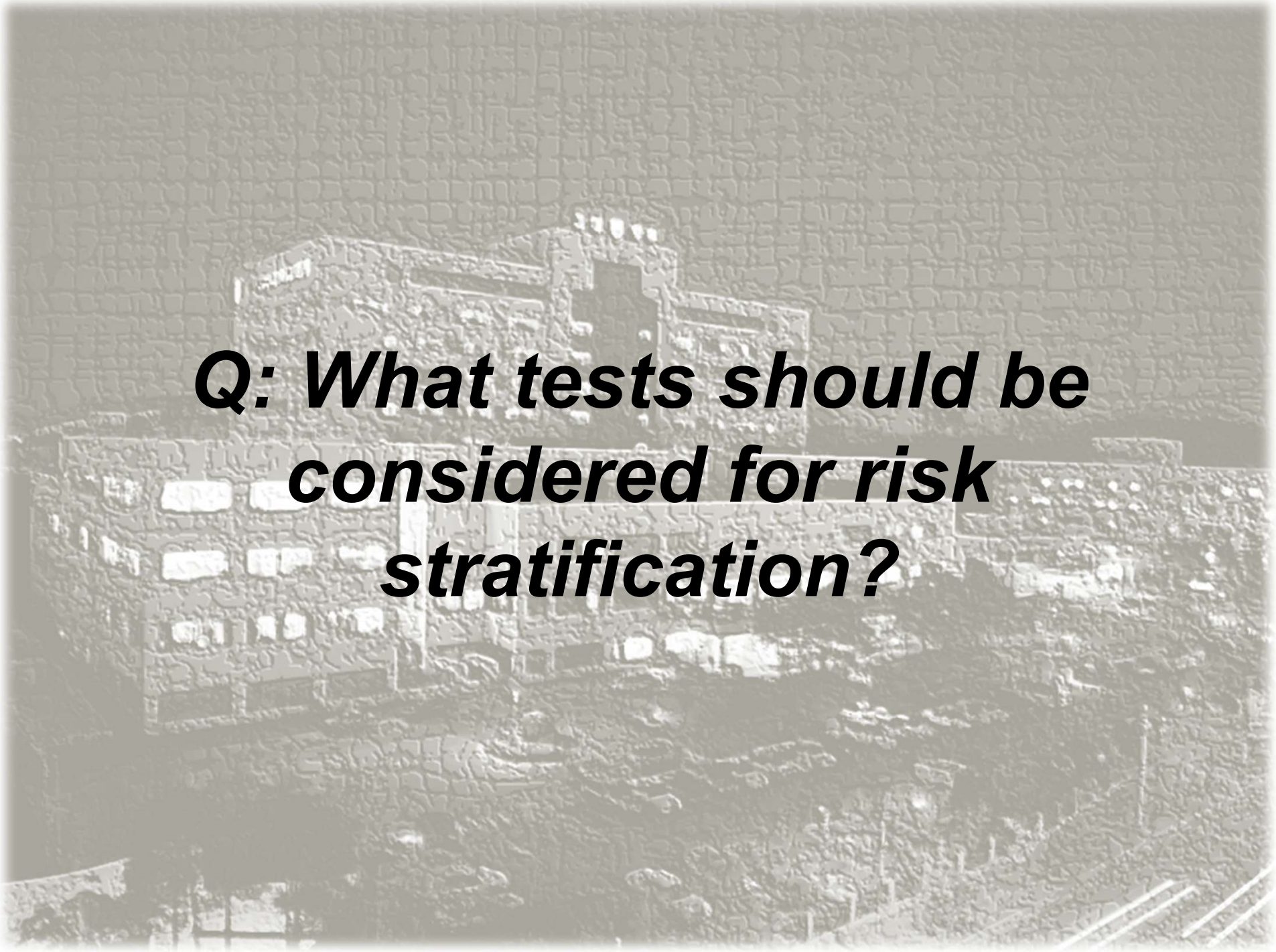
Limitations of BARI 2D

- Only moderate or stable symptoms and/or moderate angiographic CAD
- Lower rates of drug eluting stent use (1/3)
- Medical therapy group should be considered a ‘delayed or no revascularization’ group.

Cardiology implications of BARI 2D

In patients with both type 2 DM and stable CAD with documented ischemia

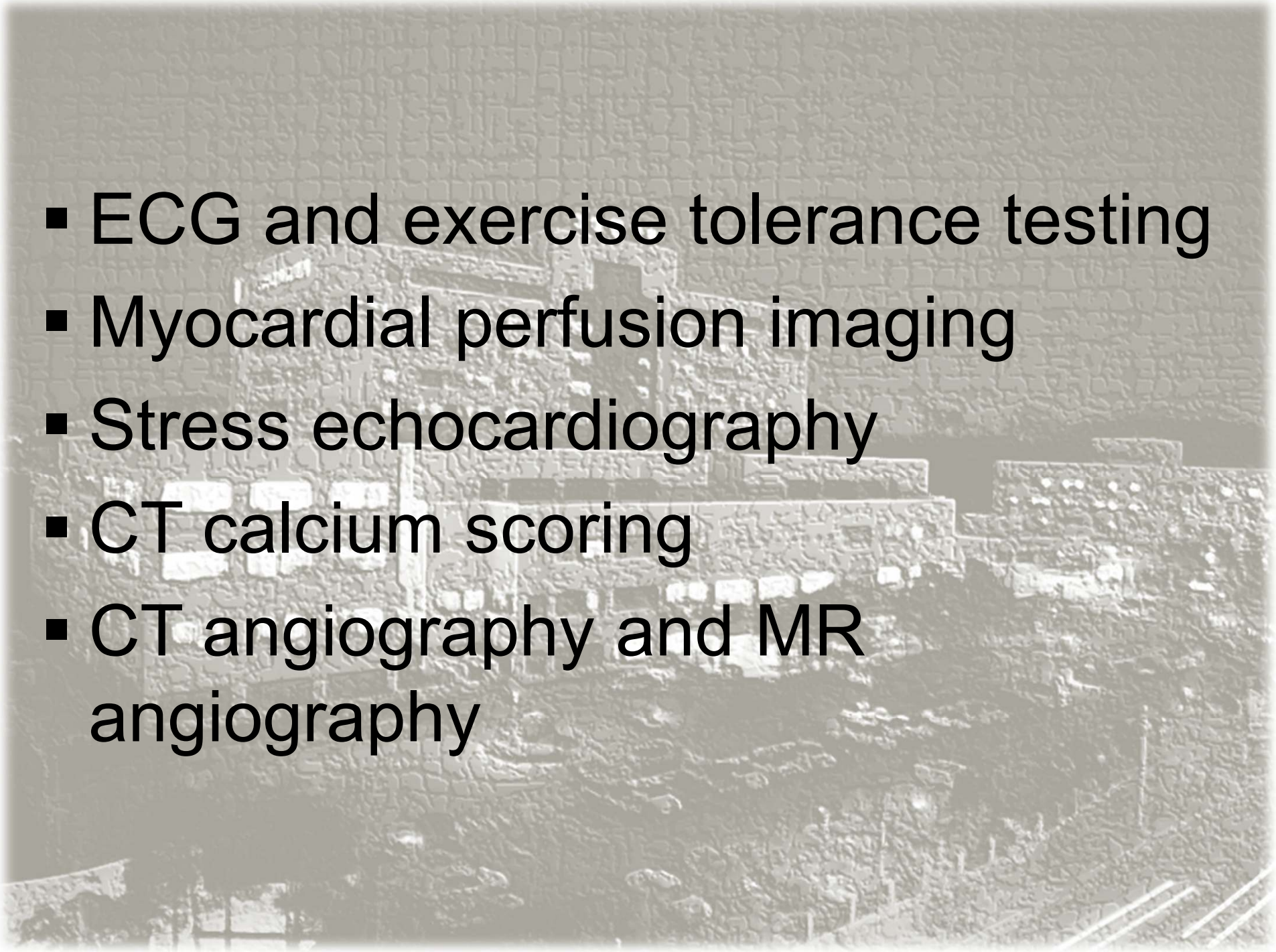
- Extensive multi-vessel CAD (high risk) - CABG
- Less extensive CAD (low risk) – medical therapy until revascularization


Q: What tests should be considered for risk stratification?

Characteristics of 14 guidelines on imaging of asymptomatic CAD

Guideline Identifier, Year (Ref. #)	Organization(s) Responsible for Guideline Development	Country Applied	AGREE Rigor Score, %	Conflicts of Interest	Proportion of Panel Members With Reported Industry Relationships
USPSTF1, 2004 (11)	U.S. Preventive Services Task Force	United States	93	EI, DIRp	—
USPSTF2, 2009 (12)	U.S. Preventive Services Task Force	United States	90	EI, SCI	0/23
NZGG, 2003 (13)	New Zealand Guidelines Group	New Zealand	79	EI, FPO, SCI,* DIRp	9/35
AHA1, 2008 (14)	American Heart Association	United States	76	SCI,* DIR, SCIR	8/11
ACCF1, 2007 (15)	American College of Cardiology Foundation, American Heart Association	United States	74	SCI,* DIR, SCIR*	4/14
CCS1, 2009 (10)	Canadian Cardiovascular Society	Canada	59	SCI*	20/23
AHA2, 2006 (8)	American Heart Association	United States	57	SCI,* DIR, SCIR*	1/4
AHA3, 2005 (9)	American Heart Association	United States	57	SCI,* DIR, SCIR*	6/12
NCEP, 2002, 2004 update (16,17)	National Heart, Lung, and Blood Institute, American College of Cardiology Foundation, and American Heart Association	United States	52	SCI,* DIR	6/28
CAR, 2009 (18)	Canadian Association of Radiologists	Canada	36	—	—
CCS2, 2009 (19)	Canadian Cardiovascular Society	Canada	31	SCI*	1/13
ACCF2, 2009 (20)	American College of Cardiology Foundation, et al.	United States	24	SCI,* DIRp, SCIR*	13/29
ACCF3, 2008 (21)	American College of Cardiology Foundation, et al.	United States	21	SCI,* DIRp, SCIR*	15/23
ACCF4, 2006 (22)	American College of Cardiology Foundation, et al.	United States	21	SCI,* DIRp, SCIR*	11/25

