



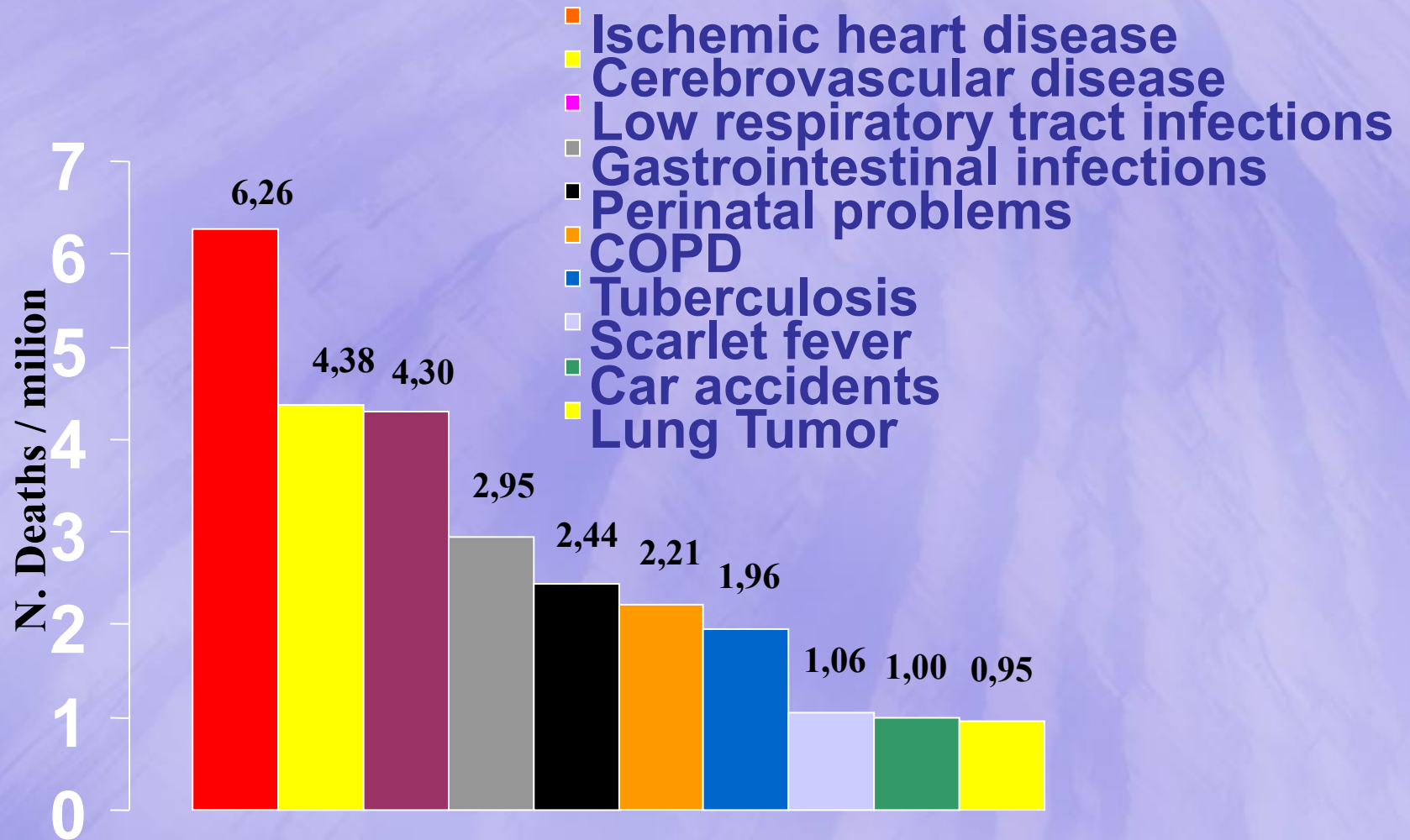
# Chronic forms of coronary artery disease

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# CAD is the first cause of death



Murray & Lopez. Lancet. 1997;349:1269-1276



# Pathophysiology

## Vascular resistance

(metabolic control, humoral and neural factors)

## Coronary blood flow

(duration of diastole / pressure gradient)

## Oxygen demand



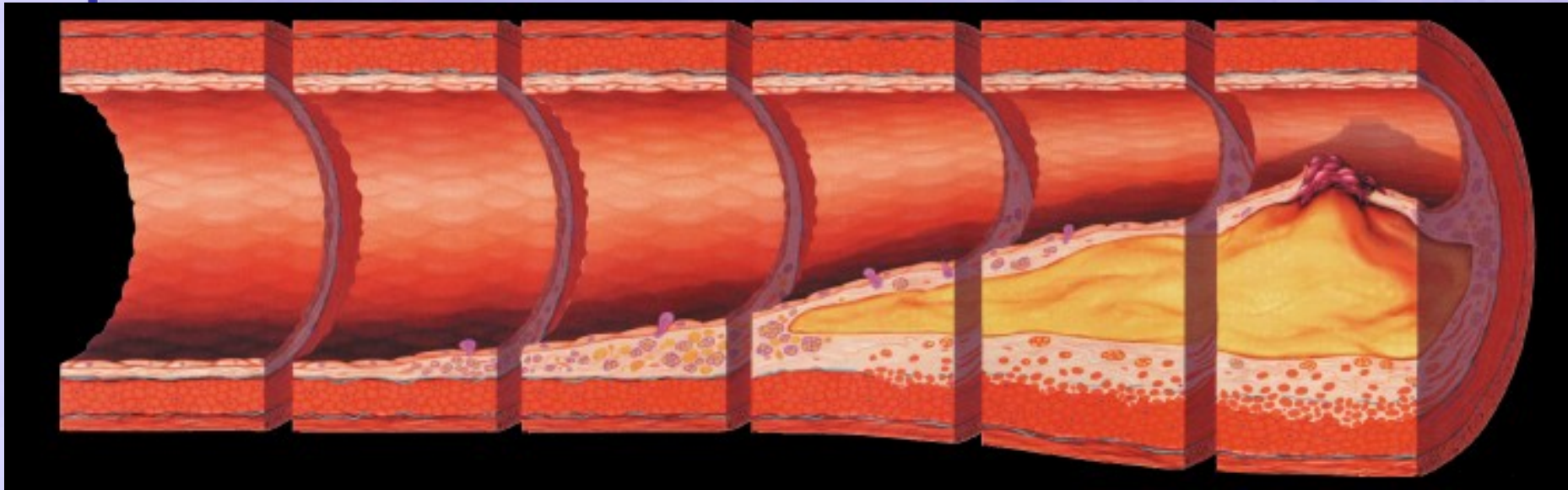
## Oxygen supply

- Heart rate
- Contractility
- Systolic wall stress



# Timeline

Foam Cells      **Fatty Streak**      Intermediate Lesion      Atheroma      **Fibrous Plaque**      Complicated Lesion/ Rupture



Endothelial Dysfunction

From First Decade

From Third Decade

From Fourth Decade



# Diagnosis

- **History of patient**

- Familiar history
- Personal history
- Sex ( M>F), age
- pain

- **Physical examination**

- **Clinical test**

- Risk assessment (low, probable, high)



# Estimate of CAD Probability (Duke Clinical Score)

- **age**, **gender** and **pain type** were the most powerful predictors
- other predictors
  - **smoking** (defined as a history of smoking half a pack or more of cigarettes per day within five years of the study or at least 25 pack-years)
  - **Q wave or ST-T-wave** changes
  - **hyperlipidemia** (defined as a cholesterol level >250 mg/dL / 6,4 mmol/L)
  - **diabetes** (glucose >140mg/dL / 7,8 mmol/L). Of these risk factors, diabetes had the greatest influence on increasing risk.

Am J Med 1983;75:771-80 ; Am J Med 1990;89:7-14  
Ann Intern Med 1993;118:81-90



## Estimate of CAD Probability

- a 64-year-old man with typical angina has
- a 94% likelihood of having significant CAD
- a 32-year-old woman with nonanginal chest pain has
- a 1% chance of CAD

