What Tests Should I Be Having Anyway?

Daniel S. Berman, MD
Director, Cardiac Imaging
Cedars-Sinai Heart Institute

2011

Professor of Medicine
David Geffen School of Medicine at UCLA
What Tests Should I Be Having Anyway?

• Why Test?
• What Test?
• Whom to Test?
• How is there benefit?
Magnitude of the Burden—Causes of Death in the United States

American Heart Association. *Heart and Stroke Statistical Update.*
Heart attack is not an earthquake! It can be predicted, therefore prevented.
Heart Attack: Often No Warning

In >50% of victims, the first symptom of asymptomatic atherosclerosis is sudden cardiac death or acute MI.
Sudden Cardiac Death or Heart Attack As Initial Presentation

Men: 62%

Women: 42%

Murabito et al, Circulation 1993
Heart Attacks Can Be Prevented

~50-60% of heart attacks could be prevented by optimal diet, exercise and currently available medications

PK Shah, MD
Heart Attacks Can Be Prevented

- Prevention of heart attacks need to look beyond traditional risk factors
Heart Attacks Can Be Prevented

• Prevention of heart attacks need to look beyond traditional risk factors
• Why?
Heart Attacks Can Be Prevented

- Prevention of heart attacks need to look beyond traditional risk factors
- Why?
- Because traditional risk factor based screening frequently fails to identify the vulnerable “at risk” patient
Of 136,905 patients hospitalized with CAD: More than 75% had LDL levels below 130 mg/dl

Lipid levels in patients hospitalized with coronary artery disease: An analysis of 136,905 hospitalizations in Get With The Guidelines

Sachdeva et al. AHJ, Vol 157, 111-117 Jan 2009
Of 136,905 patients hospitalized with CAD:
More than 75% had LDL levels below 130 mg/dl
Of 136,905 patients hospitalized with CAD:
Nearly 50% had HDL Over 40

Heart attack with normal HDL

Sachdeva et al. AHJ, Vol 157, 111-117 Jan 2009
Guidelines for Rx and Testing of Asymptomatic Patients

Framingham Risk Score (FRS)

Components

- Age
- Sex
- Total cholesterol
- HDL cholesterol
- BP
- Diabetes

FRS risk levels for MI or CD

- Low <10 (or <6)
- Intermediate (10-20 or 6-20)
- High >20

Wilson, et al, Circulation 1998;97:1837
Framingham Risk Score (FRS)

Limitations: Not Included

- Important risk factors:
  - Family history
  - Activity, fitness
  - Obesity

- Chronicity of risk factors (RF)
- Magnitude of RF over time (how much smoking, how high the BP)
Framingham Risk Score

“BLACK BOX” WARNING

Beware:
This score may not be applicable to patient populations

Asymptomatic Individuals ≠ Asymptomatic patients

A Rozanski
Problem 1 - Inaccurate Individualized Assessment of Cardiovascular Risk

Who Has More Cardiovascular Risk Factors?

Sir Winston Churchill, 91 †
- Overweight
- Not Fit
- Heavy Smoker

Jim Fixx, 53 †
- Not Overweight
- Very Fit
- Non-Smoker
CONCLUSION:

Status Quo

Unacceptable!
Heart Attack Prevention Needs

- Identification of the patient at risk
- Individualized therapeutic recommendations
- Tools to optimize patient “compliance”: changing behavior
Atherosclerotic Plaque Development

Subclinical Atherosclerosis
Carotid Intima Media Thickness (CIMT)

Normal         Abnormal

Near wall

Intima
Media
Adventitia

Intima
Media
Adventitia

Far wall

CCA
ICA
ECA
bulb
CHD incidence rate (per 1,000 person year) adjusted by C-IMT categories with and without plaque

Nambi V et al  J Am Coll Cardiol 2010
Non-Contrast EBCT Scans at the Base of the Heart

No Calcification

Moderate Calcification

Severe Calcification

Left Main

LAD

LCX

Ramus
EBCT Coronary Calcium Scoring

Area = 15 mm²
Peak CT = 450
Score = 15 x 4 = 60

Area = 8 mm²
Peak CT = 290
Score = 8 x 2 = 16

Total Score = \( \sum \)

Hn x-factor
(Agatston Scoring)

130-199  1
200-299  2
300-399  3
>400     4

43 YEAR OLD FEMALE
Coronary Artery Calcium Area by EBCT and Coronary Atherosclerotic Plaque Area: A Histopathologic Correlative Study