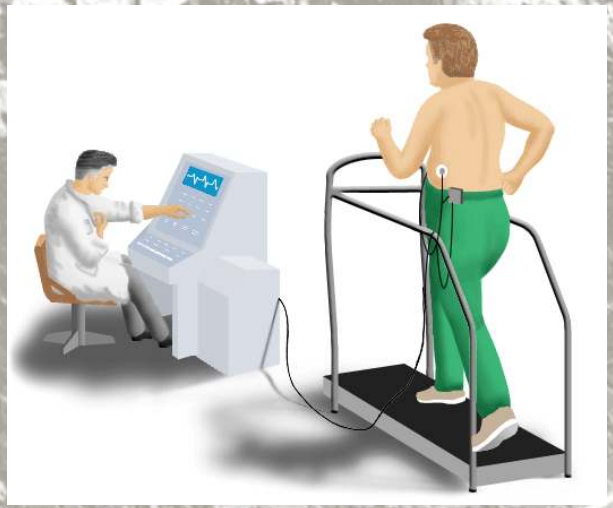
8/14 → against or insufficient evidence for screening of asymptomatic CAD
6/14 → in those with intermediate or high risk (based on 10-yr Framingham risk)


ECG and exercise tolerance testing
Myocardial perfusion imaging
Stress echocardiography
CT calcium scoring
CT angiography and MR angiography

ECG and exercise tolerance testing

- ECG – in a low-risk population, only in 1 guideline
- Stress ECG – in 4 guidelines
- Inconclusive in 3 guidelines

- Relatively inexpensive and widely available
- Low in sensitivity and positive predictive value

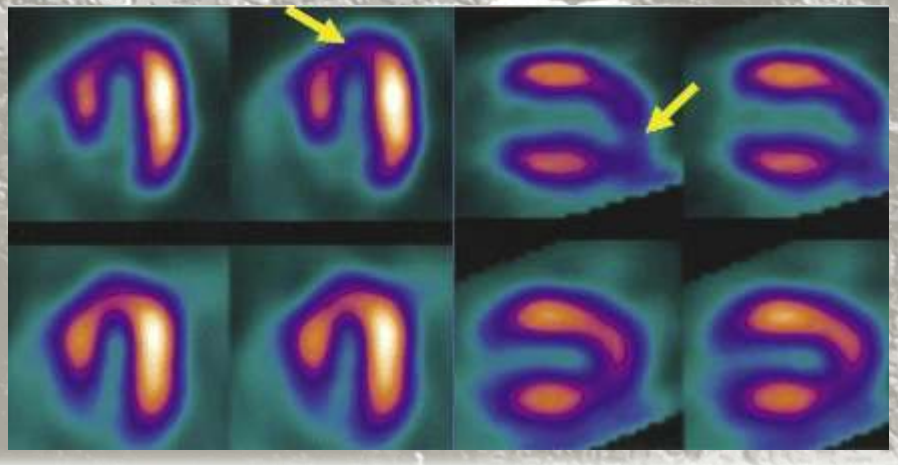


Myocardial perfusion imaging

- SPECT in 3 guidelines
- PET in 2 guidelines
- AHA (2006)

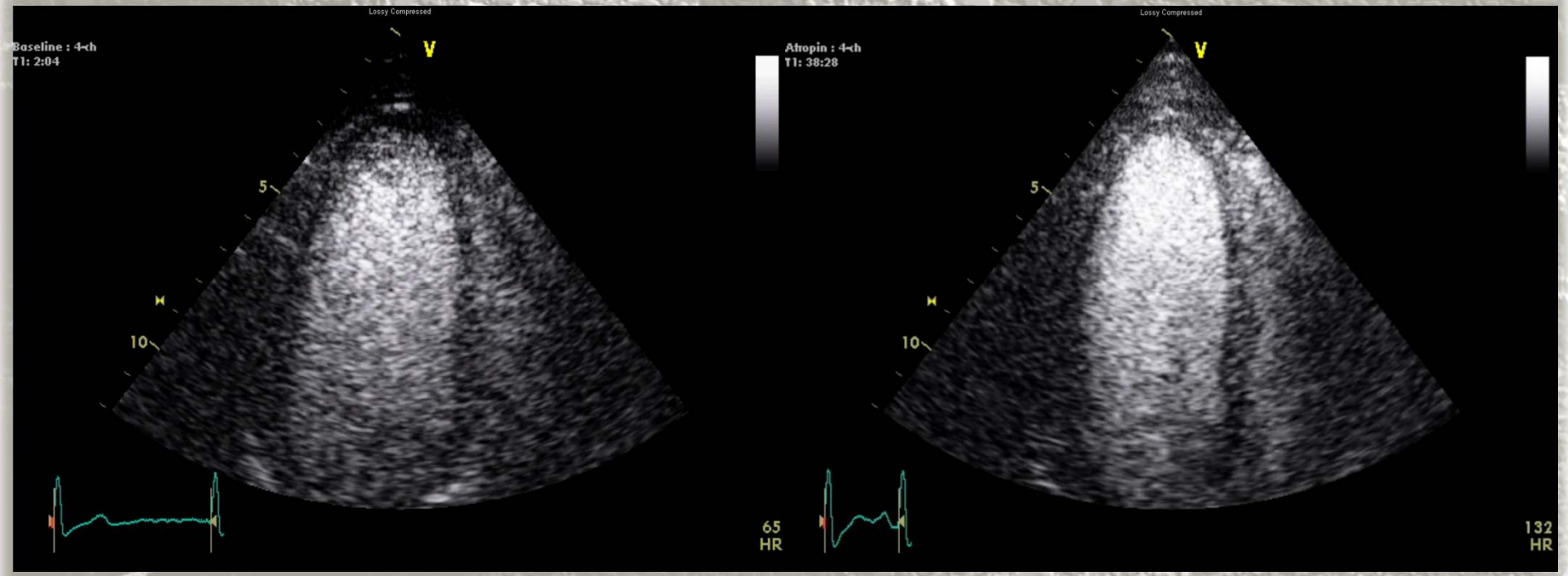
  : against any use of MPI in asymptomatic patients
- NCEP (2002, 2004) & ACCF (2009)

  : either for intermediate-risk or solely for those at high risk



Stress echocardiography

- Only in 1 guideline
- For those at high risk
- Limited data in type 2 DM patients