1



# Risk factors

- Major independent risk factors

- Advanced age
- Tobacco use
- Diabetes
- Elevated cholesterol
- Hypertension

- Conditional risk factors

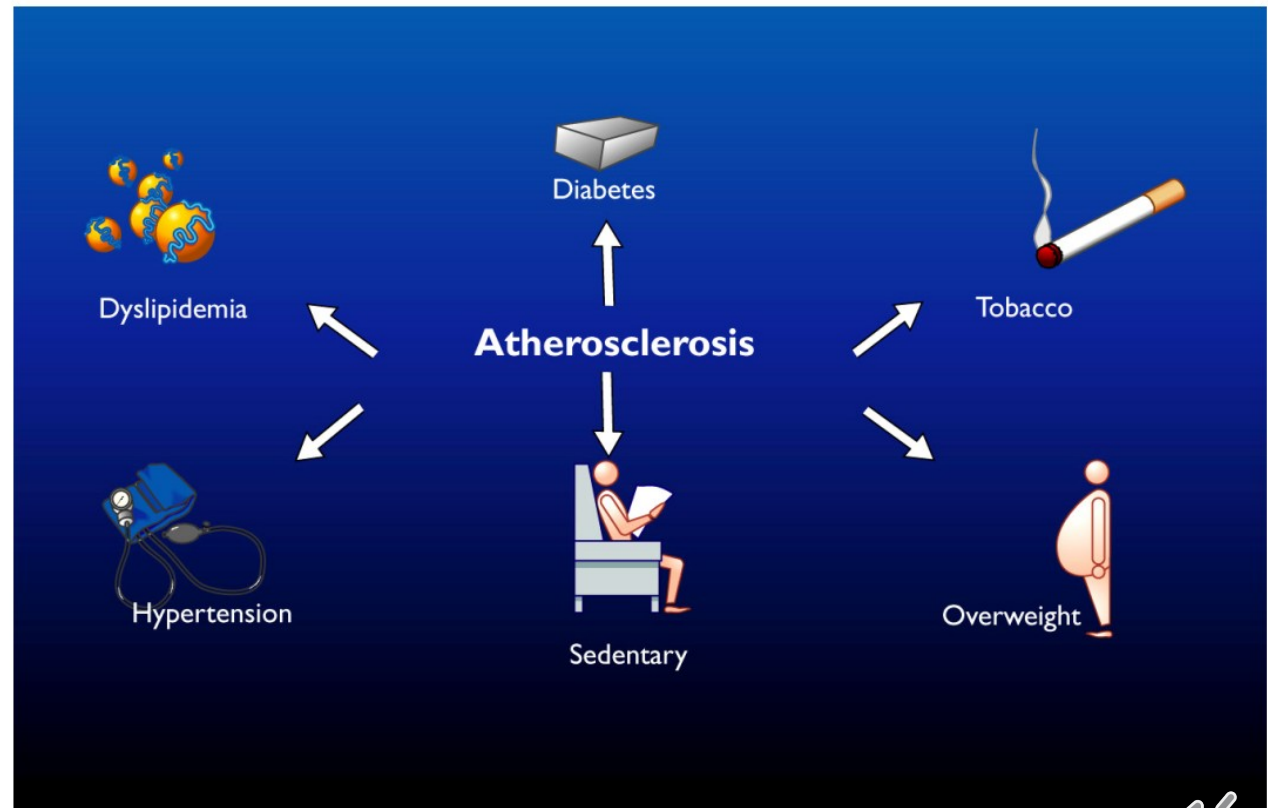
- Elevated C-reactive protein
- Inflammation
- Prothrombotic state
- Small LDL particles

- Predisposing factors

- Abdominal obesity
- Ethnicity
- Family history
- Obesity
- Psychosocial factors



## Atherosclerosis: a multifactorial disease





# Angina pectoris

## • Typical angina (definite)

- 1. **Substernal** chest discomfort with a characteristic quality and duration that is
- 2. **Provoked** by exertion or emotional stress and
- 3. **Relieved** by rest or nitroglycerin.

## • Atypical angina (probable)

- Meets **two** of the above characteristics

## • Noncardiac

- Meets

A pain or discomfort in the chest or adjacent areas caused by **insufficient blood flow** to the heart muscle.



# Pain - description

## (1) location

- located **substernally** or just below the sternum
- Less often - over the precordium
- Nevertheless - **can be located in the neck**; rarely, it may be located in the jaw
- **radiates down the arms** / the **left side is more common** than the right

## (2) quality

- **deep visceral pressure or heaviness**, **stabbing or pinprick-like pain**
- Angina is almost never associated with position or respiratory changes

## (3) duration of the discomfort

- **10-30 sec plateau and minutes**

## (4) inciting factors

- **physical activity, emotion**

## (5) factors relieving the pain



# Grading of Angina of Effort by the Canadian Cardiovascular Society

- I. “**Ordinary physical activity does not cause** ... angina,” such as walking and climbing stairs. Angina with strenuous or rapid or prolonged exertion at work or recreation.
- II. “**Slight limitation of ordinary activity.**” Walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals, or in cold, or in wind, or under emotional stress, or only during the few hours after awakening. Walking more than 2 blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal conditions.
- III. “**Marked limitation of ordinary physical activity.**” Walking one to two blocks on the level and climbing one flight of stairs in normal conditions and at normal pace.
- IV. “**Inability to carry on any physical activity without discomfort** -- anginal syndrome *may be* present at rest.”



# Stable / Unstable angina

- **Stable**: duration > 60 days
- Unstable angina: rest angina
  - severe **new-onset** angina
  - or **prior** angina **increasing** in severity
  - the acute coronary syndromes of unstable angina and non-ST-segment elevation myocardial infarction were linked
  - **Now. ACUTE CORONARY SYNDROME**



# Silent ischemia

- Asymptomatic ischemic episodes
- The prevalence : approximates 40 percent in patients with chronic stable angina
- ST-segment depression on ECG monitoring
- Pathophysiology of Silent Ischemia: neuropathy (diabetic patients) or less severe ischemia?



# Diagnosis – tests I.

- Resting 12-lead ECG (normal in 50% pts)
  - Q waves, ST segment denivelation
- Echocardiography
  - impaired systolic LV function
  - regional and global abnormalities



Name: stp QIMDS

HR: 57 BPM

Axis: -11 <

QRS: 93 ms

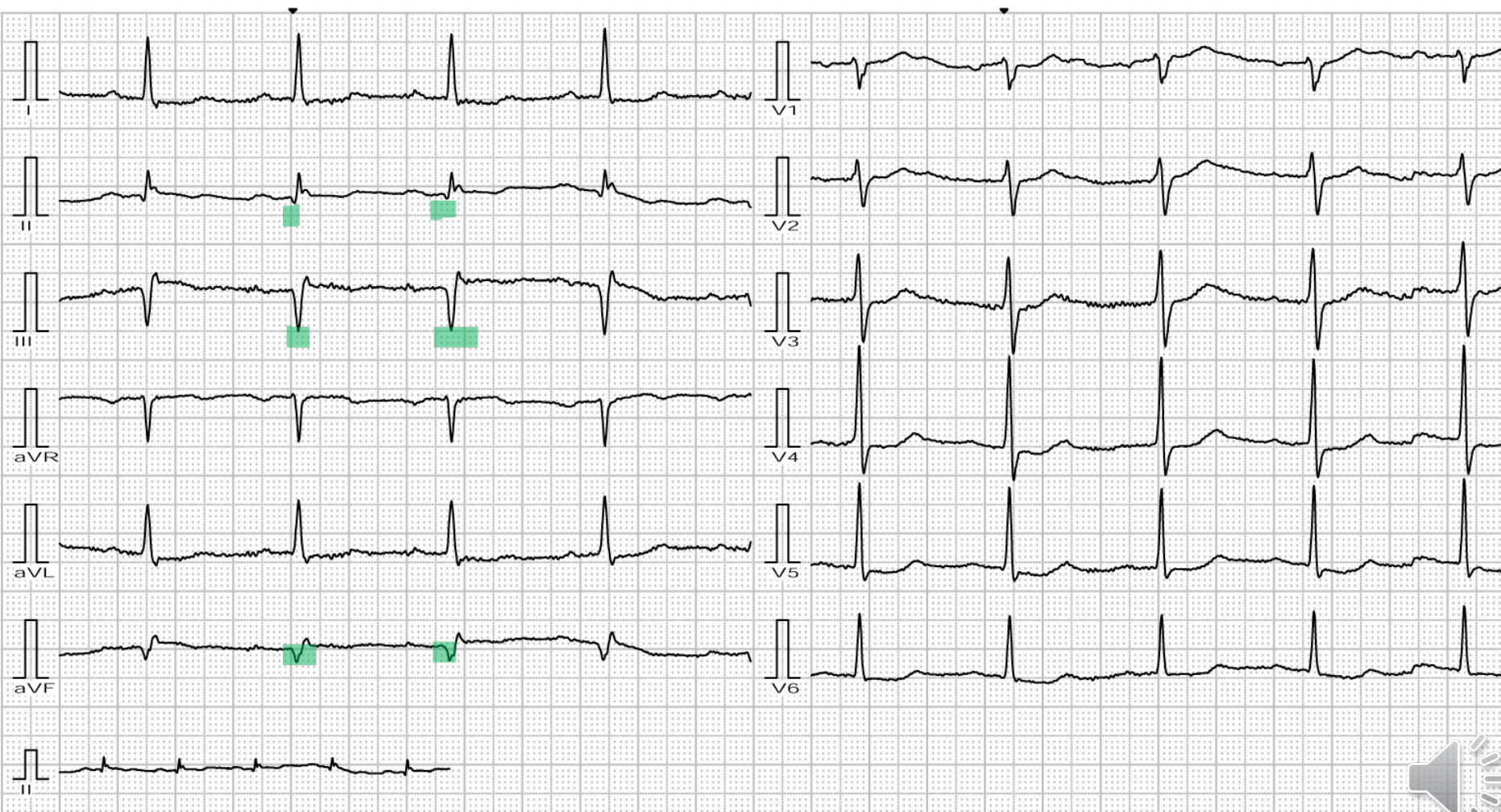
QTc: 470

PQ: 267 ms

RV5+SV1: 18.8mm

Comments:

M.D.