Square Root Sum of Plaque Areas

- n = 38
- r = 0.90
- p < 0.001

Rumberger et al, Circulation 1995;92:2157
Coronary Artery Calcification (CAC)

- CAC = coronary atherosclerosis
- Extent of coronary atherosclerosis built up over lifetime
  - Accounts for chronicity and degree of risk factors
- Low radiation dose (0.9 mSv ~3x background)
Coronary Artery Calcium (CAC) Score (Agatston)

Magnitude of Coronary Atherosclerosis

- 0 None
- 1-99 Mild
- 100-399 Moderate
- 400-999 Extensive
- \( \geq 1000 \) Very extensive
Near- & Long-Term Survival by CAC Score Nashville, TN and Los Angeles, CA

\[\chi^2 = 1503, p < 0.0001, \text{ interaction}\]

\[p < 0.0001\]


<table>
<thead>
<tr>
<th>CAC Score</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>0.0% (-)</td>
</tr>
<tr>
<td>11-100</td>
<td>0.0% (-)</td>
</tr>
<tr>
<td>101-400</td>
<td>0.7% (0.0073)</td>
</tr>
<tr>
<td>401-1,000</td>
<td>2.6% (&lt;0.0001)</td>
</tr>
<tr>
<td>&gt;1,000</td>
<td>4.9% (&lt;0.0001)</td>
</tr>
</tbody>
</table>
MESA STUDY
FU 3.9 yrs; 127 events

CAC predictive beyond FRS in all ethnicities
(p<0.001)

Detrano et al.
NEJM 2008;358:1336-45
Cardiovascular Events with Absent or Minimal Coronary Calcification: The Multi-Ethnic Study of Atherosclerosis (MESA)

3415 CAC=0, 508 CAC=1-10, FU 4.1 yrs, 28 all CHD events

Budoff et al. *Am Heart J* 2009;158:554-61
Patient last week: Coronary Artery Calcium Scan

- 50 year old woman referred by her doctor for coronary calcium scanning
- Risk factors: Family history of coronary heart disease
- Blood testing: TC 194; LDL 90; HDL 96; Glucose 84
- Blood pressure: 144/80
- Self-reported lifestyle
  - Exercise: 5/10
  - Low saturated fat diet: 5/10
F 50

Treatment Recommendations by Guidelines
F 50

Treatment Recommendations by Guidelines

Nothing
Coronary artery calcium score: 17.4 (82nd percentile)
Coronary Calcium Score Percentiles for Asymptomatic Women
Circulation, 2000;101:850-855

Calcium Score: 17.4, Age: 50 years

82% Percentile
Aggressive preventive treatment

- Low saturated fat diet
- Regular aerobic exercise
- Reduce blood pressure to 120-130/80
- Reduce LDL cholesterol to <70
Coronary Artery Calcium Area by EBCT and Coronary Atherosclerotic Plaque Area: A Histopathologic Correlative Study

Square Root Sum of Plaque Areas

- n = 38
- r = 0.90
- p < 0.001

Rumberger et al, Circulation 1995; 92: 2157
SHAPE: Screening for Heart Attack Prevention and Eradication
Naghavi, et al Am J Cardiol July 2006
Statin Therapy by NCEP vs. SHAPE Guidelines

EISNER: 2119 volunteers with risk factors

Berman et al, AHA 2007
CAC SCANNING

Who could benefit from testing?
Men over age 45 and women over age 55 with at least one additional risk factor

- High LDL cholesterol
- Low HDL cholesterol
- Diabetes
- High blood pressure
- Smoking
- Family history of premature heart disease
Impact of Coronary Artery Calcium Scanning on Coronary Risk Factors and Downstream Testing

The EISNER (Early Identification of Subclinical Atherosclerosis by Noninvasive Imaging Research) Prospective Randomized Trial

Alan Rozanski, MD,* Heidi Gransar, MS,† Leslee J. Shaw, PHD,‡ Johanna Kim, MPH,† Lisa Miranda-Pearts, MPH,† Nathan D. Wong, PHD,§ Jamal S. Rana, MD, PHD,† Raza Orakzai, MD,† Sean W. Hayes, MD,† John D. Friedman, MD,† Louise E. J. Thomson, MBChB,† Donna Polk, MD,|| James Min, MD,¶ Matthew J. Budoff, MD,# Daniel S. Berman, MD†

New York, New York; Los Angeles, Irvine, and Torrance, California; Atlanta, Georgia; and Providence, Rhode Island

2137 middle age subjects with risk factors: randomized to CAC scan and no scan groups and followed up for 4 years

Rozanski…Berman: J Am Coll Cardiol 2011
Conclusions

• CAC scanning led to improved risk factor profile
  – greater reduction in systolic BP
  – LDL cholesterol
  – waist circumference
  – weight

• Degree of risk factor modification increased as CAC score increased

Rozanski…Berman: J Am Coll Cardiol 2011
Concern about Cost

- Overall rates of downstream medical testing and procedures did not differ among the scan and no-scan groups, resulting in comparable costs during follow-up.