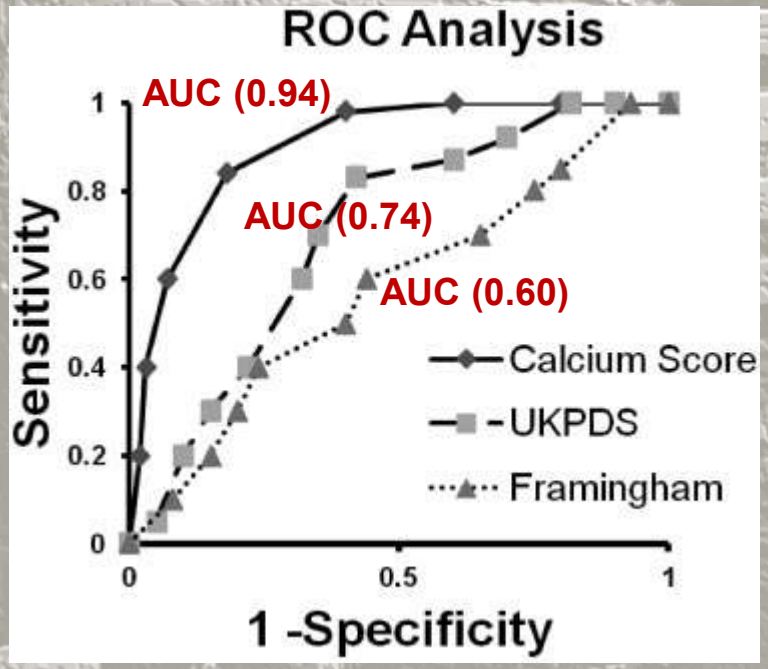


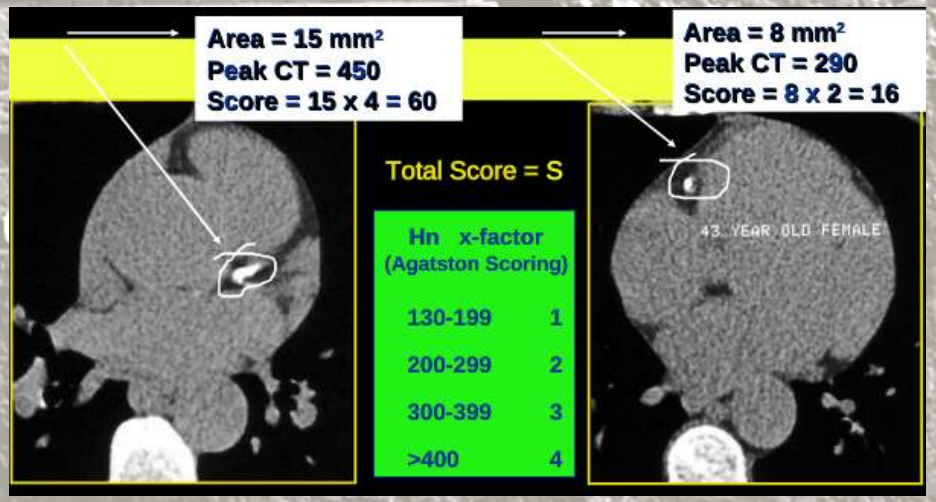
Baseline

Peak

CT calcium scoring

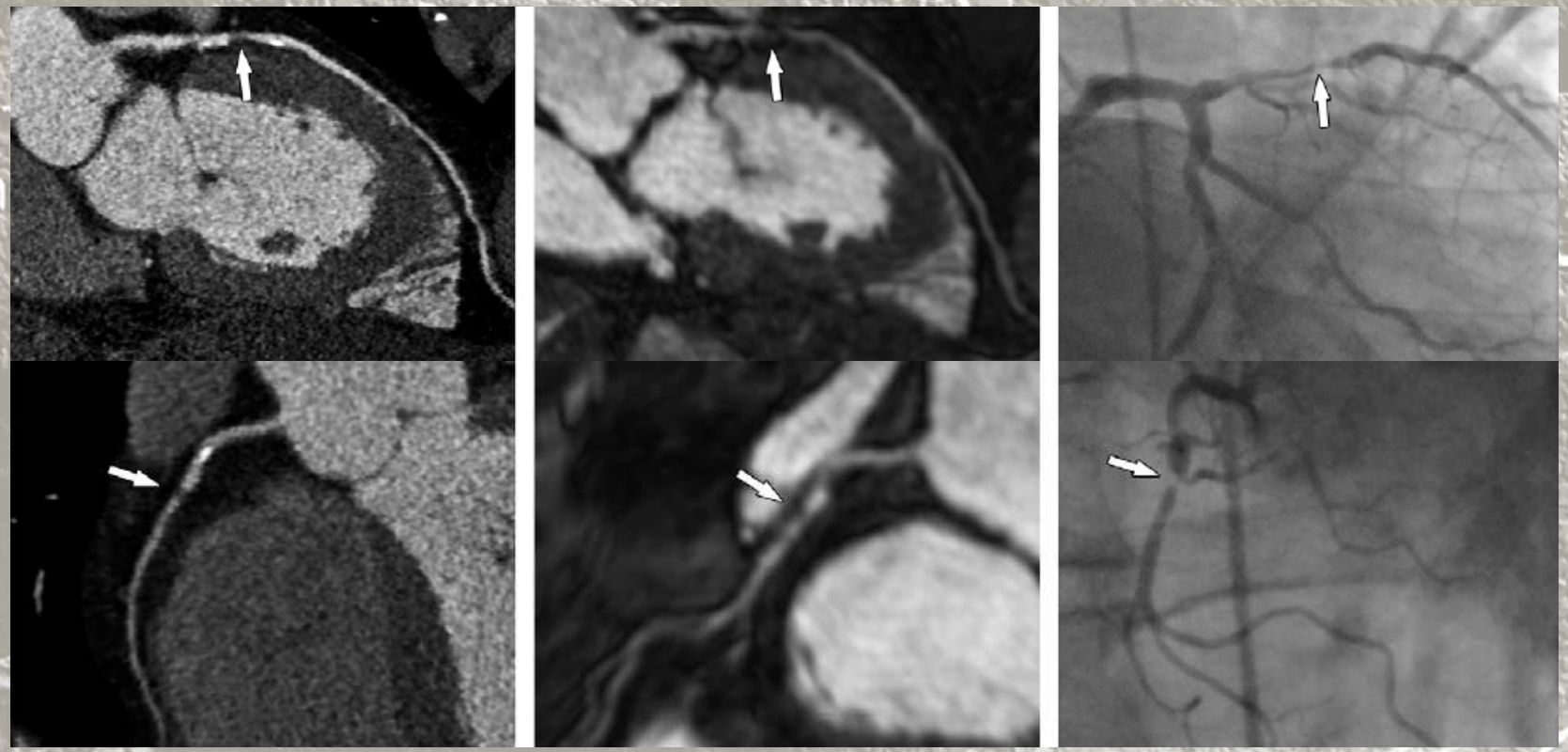
- In most guidelines (10/14)
- Solely in an intermediate CAD risk population
- Superior at predicting future events





CT angiography and MR angiography

- In 4 guidelines, but none of these guidelines advocated their use.
- Insufficient data in asymptomatic type 2 DM



CT angiography and MR angiography

Advantages and Disadvantages of Coronary CT and MR Angiography

Favorability	CT Angiography	MR Angiography
Advantages		
Time, preference, and comprehensive assessment	Shorter total examination time and preferred by patients	Allows combined assessment of function, perfusion, and viability in the same session*
Radiation exposure	Single breath-hold of only 8–10 sec†	No radiation exposure or use of iodinated contrast agent‡
Resolution	Higher spatial resolution	Better temporal resolution
Disadvantages		
Diagnostic problems and contraindications	Calcifications can lead to overestimation of stenosis	Contraindicated in patients with pacemakers and shrapnel located in biologically sensitive areas
Contrast agent use and cost	Use of iodinated contrast agent (60–100 mL)§	Higher costs and less widely available

Radiology 2011

Diagnostic test	Sensitivity (%)	Specificity (%)
Exercise ECG	61	70
Stress echocardiography	79	87
Single-photon emission CT	88	73
Positron emission tomography	91	89
Positron emission tomography/CT	85	83
CT coronary angiography	98	93

Heart 2011

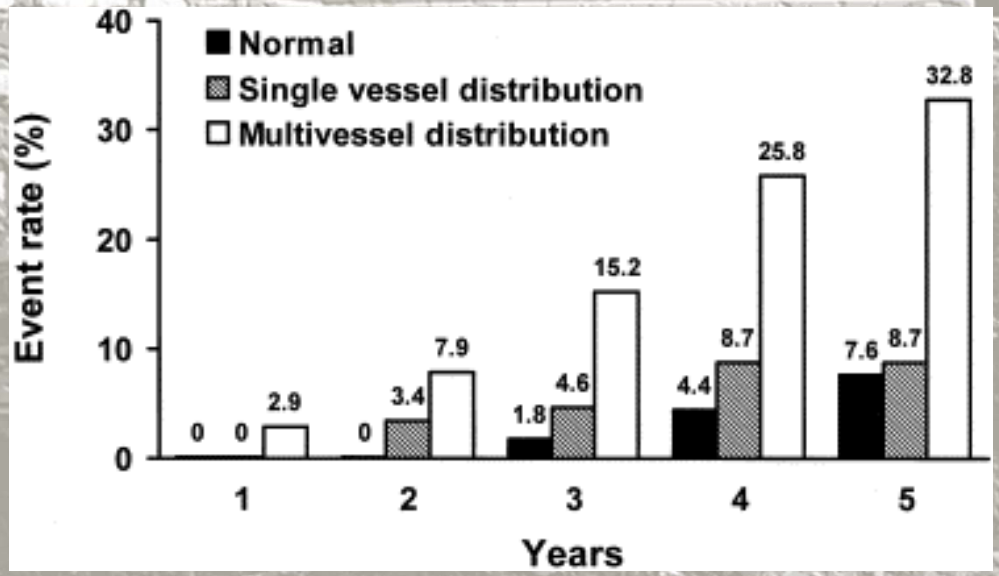
Q: What tests should be considered for risk stratification?

- Guidelines on risk assessment by imaging of asymptomatic CAD give conflicting recommendations.
- Guidelines recommend to consider testing of asymptomatic CAD for those with either at *intermediate risk (?)* or high risk for having a CAD.
- Even though the CAD asymptomatic DM patient is at intermediate risk, routine screening for CAD is not supported.
- The majority of guidelines support the use of coronary CT calcium scoring.

Q: When is the timing of serial imaging assessment in patients with initially normal tests?

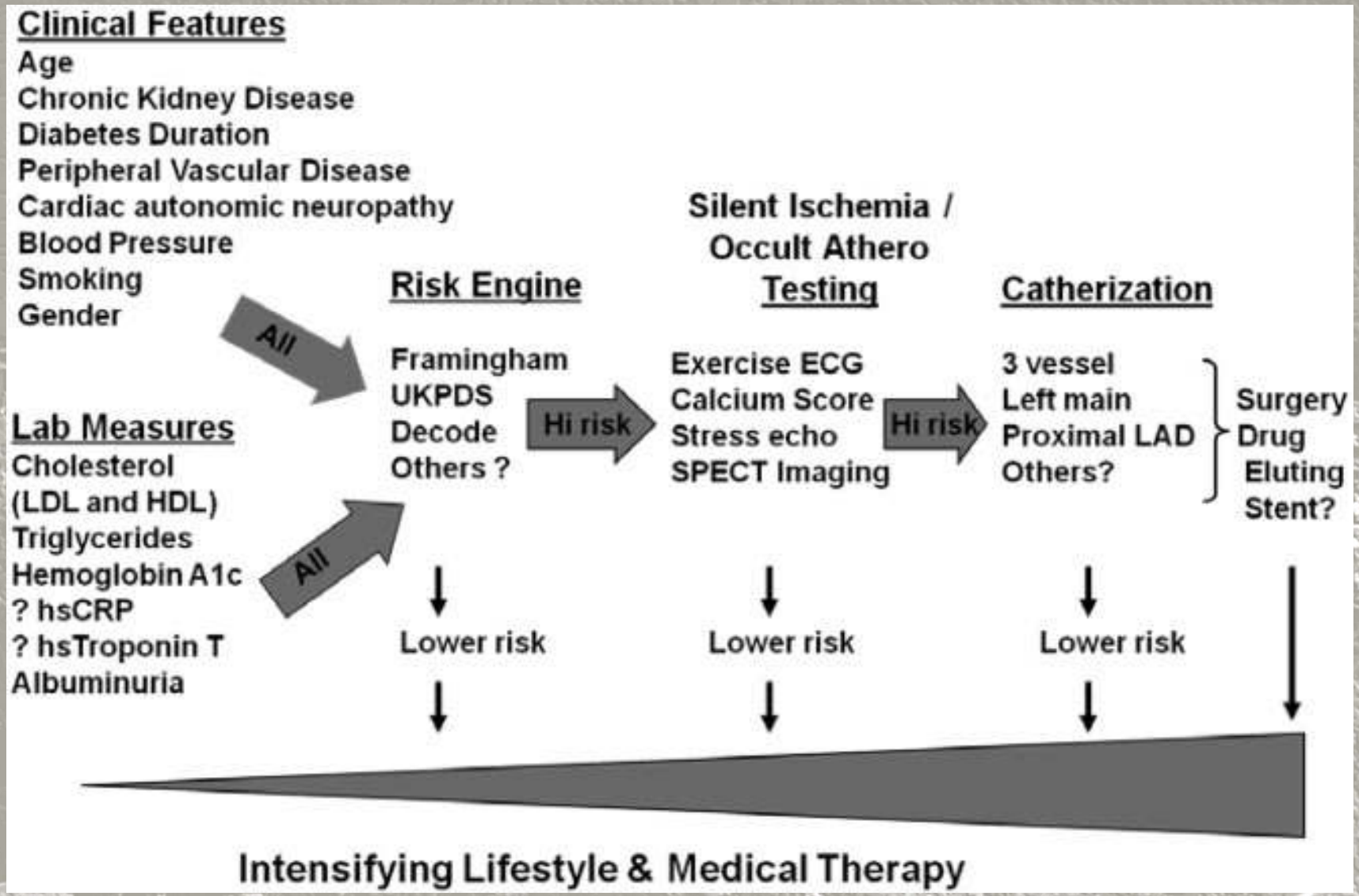
"Warranty"