Name: QS AL

HR: 80 BPM

QRS: 80 ms

PQ: 203 ms

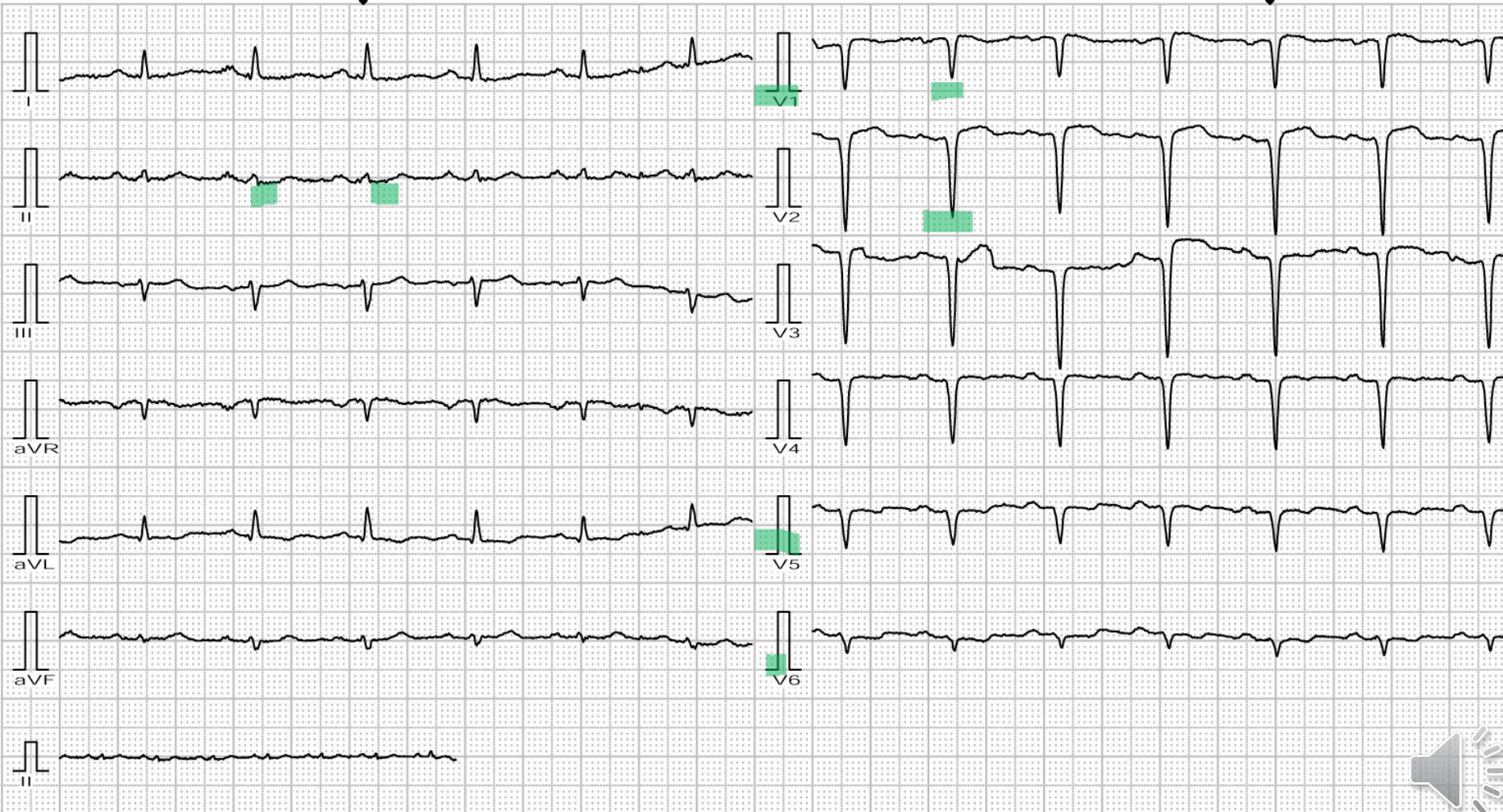
Axis: -6 °

QTc: 400

RV5+SV1: 8.3mm

Comments:

M.D.





Name: LBBB 2

HR: 65 BPM

Axis: -13 <

QRS: 137 ms

QTc: 470

PQ: 187 ms

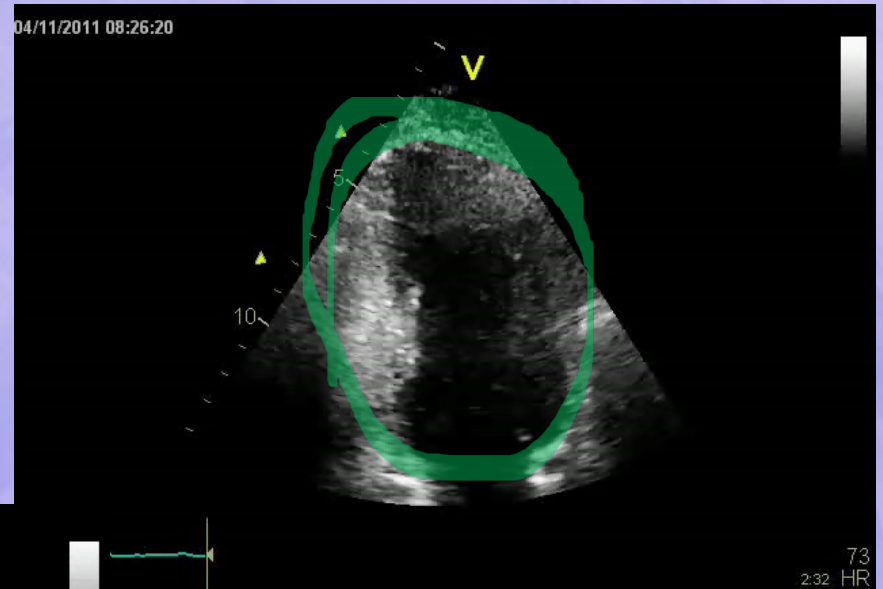
RV6+SV1: 30.7mm

Comments:

M.D.



# Echocardiography – anterior wall



Courtesy of:  
MUDr. Jan Maňoušek



# Diagnosis – tests II

## Exercise ECG stress testing

- Ergometry, treadmill , hand-grip
- Ecg, BP, heart rate
- difficulties in woman

## Stress Echocardiography - dobutamine

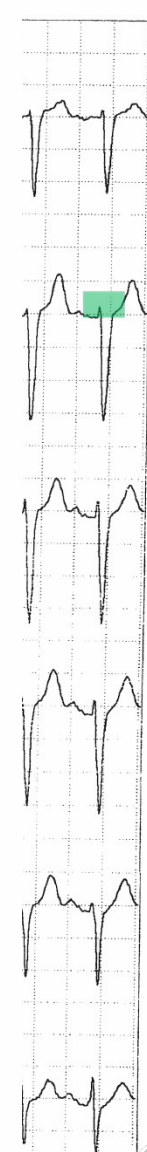
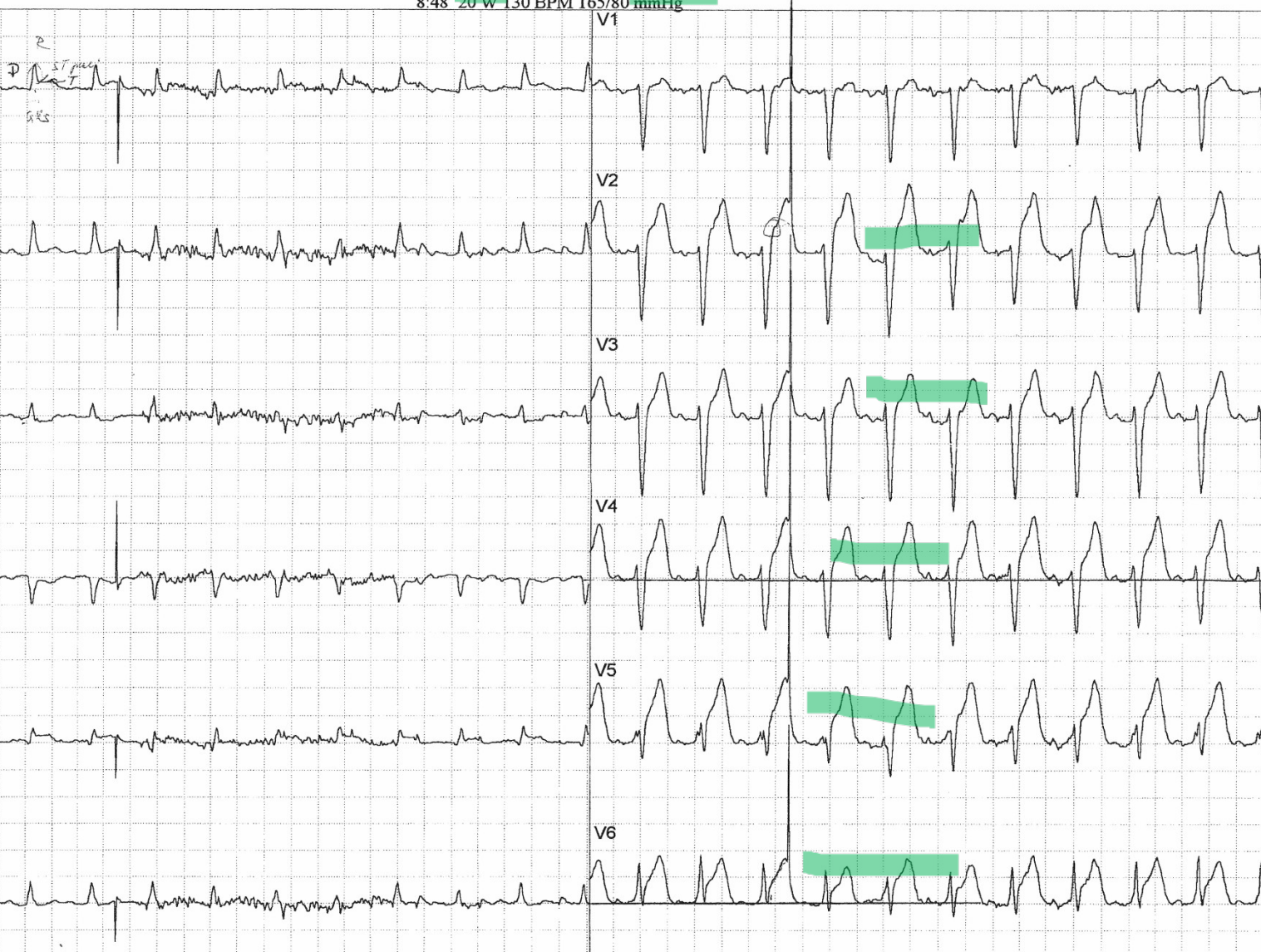
- (1) decrease in wall motion in one or more LV segments with stress
- (2) diminution in systolic wall thickening in one or more segments during stress, and
- (3) compensatory hyperkinesis in complementary (nonischemic) wall segments