Rozanski…Berman: J Am Coll Cardiol 2011
Monitoring CAC Progression

Coronary Artery Calcium Progression: An Important Clinical Measurement?

A Review of Published Reports

John W. McEvoy, MB,* Michael J. Blaha, MD, MPH,* Andrew P. DeFilippis, MD, MSc,* Matthew J. Budoff, MD,† Khurram Nasir, MD, MPH,*‡ Roger S. Blumenthal, MD,* Steven R. Jones, MD*

Baltimore, Maryland; Torrance, California; and New Haven, Connecticut
Monitoring CAC Progression

- Increased rates of CAC progression have been shown to increase the risk for future cardiac events.
- Yearly testing NOT recommended
- Repeat testing recommendations:
  - 0 score: 5 years
  - Non-zero scores: 3-5 years
“EBCT has the greatest potential for further determination of risk in patients at intermediate risk of developing CHD (i.e., patients in the appropriate age group with multiple risk factors)”

ACC/AHA O’Rourke et al. JACC 2000;36:326-40
ACCF/AHA Guidelines for Assessment of CV Risk in Asymptomatic Adults

Recommendations for CAC Scoring

- Class IIa: reasonable for CV risk assessment in asymptomatic adults at intermediate risk (10% to 20% 10-year risk (Evidence B)

- Class IIb: reasonable for CV risk assessment in asymptomatic adults at low to intermediate risk (6% to 20% 10-year risk (Evidence B)

JACC 2010:56:2182-99
ACCF/AHA Guidelines for Assessment of CV Risk in Asymptomatic Adults

Recommendations for CAC Scoring Diabetes

• In asymptomatic adults with diabetes, 40 years of age and older, measurement of CAC is reasonable for CV risk assessment (Evidence B)

JACC 2010:56:2182-99
Who Does NOT Need CAC Scanning?

- Young or no risk factors
- Known heart disease
  - Myocardial infarction
  - Coronary angioplasty
  - Bypass surgery
- Patients with chest pain symptoms
65 M

Asymptomatic

CACS 4350 (99th percentile)
Further Testing in Asymptomatic Individuals with High CAC Scores

• Patients with coronary artery blockages may have “silent” ischemia (inadequate heart muscle blood flow)

• EISNER study:
  – Patients with CAC scores more than 400 have higher frequency of ischemia
  – Patients with ischemia need additional medications and may be candidates for cardiac catheterization

Berman, et al JACC 2004
Clinical Value of CAC Scanning

Unanswered questions

• Does preventive therapy based on CAC reduce events?
• Does ischemia testing prompted by high CAC alter outcomes?
• No randomized trial has been done
  – But sometimes the data is compelling and trials aren’t needed
Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials

Gordon C S Smith and Jill P Pell

BMJ 2003;327;1459-1461
doi:10.1136/bmj.327.7429.1459
Cedars-Sinai Heart Institute
SHAPE Program

- Calcium scanning/carotid IMT scanning combined with lipid profile
- Calcium scan: cost of dinner for two (***)
- Can self-refer, but must give name of your physician
- 310 423 8000

(Society for Heart Attack Prevention and Eradication)
Temporal resolution

- 0.28 ms gantry rotation
- (~75 msec imaging)
- 2 x 128 slices
Positive remodeling (+), Soft plaque (+),
Fibrous plaque (+), Calcification (-)

Motoyama et al. JACC 2007;50:319-26
Coronary CT Angiography

• Not recommended for screening because of cost

• Quote PK: “if you had a test for $500 and 2 mSv radiation, you would have a screening test: we are almost there
Imaging for Atherosclerosis

- Predicts risk more accurately than risk factors
- Helps guide recommended treatment
- Increases motivation/helps change behavior
- Likely prevents heart attacks
- Widely available, inexpensive
Imaging for Atherosclerosis

- Predicts risk more accurately than risk factors
- Helps guide recommended treatment
- Increases motivation/helps change behavior
- Likely prevents heart attacks
- Widely available, inexpensive

- Consider getting in SHAPE!
Thank you very much