Prognostic stratification of diabetic patients by exercise echocardiography

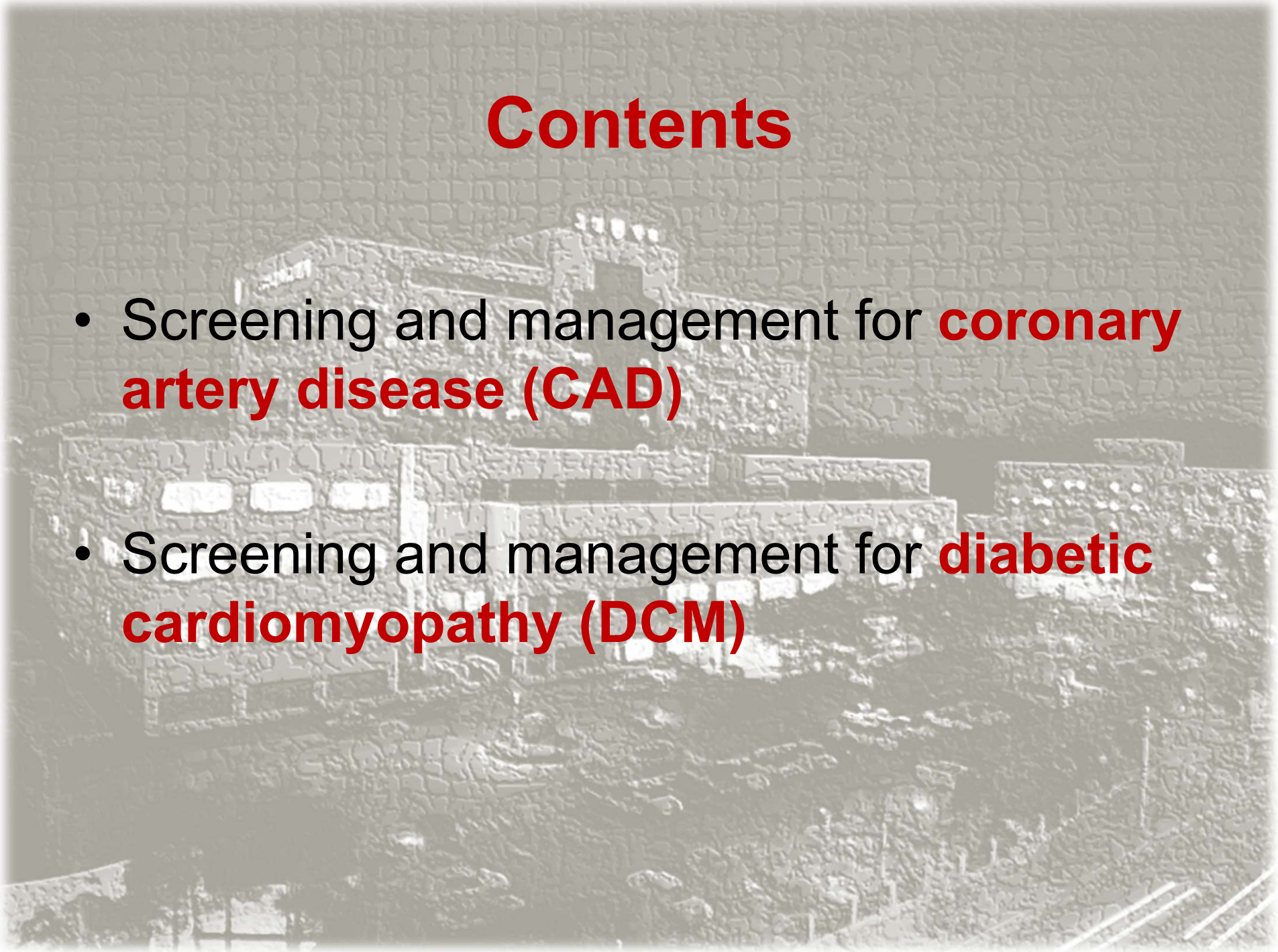


JACC 2001

Summary



JECM 2012

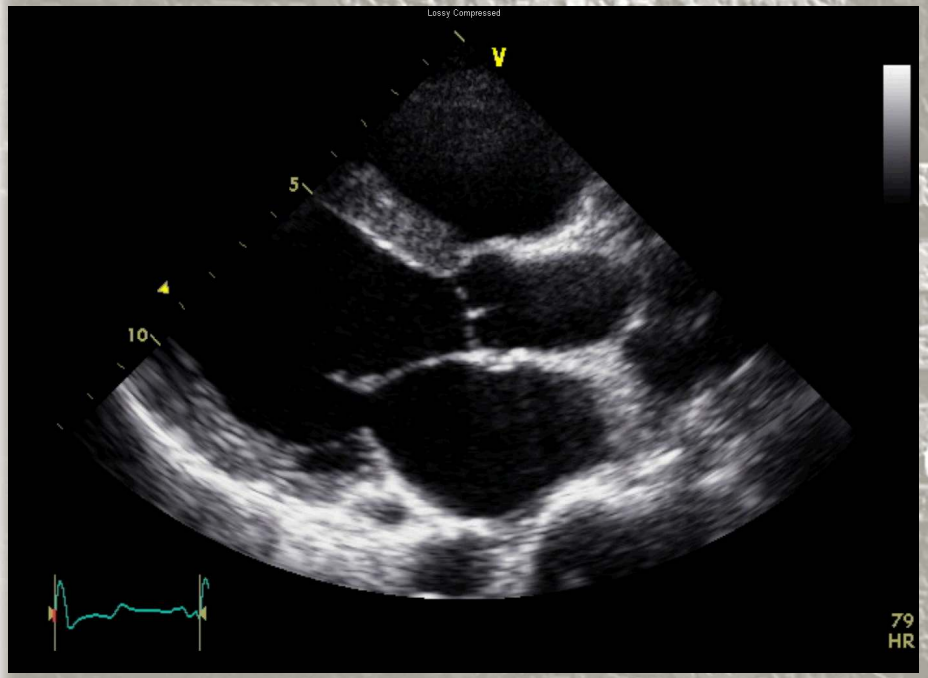


Contents

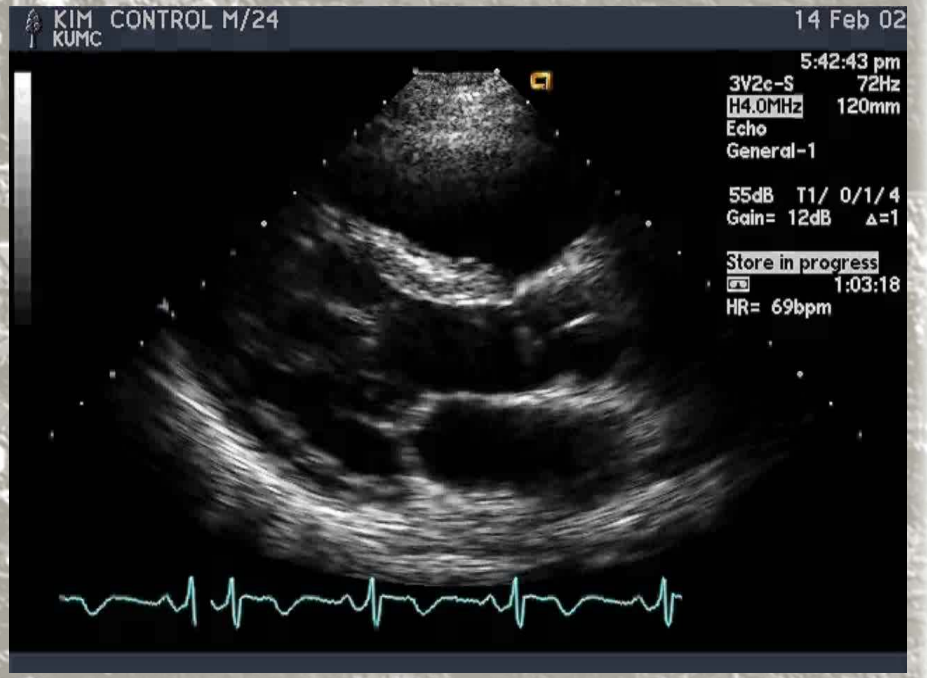
- Screening and management for **coronary artery disease (CAD)**
- Screening and management for **diabetic cardiomyopathy (DCM)**