## Myocardial Perfusion Imaging

- thallium -201 ( $^{201}\text{Tl}$ ); technetium-99m ( $^{99\text{m}}\text{Tc}$ )
- single-photon emission computed tomography (SPECT)



8:48 20 W 130 BPM 165/80 mmHg

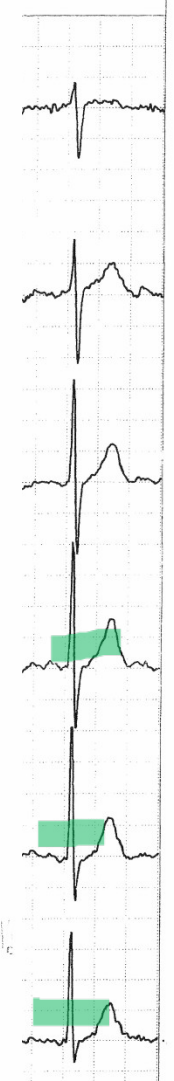
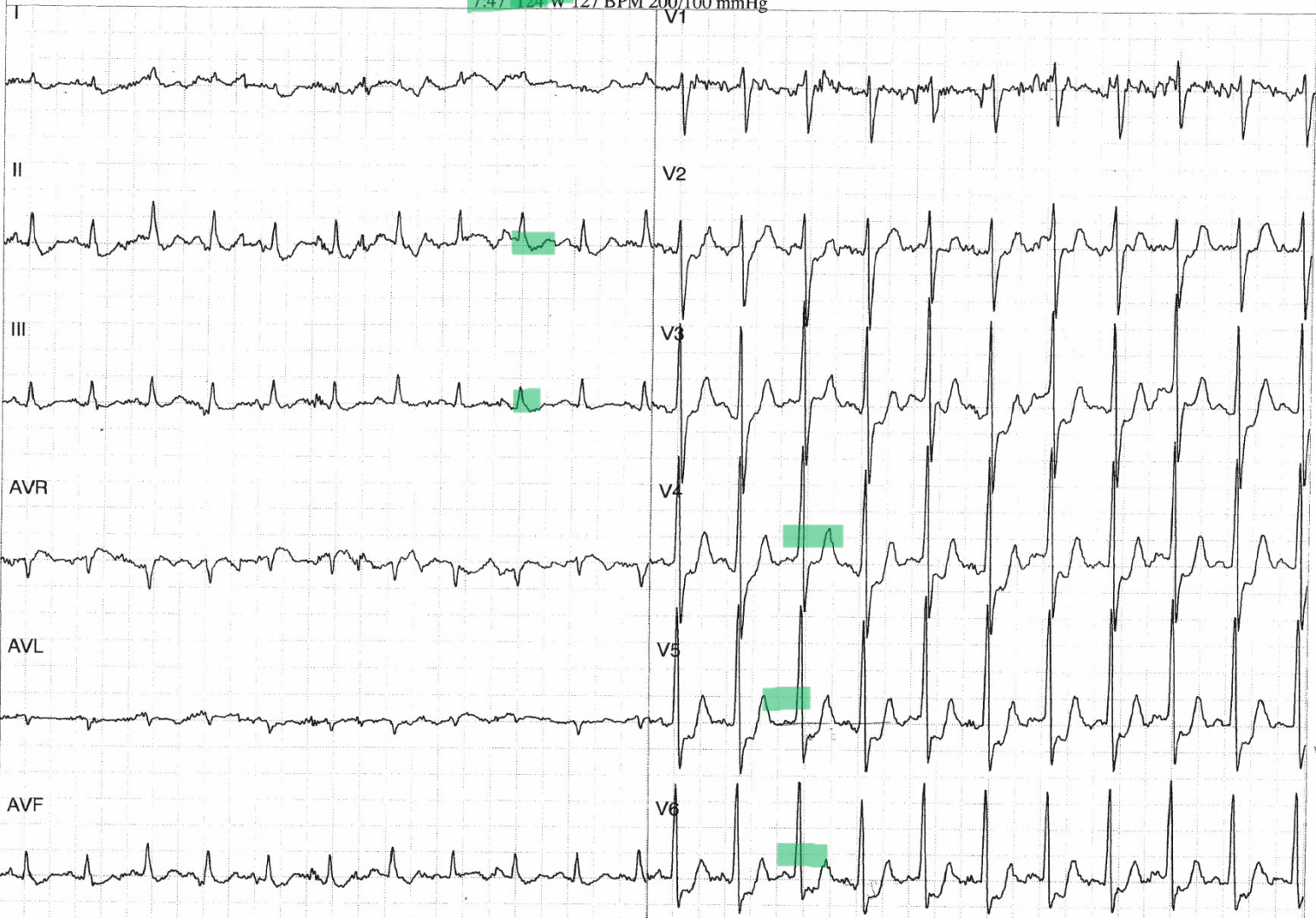


Jan Burda  
Date of Birth: 01.01.1948 (57 y.)  
Male, 174 cm, 83.0 kg

EXERCISE TEST / Stored ECG  
Patient ID 480101/440

HELLIGE CardioSoft V2.51

7:47 124 W 127 BPM 200/100 mmHg



# Comparison of Stress Tests

- meta-analysis on 44 articles (published between 1990 and 1997)

	Sensitivity	Specificity
ECG	52%	71%
Echocardiography	85%	77%
Scintigraphy	87%	64%

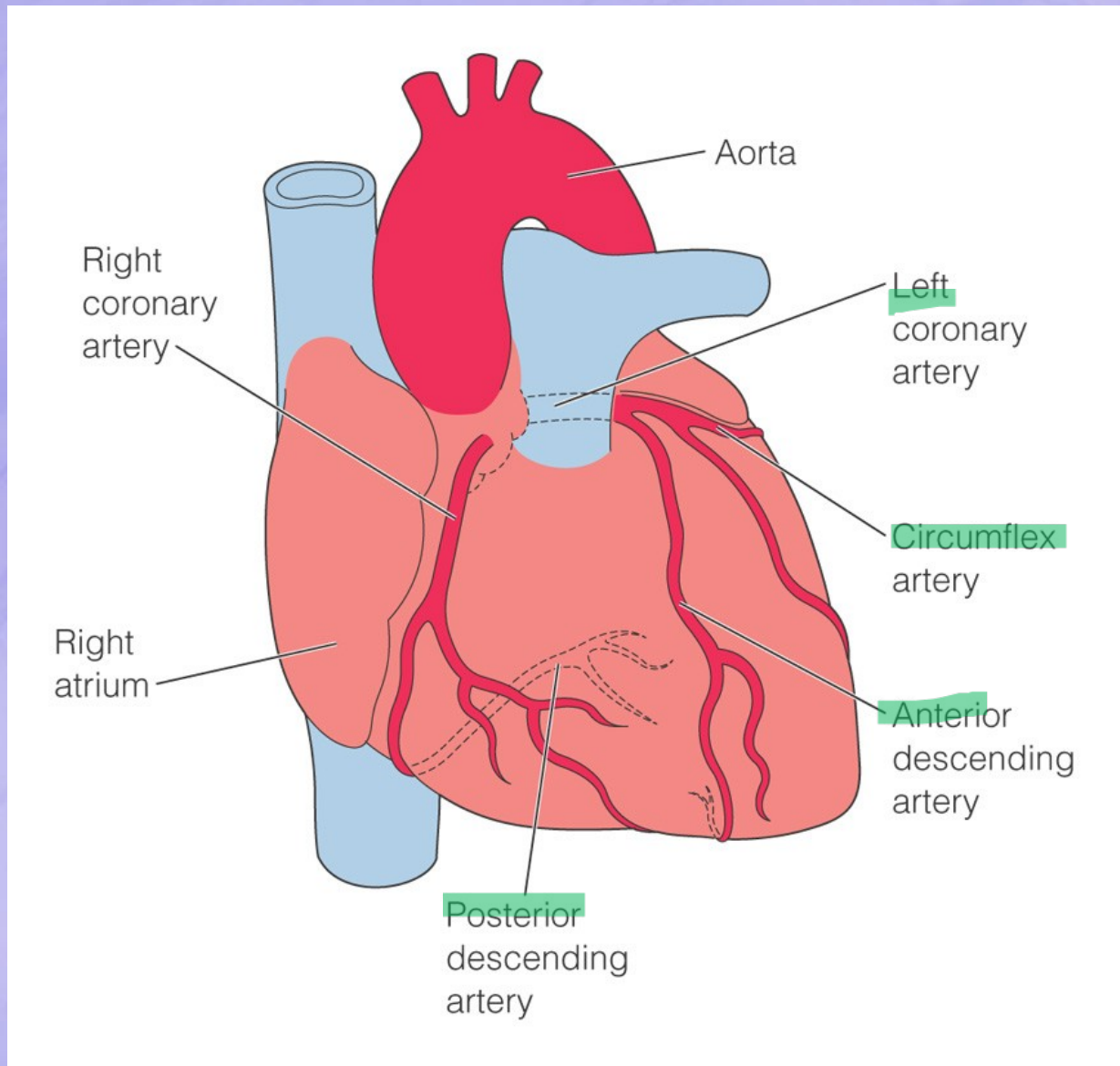
exercise echocardiography had significantly better discriminatory power than exercise myocardial perfusion imaging



# Diagnosis – coronary angiography

- Who?
  - **pain + pathological** non-invasive **tests**
  - **Clinical probability** ( smoker, obesity, familiar history, male)
  - **Other problem**: heart failure, arrhythmias, unstability
- rationale is to **identify high risk patients** in whom coronary angiography and subsequent revascularization might improve survival

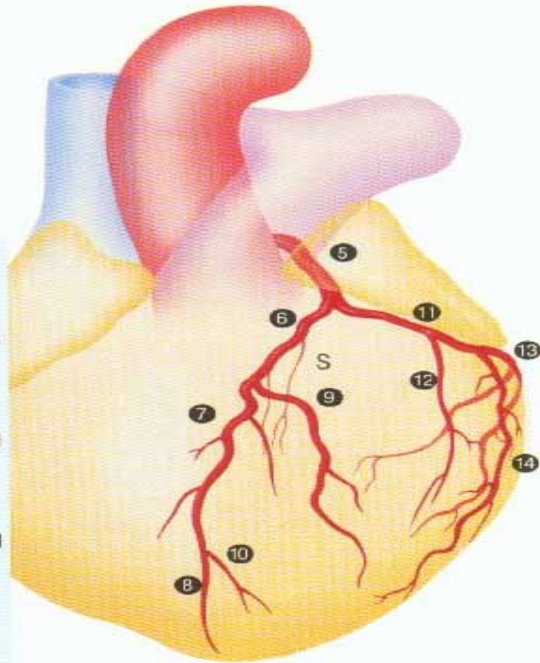






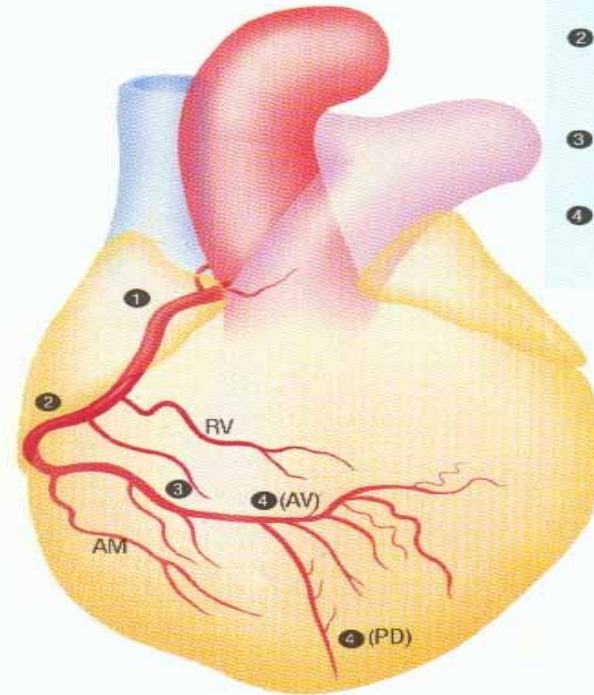
# Coronary Angiography

- 5 Left Main Trunk (LMT)
- 6 L. Anterior descending branch proximal (LAD proximal)
- 7 L. Anterior descending branch middle (LAD middle)
- 8 L. Anterior descending branch distal (LAD distal)
- 9 1st Diagonal branch (D1)
- 10 2nd Diagonal branch (D2)
- Septal branch (S)



LAO

LAO



- 1 R. Coronary artery proximal (RCA proximal)
- 2 R. Coronary artery middle (RCA middle)
- 3 R. Coronary artery distal (RCA distal)
- 4 AV node artery (AV)



# Chronic Stable Angina

## *Treatment Objectives*

- To reduce the risk of mortality and morbid events
- To reduce symptoms
  - anginal chest pain or exertional dyspnea
  - palpitations or syncope
  - fatigue, edema or orthopnea



# Treatment

- Non – pharmacological

- **Revascularisation**

- Coronary artery bypass grafting (CABG)
    - percutaneous coronary intervention (PCI, PTCA)

- Heart transplantation

- **Pharmacological**

- **Betablockers**
  - **antiplatelet agents**
  - **Lipid lowering agents**
  - **angiotensin-converting enzyme inhibitor ACEI**
  - **Nitroglycerin / nitrates**
  - **(Calcium – antagonist)**



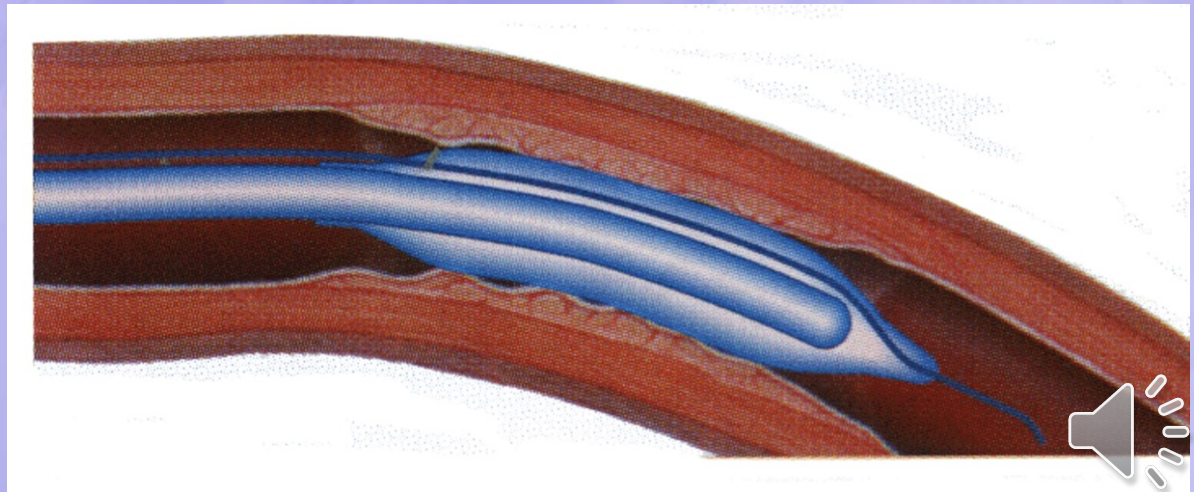
# Indications of revascularisation

1. To be candidate for revascularization procedure, one must have **symptomatic** or **objective signs** of ischemia.
2. Indications for **Percutanous Coronary Intervention (PCI**, formerly Percutaneous transluminal coronary angioplasty PTCA) or **Coronary Artery Bypass Graft (CABG)** may vary from one center to another according to experience, skills and results.
3. Definite indications for **CABG: 3 VD with proximal stenosis**, LM disease.
4. Definite indications for **PCI**: SVD (apart from ostial LAD), favourable morphology .

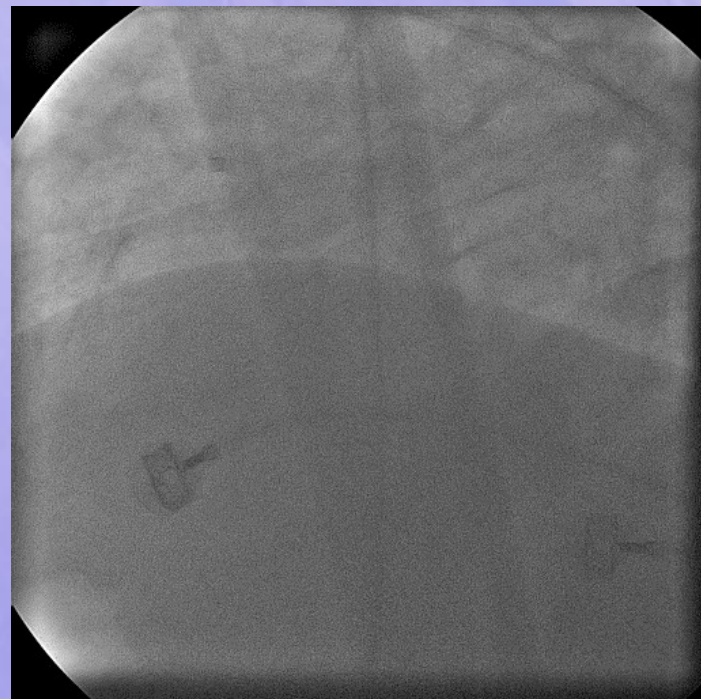
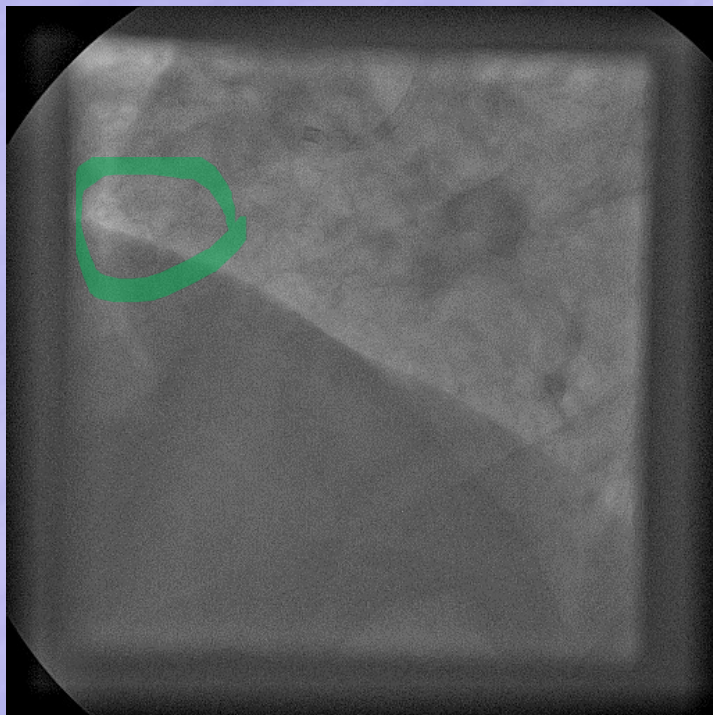