Case

Echocardiogram



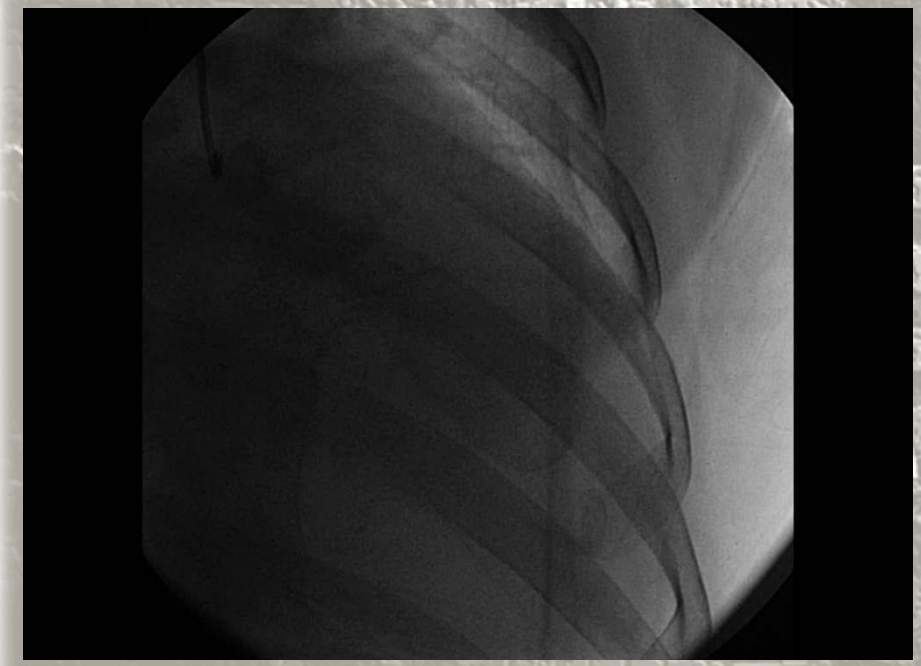
Case



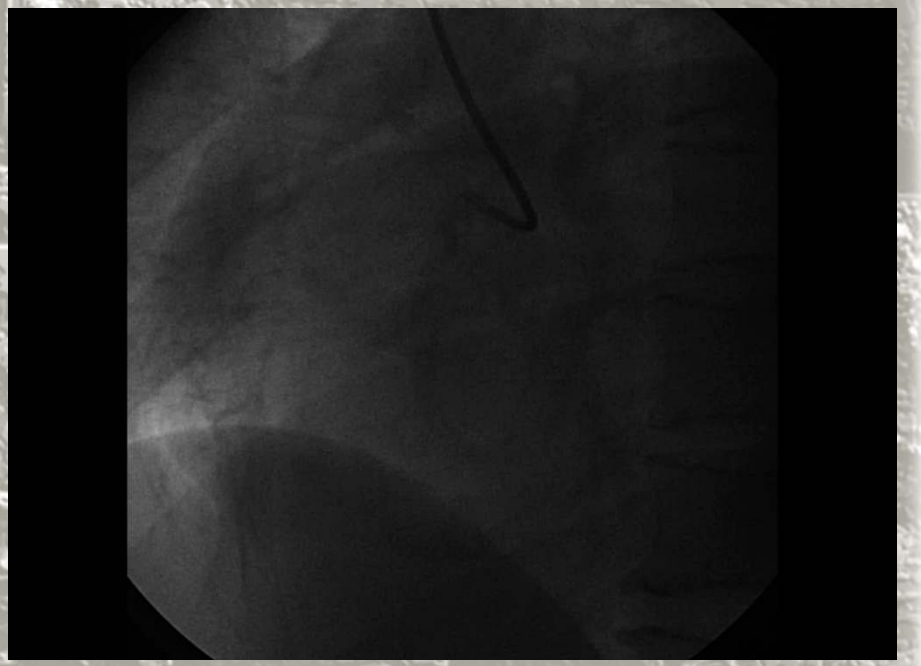
Control

Case

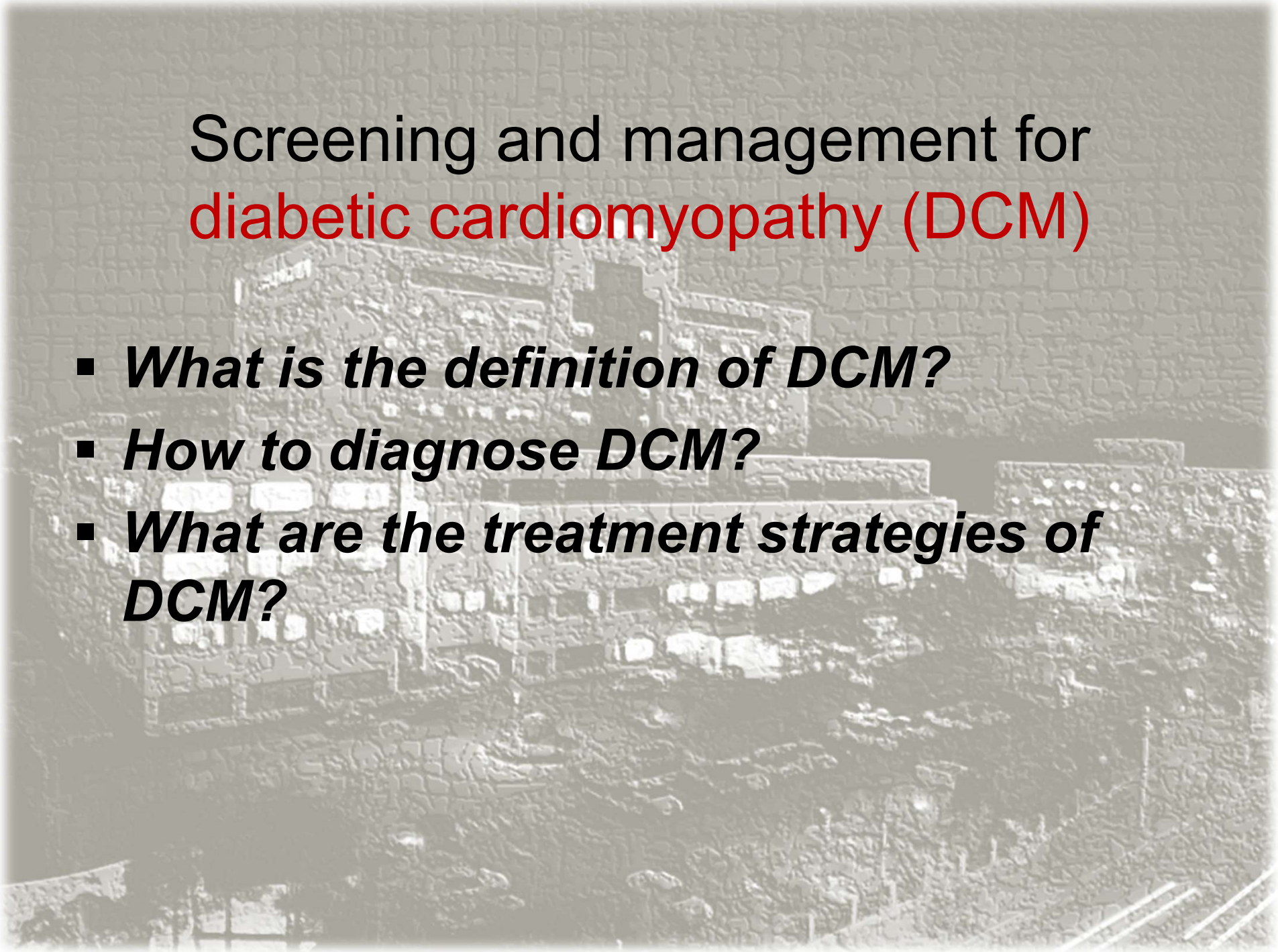
Coronary angiogram



LCA



RCA



Screening and management for diabetic cardiomyopathy (DCM)

- ***What is the definition of DCM?***
- ***How to diagnose DCM?***
- ***What are the treatment strategies of DCM?***

DCM?

- First report in 1972 by Rubler et al.
  : 4 patients with LV dilatation in the absence of other causes
- Independent risk factor for the development of HF
  : The Framingham Study / NHANES / Cardiovascular Health Study / UKPDS / Euro Heart Failure Surveys

DCM?

Why do diabetics develop HF?

- Common risk factors for both HF & diabetes (CHD & hypertension)
- Active neurohormonal system
- A direct effect on myocardium

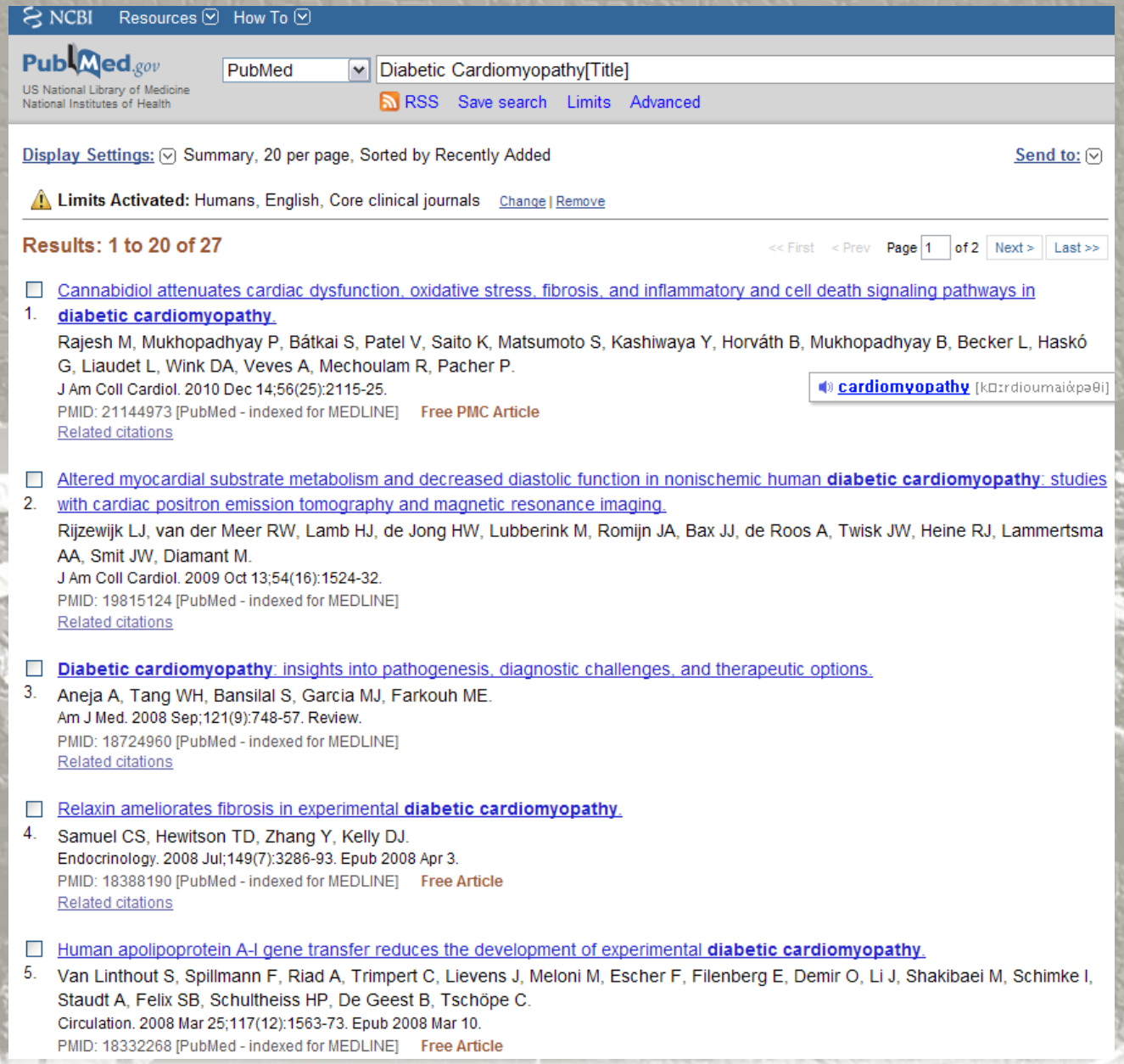
DCM

Definition

Ventricular dysfunction occurring independent of CAD or hypertension in diabetic patients

The concept of DCM suggests a ***direct*** cellular insult to the myocardium

DCM in PubMed



Secondary Cardiomyopathies

DCM

Contemporary Definitions and Classification of the Cardiomyopathies by AHA

- Infiltrative*
  - Amyloidosis (primary, familial autosomal dominant†, senile, secondary forms)
  - Gaucher disease†
  - Hurler's disease†
  - Hunter's disease†
- Storage‡
  - Hemochromatosis
  - Fabry's disease†
  - Glycogen storage disease† (type II, Pompe)
  - Niemann-Pick disease†
- Toxicity
  - Drugs, heavy metals, chemical agents
- Endomyocardial
  - Endomyocardial fibrosis
  - Hypereosinophilic syndrome (Löeffler's endocarditis)
- Inflammatory (granulomatous)
  - Sarcoidosis
- Endocrine
  - Diabetes mellitus†
  - Hyperthyroidism
  - Hypothyroidism
  - Hyperparathyroidism
  - Pheochromocytoma