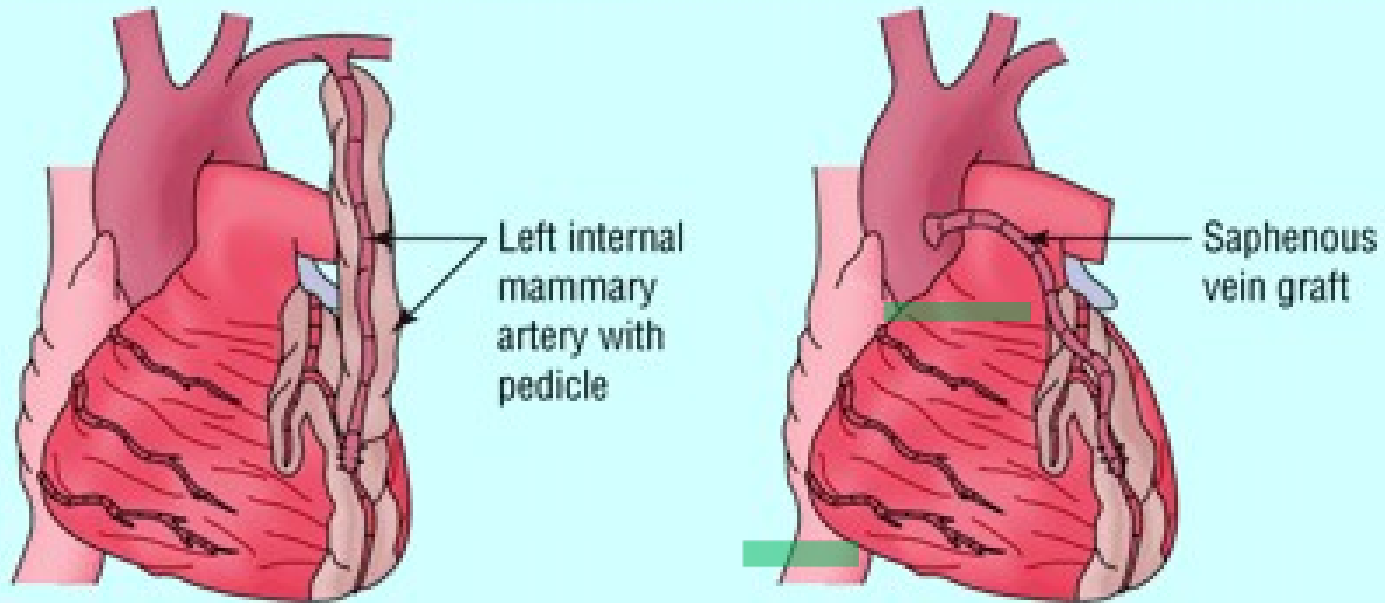
# Procedure

- Sheath in femoral, radial or brachial artery
- diameter sheath (usually 6F, but also 5 to 8)
- guiding catheter
- guide wire 0.014 inch
- balloon
- stent



# PCI - ACD





**Saphenous vein grafts (SVG)** are conduits made by harvesting a piece of vein from the patient's leg and attaching it between the aorta and coronary artery

**Arterial bypass grafts** involve re-routing an artery from its normal course and attaching it to the coronary artery

- Internal Mammary Artery
- Gastroepiploic Artery
- Radial Artery



# Current Medical State of SVG Disease

Average lifespan for a vein graft is 5-10 years

- 50% of SVGs will be occluded within 10 years
- 75% will develop severe narrowing in same period

SVG lesions presenting within the first year after surgery are typically caused by intimal hyperplasia

- respond well to balloon dilatation

Late vein graft stenoses are more commonly caused by diffuse atherosclerosis

- friable plaque and thrombus tend to fragment and embolize into distal coronary vessels





# Ischemia Trial 2019

Patients with **stable** ischemic ischemic heart disease and moderate to severe ischemia were randomized to routine **invasive therapy** (n = 2,588) versus **optimal medical therapy** (n = 2,591)

Duration of follow-up: **3.3 years**

Mean patient age: 64 years

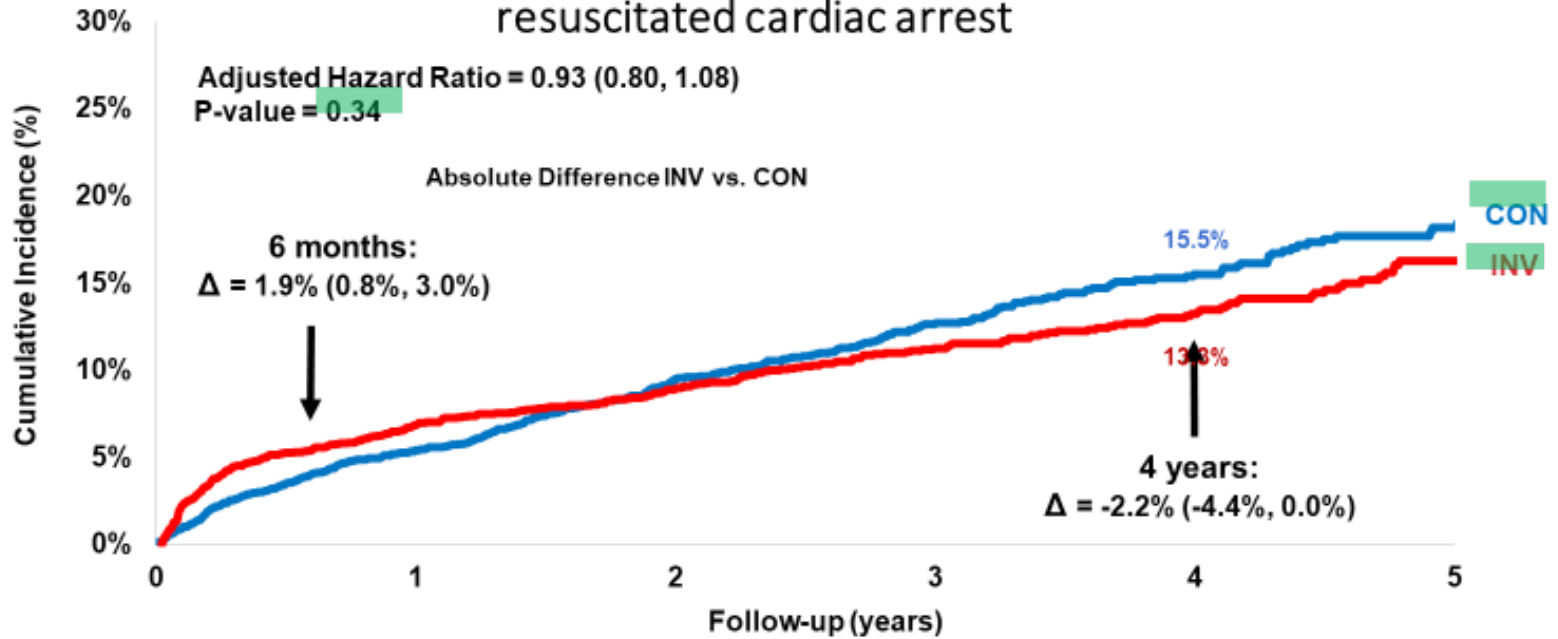
Inclusion: Moderate to severe ischemia on noninvasive stress testing

Presented by Judith S. Hochman at the American Heart Association Annual Scientific Sessions (**AHA 2019**), Philadelphia, PA, November 16, 2019.



# Ischemia Trial

Primary Outcome: CV Death, MI, hospitalization for UA, HF or resuscitated cardiac arrest



## Subjects at Risk

	0	1	2	3	4	5
CON	2591	2431	1907	1300	733	293
INV	2588	2364	1908	1291	730	271



NYU Langone Health Cardiovascular Clinical Research Center

ISCHEMIA trial showed that **heart procedures added to taking medicines and making lifestyle changes did not reduce the overall rate of heart attack or death** compared with medicines and lifestyle changes alone.



# Treatment

- Non – pharmacological

- Revascularisation: CABG / PCI
- heart transplantation

- Pharmacological

- antiplatelet agents
- Betablockers
- ACEI
- Calcium – antagonist
- Lipid lowering agents
- Nitroglycerin / nitrates



# Treatment – antiplatelet agents

- Cyclooxygenase inhibitors

- Aspirin (**Acetylosalicylic acid**) 100 mg daily

- Adenosine diphosphate (ADP) receptor inhibitors 6-12 month after MI

- Ticagrelor (**Brilique**)
- Prasugrel (Efient)
- Clopidogrel 75 mg daily
- (Ticlopidine)

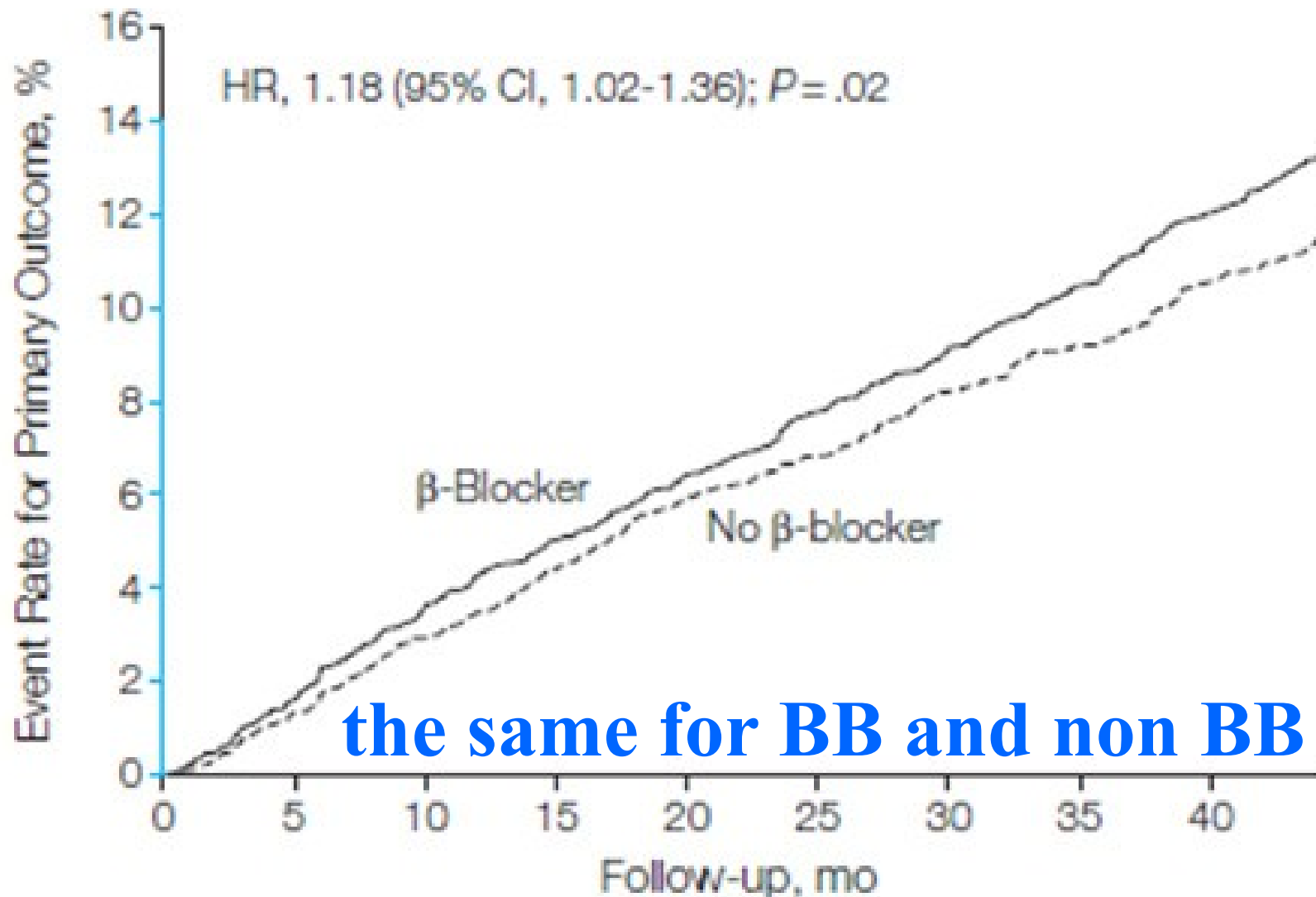


# Treatment - betablockers

- Cardioselective
  - Metoprolol: 100-400 mg
  - Atenolol: 50-200 mg
  - Betaxolol 5-40 mg (long half-life)
- With intrinsic sympathomimetic activity
  - Acebutolol 400-1200 mg
- Non-selective (with alfa  $\alpha$ -blocking activity)
  - Carvedilol 25-100mg



- Freemantle Nick, et al:  **$\beta$  Blockade after myocardial infarction: systematic review and meta regression analysis** BMJ 1999;318:1730
- Systematic review of randomised controlled trials.
- **Subjects:** Patients with acute or past myocardial infarction.
- **Intervention:**  $\beta$ Blockers compared with control.
- **Main:**outcome measures All cause mortality and non-fatal reinfarction
- We identified a **23% reduction in the odds of death** in long term trials (95% confidence interval 15% to 31%)



- Bangalore S, Steg G, Deedwania P, et al; REACH Registry Investigators. JAMA. 2012;308(13):1340-1349

Tab. 4 Metaanalýza studií – kvantifikace účinku statinů<sup>4</sup>

	Denní dávka statinu				
	5 mg	10 mg	20 mg	40 mg	80 mg
<b>a) Absolutní pokles (mmol/l) LDL cholesterolu v séru</b>					
Simvastatin	1,08	1,31	1,54	1,78	2,01
Lovastatin		1,02	1,3	1,77	2,15
Pravastatin	0,73	0,95	1,17	1,38	1,6
Fluvastatin	0,46	0,74	1,02	1,3	1,58
Atorvastatin	1,51	1,79	2,07	2,36	2,64
Rosuvastatin	1,84	2,08	2,32	2,56	2,8
<b>b) Procentuální pokles (%) LDL cholesterolu v séru</b>					
Simvastatin	23	27	32	37	42
Lovastatin		21	29	37	45
Pravastatin	15	20	24	29	33
Fluvastatin	10	15	21	27	33
Atorvastatin	31	37	43	49	55
Rosuvastatin	38	43	48	53	58

Barevně jsou vyznačeny ekvipotence dle Wenga a spol., 2010.<sup>5</sup> Dávky statinů schopné snížit LDL cholesterol zhruba o 20–30 % jsou označeny bíle a dávky schopné snížit LDL cholesterol zhruba o 30–40 % jsou označeny tmavě zeleně.

Tab. 1 Cílové hodnoty cholesterolu a apolipoproteinu B

	Populace obecně	Bez KVO, riziko $\geq 5\%$ , DM2 nebo DM1 s mikro-albuminurií	Přítomnost KVO
Celkový cholesterol	< 5 mmol/l	< 4,5 mmol/l	< 4,0 mmol/l
LDL cholesterol	< 3 mmol/l	< 2,5 mmol/l	< 2,0 mmol/l
Non-HDL cholesterol	< 3,8 mmol/l	< 3,3 mmol/l	< 2,8 mmol/l
Apolipo-protein B	< 1,0 g/l	< 0,9 g/l	< 0,8 mmol/l

Podle: Doporučení pro diagnostiku a léčbu dyslipidemií v dospělosti<sup>1</sup>

Tab. 2 Optimální hodnoty HDL cholesterolu a triglyceridů (stejně pro všechny kategorie rizika)

	Muži	Ženy
HDL cholesterol	> 1,0 mmol/l	> 1,2 mmol/l
Triglyceridy	< 1,7 mmol/l	< 1,7 mmol/l

Podle: Doporučení pro diagnostiku a léčbu dyslipidemií v dospělosti<sup>1</sup>



# Treatment - nitrates

- **tolerance is** a problem
- **Nitroglycerin 0.4 mg spray** (Aborts acute attacks; headaches, hypotension )
- Nitroglycerin 0.4–0.6 mg SL
- Nitroglycerin 0.1–0.6 mg/h patches Prophylactic therapy
- **Isosorbide dinitrate** 10–60 mg three times daily
- **Isosorbide mononitrate** 20 mg twice daily Take 7 h apart, slow release form – once daily
  
- Night: **molsidomin** 2-8 mg (vasodilators)



# Treatment : ca blockers

## • Calcium Channel Blockers:

- Heart Rate Lowering
- Verapamil 120–480mg Heart-rate lowering; AV block, heart failure, constipation

## • Dihydropyridine Calcium Channel Blockers

- Amlodipine 5–10mg Least myocardial depression
- Felodipine 5–20mg High vascular selectivity



# Alternative Diagnoses to Angina for Patients with Chest Pain

- Non-Ischemic CV: aortic dissection, pericarditis

- Pulmonary

- pulmonary embolus
- pneumothorax
- Pneumonia, pleuritis

- Chest Wall / back pain

- Costochondritis, fibrositis, rib fracture
- sternoclavicular arthritis, herpes zoster
- Spasm / injuries

- Gastrointestinal

- Esophageal: esophagitis, spasm, reflux
- Biliary: colic, cholecystitis, choledocholithiasis, cholangitis
- Peptic ulcer / Pancreatitis



# Variant (Prinzmetal's) angina

- Spasmus of vessels
- Provocation during coronarography  
(ergonovine=ergometrine intra arterially)
- Ca blockers (verapamil)



# Cíle po IM – sekundární prevence

- ✦ Zanechat kouření
- ✦ Kompenzace DM – HbA1C < 6,5%
- ✦ Redukce nadváhy (BMI ≤ 30 kg/m<sup>2</sup>)
- ✦ TK < 130/80
- ✦ TCH < 4,0 mmol/l
- ✦ LDL < 2,0 mmol/l
- ✦ TG < 1,7 mmol/l, HDL > 1 (1,2 ženy) mmol/l