2006

DCM

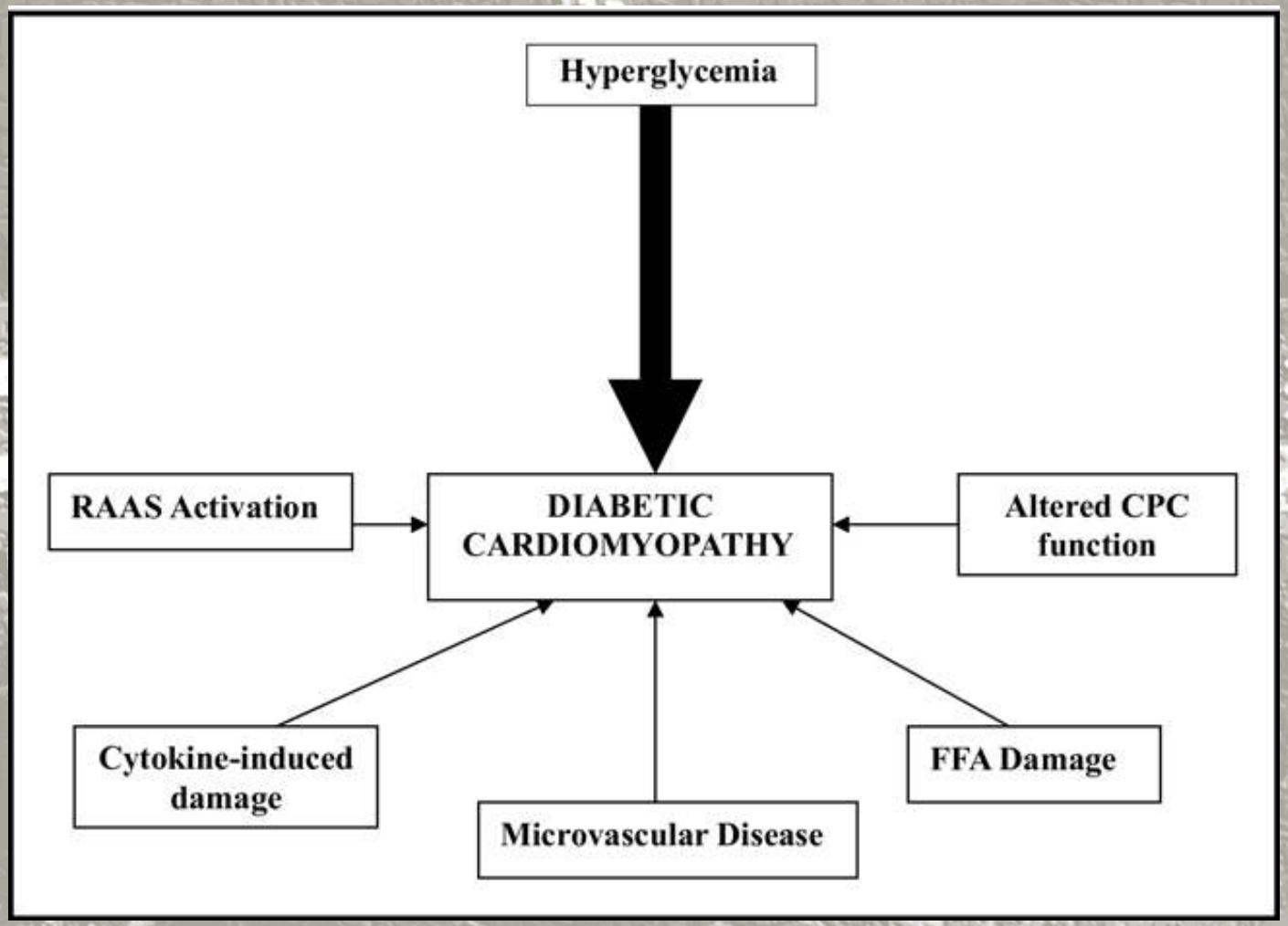
Classification of the Cardiomyopathies by ESC

	HCM	DCM	ARVC
Familial	Familial, unknown gene Sarcomeric protein mutations ß myosin heavy chain Cardiac myosin binding protein C Cardiac troponin I Troponin-T α-tropomyosin Essential myosin light chain Regulatory myosin light chain Cardiac actin α-myosin heavy chain Titin Troponin C	Familial, unknown gene Sarcomeric protein mutations (see HCM) Z-band Muscle LIM protein TCAP Cytoskeletal genes Dystrophin Desmin Metavinculin Sarcoglycan complex CRYAB Epicardin	Familial, unknown gene Intercalated disc protein mutations Plakoglobin Desmoplakin Plakophilin 2 Desmoglein 2 Desmocollin 2 Cardiac ryanodine receptor (RyR2) Transforming growth factor-β3 (TGFβ3)
Non-familial	Obesity Infants of diabetic mothers Athletic training Amyloid (AL/prealbumin)	Myocarditis (infective/toxic/immune) Kawasaki disease Eosinophilic (Churg Strauss syndrome) Viral persistence Drugs Pregnancy Endocrine	Inflammation?