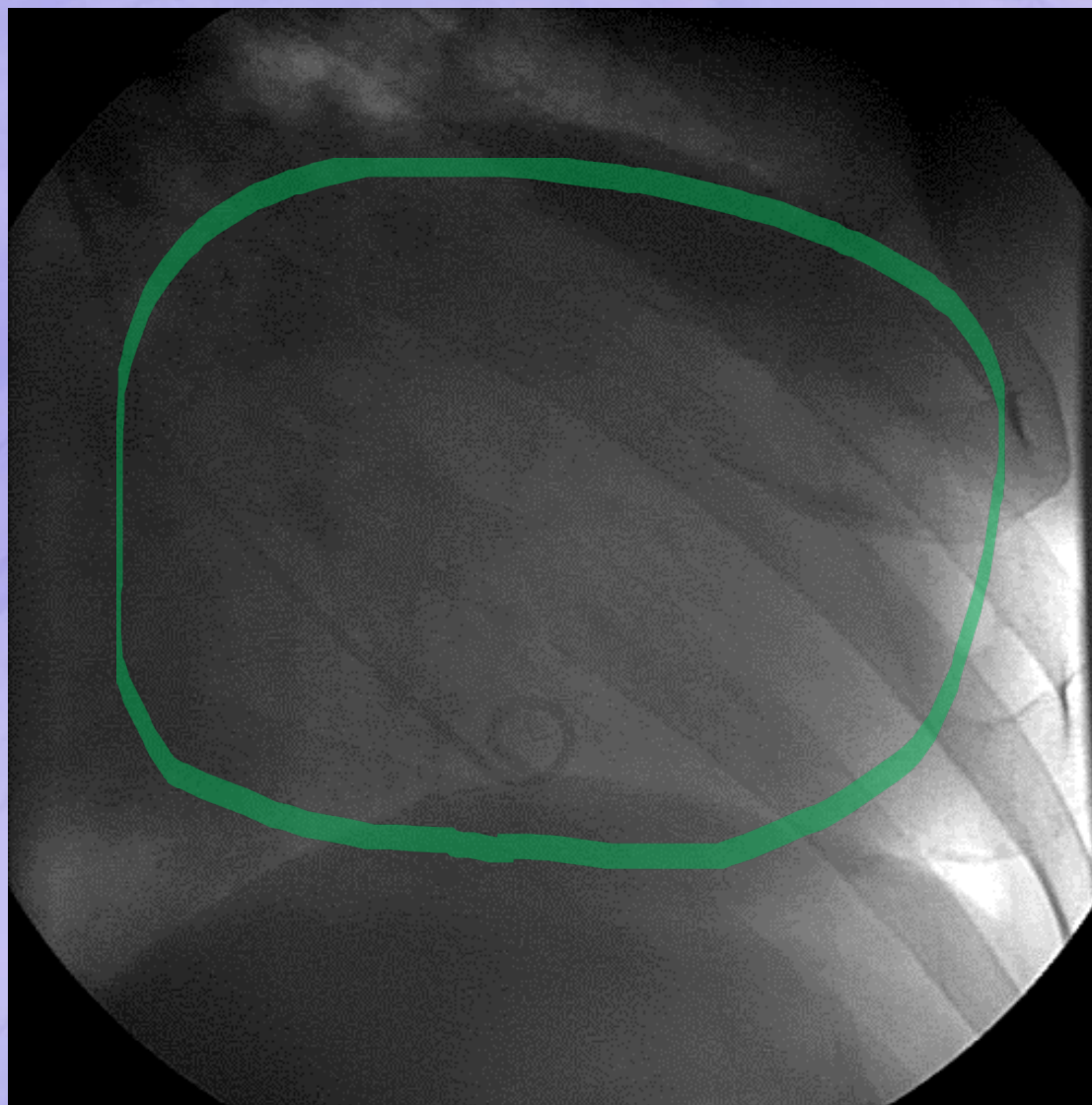


# Treatment

- A = Aspirin and Antianginal therapy
  - B = Beta-blocker and Blood pressure (BP)
  - C = Cigarette smoking and Cholesterol
  - D = Diet and Diabetes
  - E = Education and Exercise
- 
- Therapy (risk reduction of new MI)
    - ASA (clopidogrel / ticlopidin) : -25%
    - BB risk reduction of new MI: -20% ?
    - ACEI risk reduction of new MI: -25
    - Statins risk reduction of new MI: -30%



# CAD with heart failure



# CAD with heart failure

- Diagnosis: **echo**, CT scan, **coronarography**
- Therapy: **revascularisation**
- Therapy of heart failure
  - **diuretics**
  - **BB**
  - **ACEI**
  - **ASA**
  - **CRT / ICD**





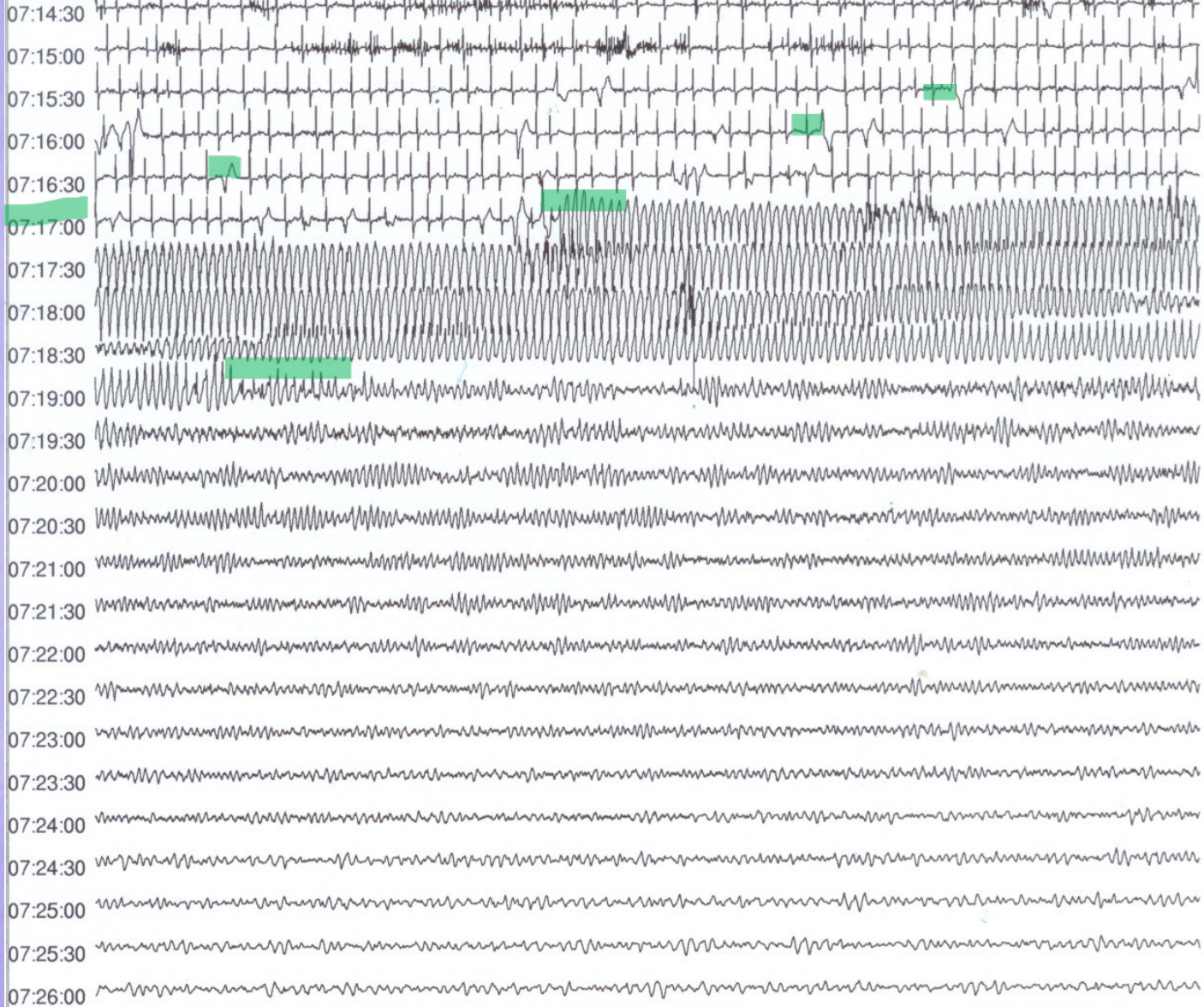
# Arrhythmias - supraventricular

- **Atrial fibrillation**
  - Th: **Beta blockers** / **amiodarone** / (**digoxin**)
  - Radiofrequency ablation
- **Sick sinus syndrome** (SA arrest / brady / tachy syndrome)
- **Atrio ventricular block**
  - **Pacemakers** (VVI, DDD, CRT)





01-Dec



VE Run Length 20 beats (195 bpm) 01-Dec-2009 07:19:03

126 BPM at cursor

Myocardial infarction

Coronary thrombosis

Arrhythmia & Loss of muscle

Sudden death

Myocardial ischaemia

- Revascularisation
- ASA +(ADP blockers)
- BB / ACEI
- Statins
- No smoking
- Correction of HT and DM

Remodelling

CAD

Ventricular dilatation

Atherosclerosis  
LVH

Heart failure

Risk factors  
(HT, LDL ↑, DM, etc)

Endstage  
heart disease



**Thank You for You attention!**