2008

DM & Heart

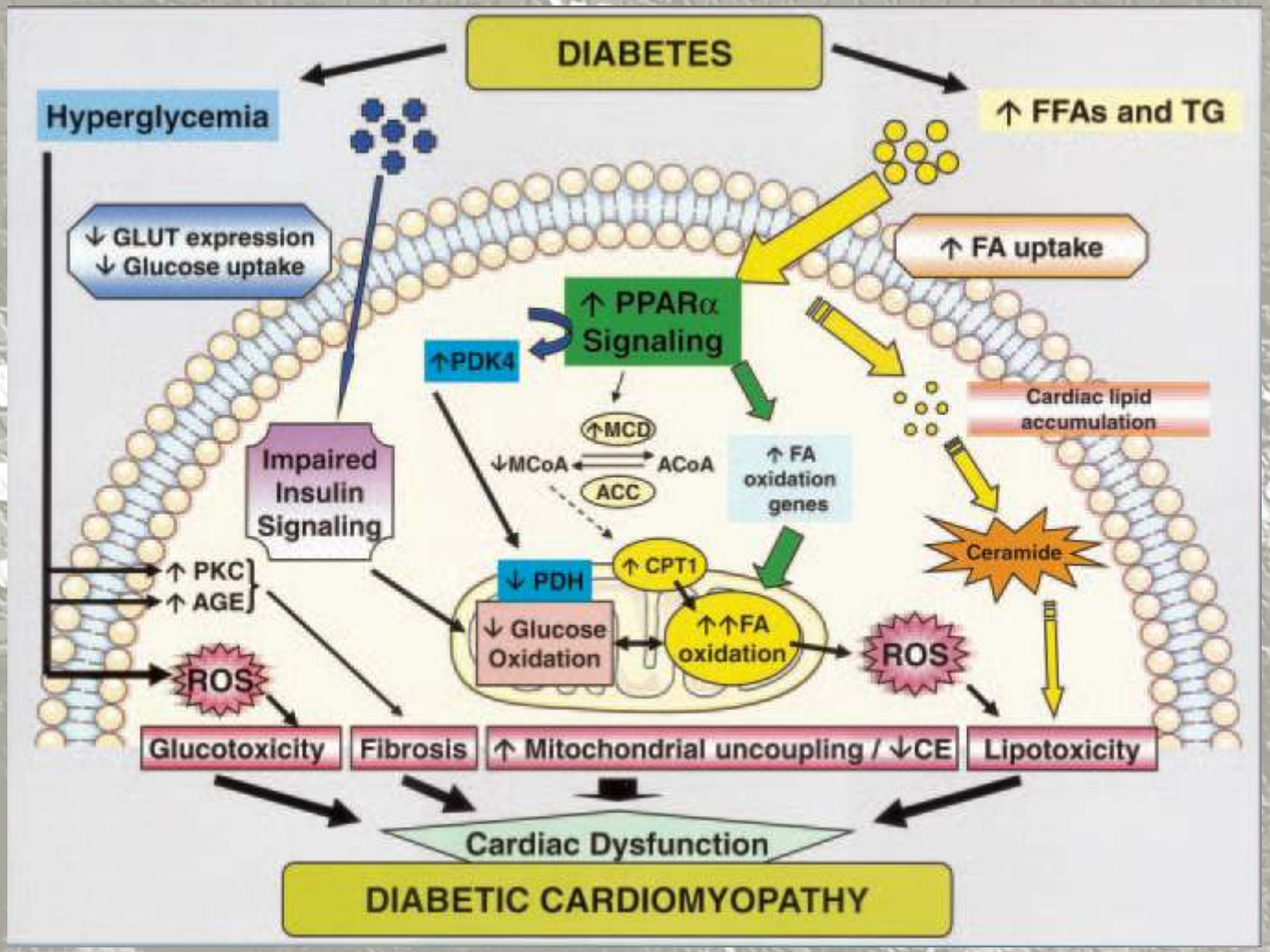
- Pathogenesis of DCM -



The American Journal of Medicine 2008

DM & Heart

- Pathogenesis of DCM -



Circulation 2007

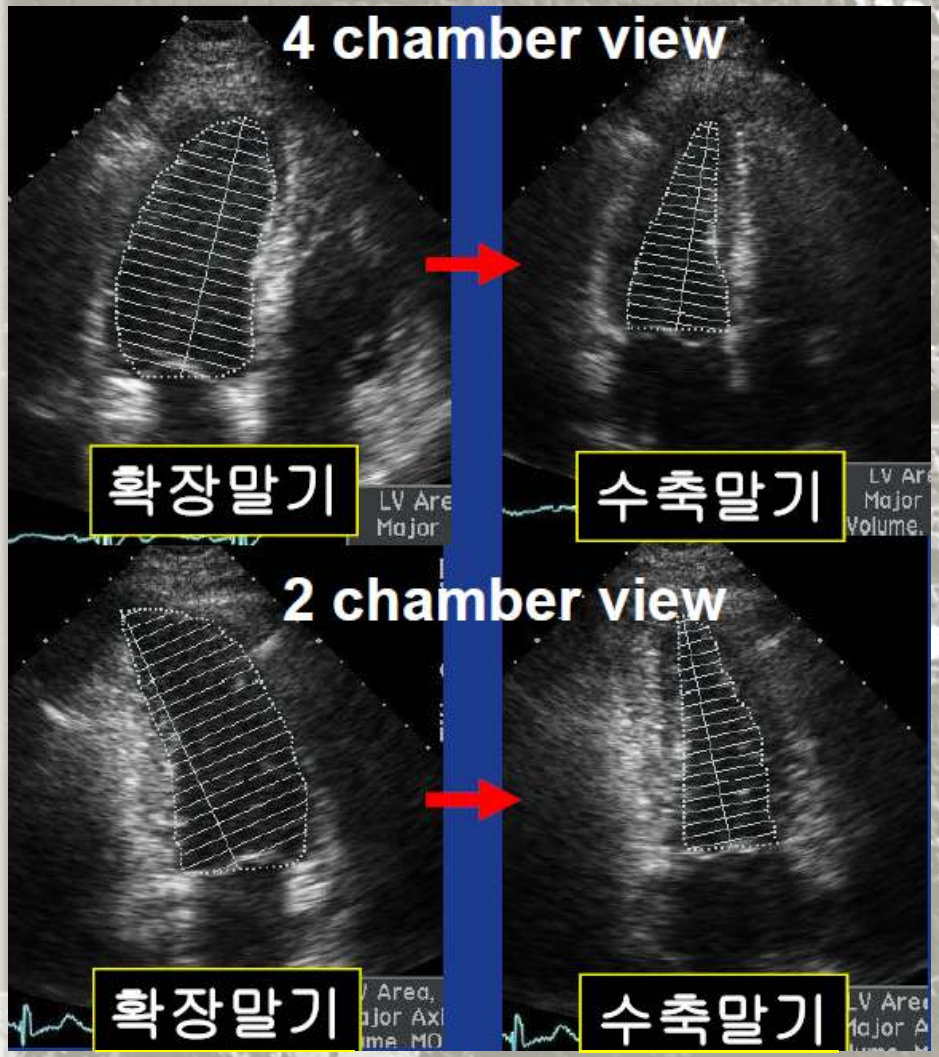
DM & Heart

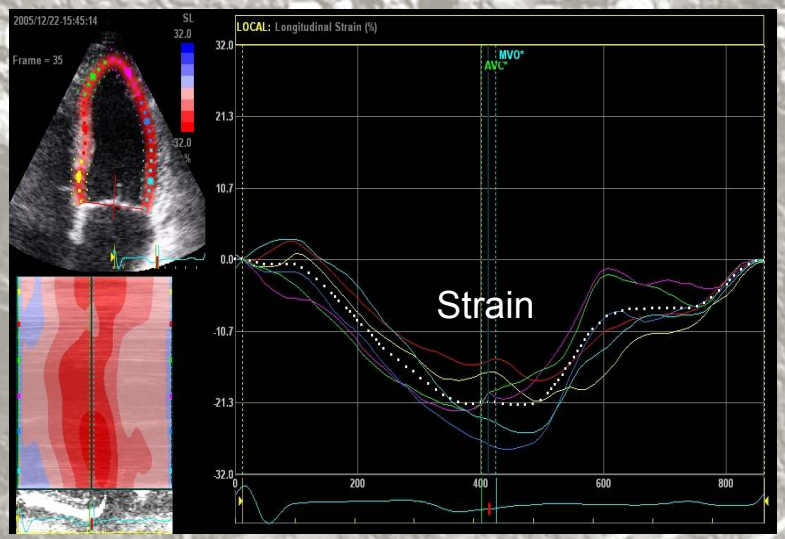
- Diagnosing DCM -

Imaging technique	Myocardial measurements	Pros	Cons
Two-dimensional echocardiography			
Echocardiography	LV and RV dimension, mass and volume (include left atrial volume, LVEF)	Portable Inexpensive Available at the bedside	Poor acoustic window Inadequate endocardial border discrimination in 5–10% of patients Geometric assumptions made for ejection fraction calculation
Doppler	LV diastolic function, cardiac output, RV systolic pressure and pulmonary vascular resistance	The best methodology for diastolic function assessment	Load-dependent measures
Tissue Doppler	LV and RV systolic and diastolic tissue velocities, and strain rate	Myocardial characterization indices of greater sensitivity Favorable signal-to-noise ratio compared with B-mode ultrasonography data Good endocardial definition is not prerequisite Limited load dependence Best for early systolic and diastolic functional assessment	Noise present in the strain-rate signal Angle dependence of data
Integrated backscatter	Myocardial calibrated integrated backscatter	Index of myocardial fibrosis	Noise present in the backscatter signal with cardiac cycle variation

DM & Heart

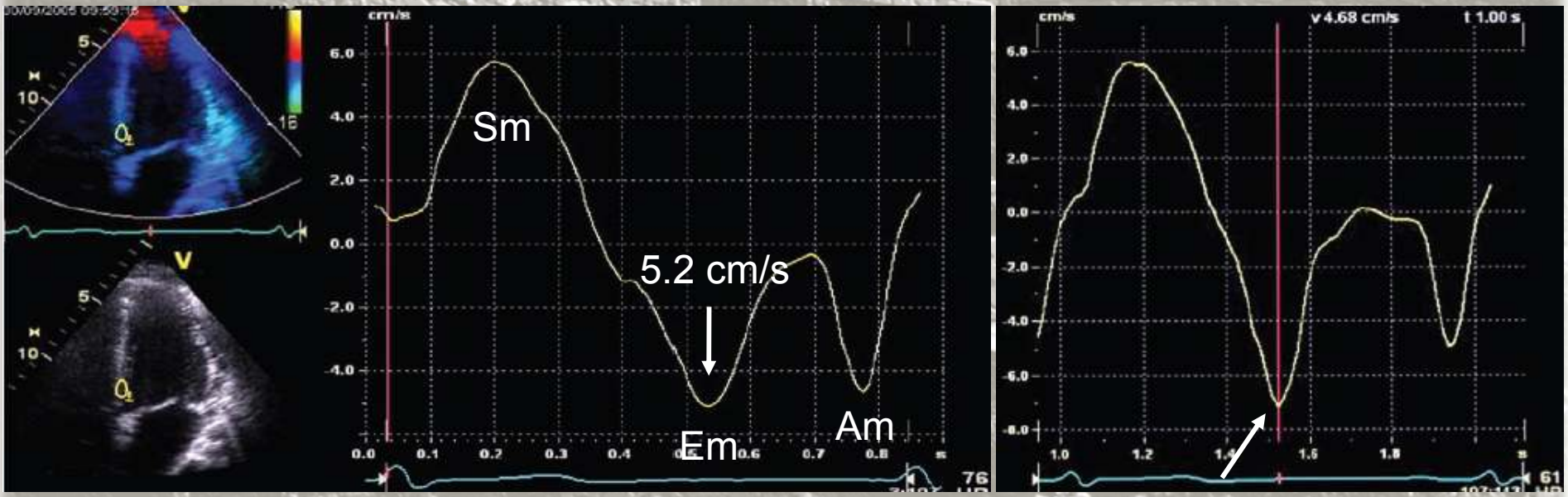
- Diagnosing DCM -





DM & Heart

- Diagnosing DCM -



DM & Heart

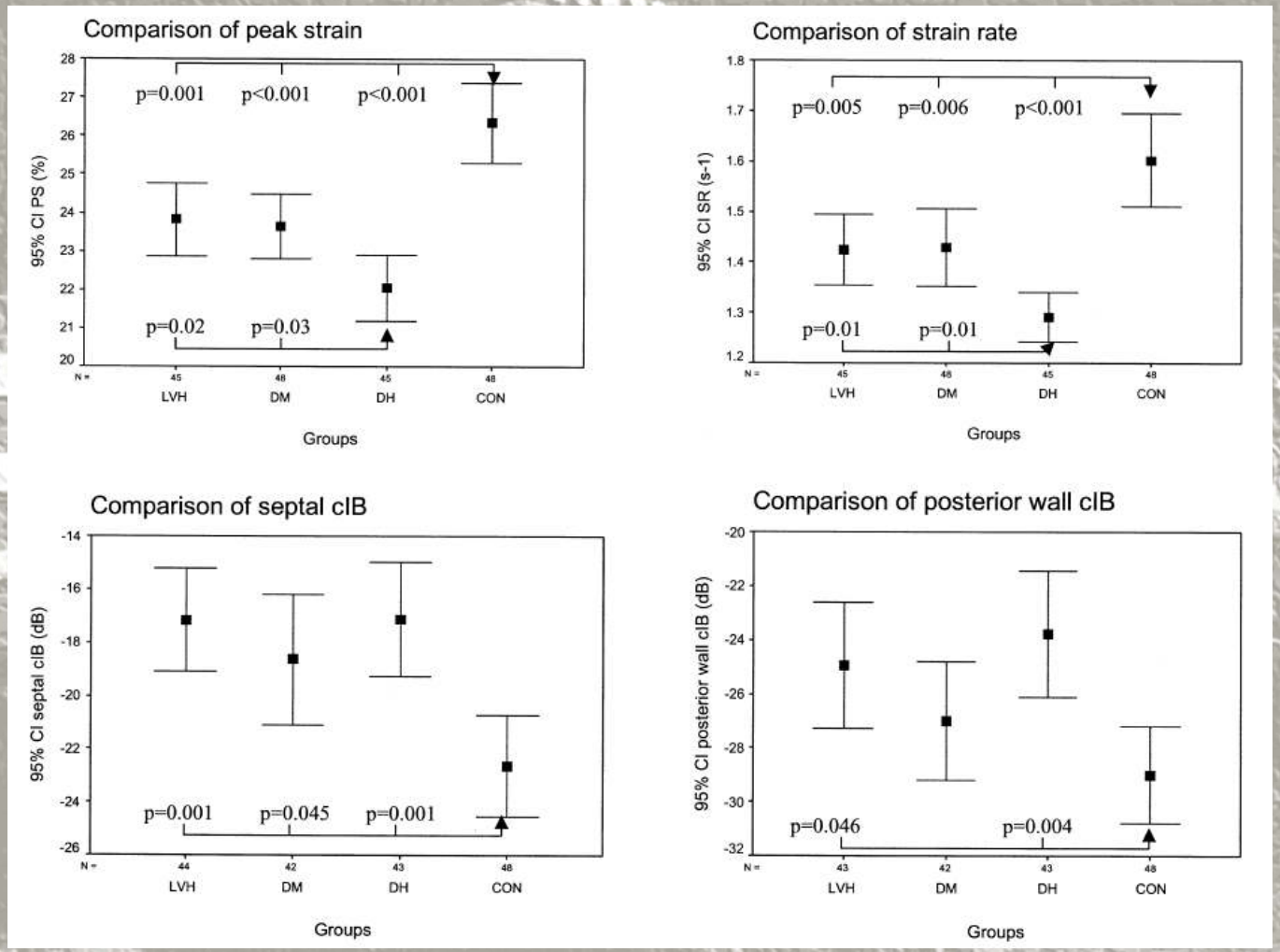
- Changes of LV structure & function -

	DM Group (n = 48)	Control Group (n = 48)
LVDD (cm)	4.6 ± 0.5‡	4.5 ± 0.4
IVSD (cm)	1.1 ± 0.2‡	1.0 ± 0.2
PWD (cm)	1.0 ± 0.1‡	0.9 ± 0.2
LVFS (%)	29.0 ± 4.4	29.6 ± 3.9
LVMI (g/m^2)	95 ± 20‡	90 ± 19
LVEDV (ml)	90 ± 21	79 ± 21
LVESV (ml)	36 ± 15	29 ± 9
LVEF (%)	63 ± 6	63 ± 7
E (m/s)	0.84 ± 0.21(38)	0.80 ± 0.22 (43)
A (m/s)	0.82 ± 0.27(38)	0.77 ± 0.29(43)
E/A < 1	20/38 (53%)	20/43 (47%)
Deceleration time (ms)	258 ± 55(37)	226 ± 56(40)
Em (cm/s)	5.0 ± 2.4 (45)*	7.0 ± 2.1 (47)
Am (cm/s)	6.4 ± 2.2 (45)*	7.7 ± 1.6 (47)
Em/Am < 1	35/45 (78%)	28/47 (60%)

JACC 2003

DM & Heart

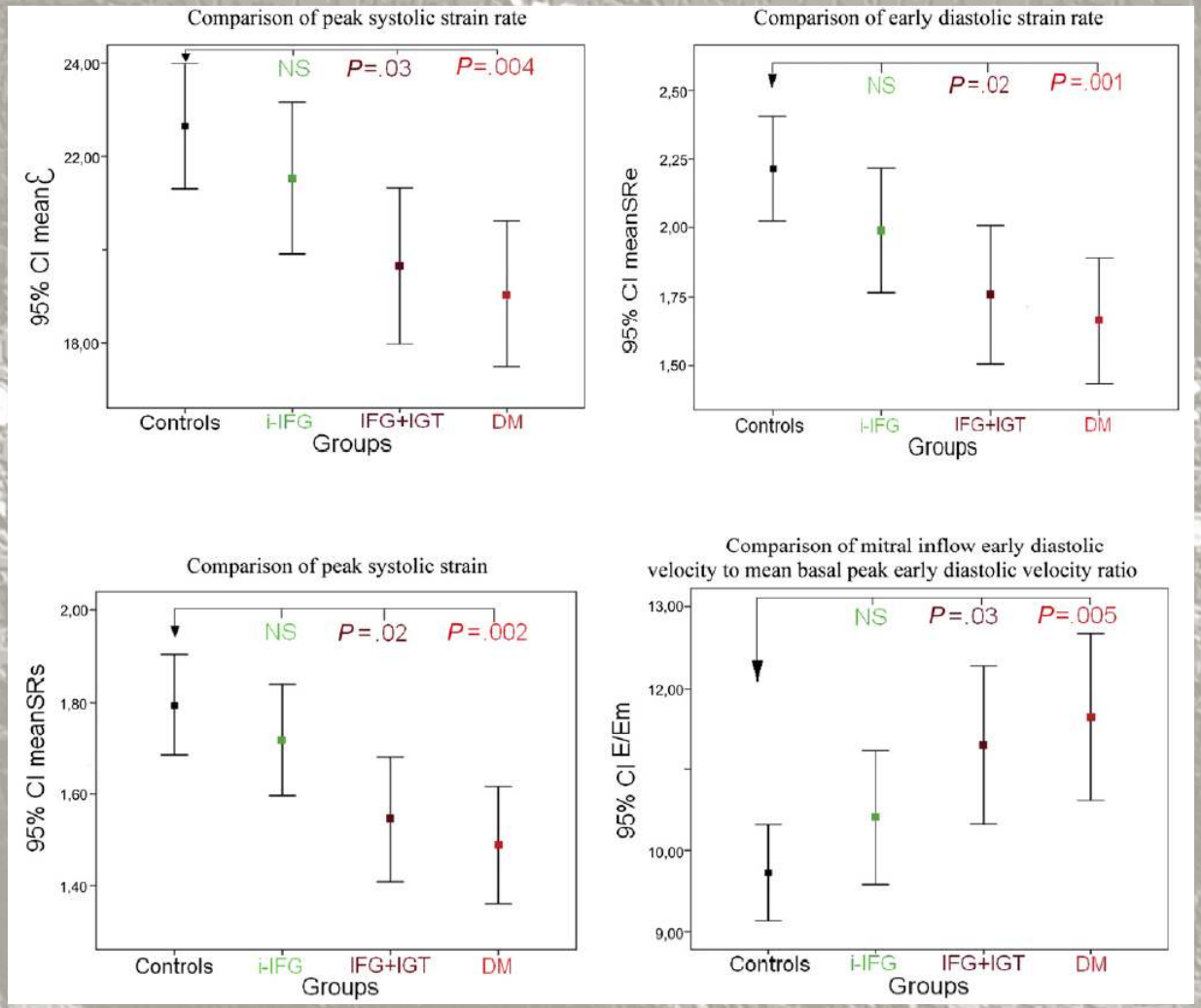
- **Changes of LV structure & function**



JACC 2003

PreDM & Heart

- Changes of LV structure & function -



JASE 2012

PreDM & DM & Heart

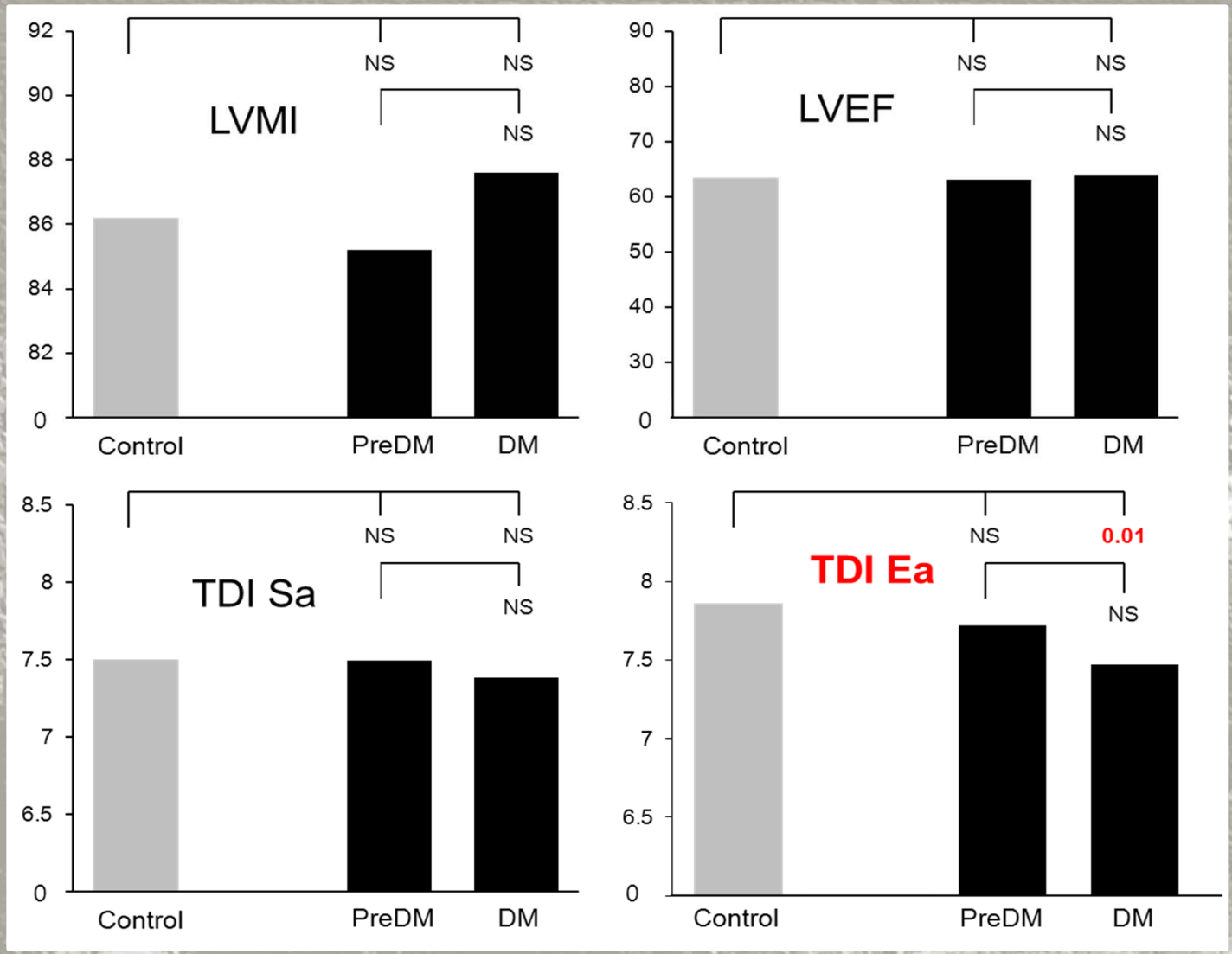
CVD risk factors of 1,681 Ansan cohort participants without HTN according to glucose metabolism

Variables	Categories of glucose metabolism			ANOVA p value
	Control (n=824)	PreDM (n=640)	DM (n=217)	
Age, years	54.1±5.8	55.6±6.6	57.5±7.4	<0.001
Male, %	42.6	47.0	59.9	<0.001
Systolic BP, mmHg	108.0±11.1	111.4±11.5	113.0±11.6	<0.001
Diastolic BP, mmHg	72.8±7.5	75.0±7.7	74.3±7.7	<0.001
Heart rate, bpm	63.8±8.9	65.2±8.5	66.9±8.7	<0.001
Body mass index, kg/m^2	23.4±2.5	24.5±2.7	24.8±2.9	<0.001
Waist circumference, cm	77.5±7.1	80.6±7.5	83.0±7.6	<0.001
hsCRP	1.06±2.10	1.46±3.33	1.76±5.29	0.004
Fasting plasma glucose, mg/dL	88.7±5.7	97.1±8.8	133.9±53.6	<0.001
Fasting plasma insulin, μIU/ml	7.6±2.8	9.1±3.8	11.5±11.3	<0.001
HbA1c	5.42±0.35	5.61±0.39	6.79±1.27	<0.001
Total cholesterol, mg/dL	204±35	206±34	199±39	0.033
HDL-cholesterol, mg/dL	46.7±11.4	45.2±11.1	40.7±9.0	<0.001
Triglycerides, mg/dL	125±88	149±118	182±132	<0.001

Kim SH. Unpublished data. 2012

PreDM & DM & Heart

Relation of glucose metabolism with LV structural and functional parameters in 1,659 KoGES (Ansan cohort) participants without HTN after adjustment for cardiovascular risk factors



Kim SH. Unpublished data. 2012

DM & Heart

- Prevention & Treatment -

- Glycemic control
  - weak evidence, favor GLP-1 analogues & DPP-4 inhibitors, avoid TZD (NYHA III-IV)
- RAAS
- Beta-blockers
  - for DM patients with HF, new generation drugs
- Statins
  - favorable outcomes

Conclusions

- DCM is common and related to increased morbidity and mortality.
- Multiple pathophysiologic mechanisms are involved in the development of DCM in addition to hyperglycemia.
- Subclinical LV dysfunction can be detected by noninvasive cardiac imaging techniques, such as conventional echocardiography, TDI, and strain/strain rate.
- DCM takes years to reach overt LV systolic/diastolic HF, which means that diabetes-specific aggressive strategies are likely to succeed at earlier stages of LV dysfunction.


Thank you for your attention!