Clinicopathological Conference
AWAAC
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*Cardiology*

Kent Lewandrowski, M.D.
*Pathology*
History of Present Illness

• 54 year old woman with HIV infection was admitted with chest pain and dyspnea.
• She had been well until 10 days prior to admission when she developed shortness of breath.
• Approximately 1 hour before presentation, she developed sub-sternal chest pain, radiating to her neck, accompanied by dyspnea, nausea and diaphoresis.
• She went to the emergency department, where her pain resolved spontaneously
Past Medical History

• Diagnosed with HIV infection 18 yrs ago
• Nadir CD4 cell count 264
• Initially treated with zidovudine and lamivudine; indinavir added in 1996
• Subsequent ARVs (given at different times): stavudine, didanosine, hydroxyurea, abacavir (for 1 month about 7 yrs before admission), nelfinavir, saquinavir and nevirapine.
• Persistent viremia on these regimens.
• Approximately 14 mo. before presentation, started on tenofovir, emtricitabine, lopinavir/ritonavir.
• For 12 mo. prior to this presentation, HIV RNA level undetectable; CD4 count increased from 406 to 614
Past Medical History (continued)

- Oral candidiasis
- Lipodystrophy (facial lipoatrophy)
- HCV infection. HCV RNA >700,000 IU/mL. Liver biopsy: chronic active hepatitis
- Cholesterol 217 mg/dl (reference range <200 desired), Triglycerides 278 mg/dl (40-150), HDL 29 mg/dl (32-100), LDL 132 mg/dl (<130 desired)
- Medications: lopinavir/ritonavir, emtricitabine and tenofovir
Past Medical History (continued)

• Social history: Mediterranean ancestry. Worked in service industry. Drank alcohol occasionally. Had stopped smoking (4 years before). Had discontinued illicit injection drug use (more than 15 years before).

• Family history:
  – Father and brother had myocardial infarctions (MIs) in their fifties. Father, brother and sister had hyperlipidemia
  – Mother had hypertension, a MI in her seventies, stroke and arthritis
Physical Examination

• Patient was in mild distress but did not appear toxic.
• Vital signs and oxygen saturation were normal. Weight was 49.9 kilograms, height 157 centimeters, and body mass index 20.2.
• She had facial atrophy.
• There were crackles in the lung bases.
• Remainder of the examination was normal.
Studies

• Renal function normal
• White blood cell count 12.1 with a normal differential; remainder of complete blood count normal.
• Creatine kinase isoenzymes and troponin-I were initially negative
• Coagulation tests normal

• Chest radiograph: minimal atelectasis or scarring at the left lung base, without evidence of focal pneumonia. The heart and mediastinum normal.
Cardiology Studies

Claudia Chae, M.D.
Initial ECG

Sinus rhythm, 60 per minute with one premature atrial beat and non-specific ST-segment and T-wave changes.
Within 18 minutes, severe chest pain recurred; repeat ECG demonstrated sinus rhythm at a rate of 54 per minute, with ST-segment elevation (up to 5 mm) in leads II, III, aVF, V4 through V6, and ST-segment depression (up to 6 mm) in leads I, aVL, aVR, and V1 through V3.
Clinical course

• Patient’s chest pain resolved spontaneously.

• Aspirin, heparin, eptifibatide and metoprolol were administered.

• Subsequent ECGs showed normalization of ST-segments, followed by transient ST-segment elevations in the absence of pain.

• A diagnostic test was performed.
Differential diagnosis

- Acute myocardial infarction: leading diagnosis
  - Risk factors: age, post-menopausal status, family history, hyperlipidemia, former smoking
  - Patient’s symptoms strongly suggestive of acute coronary syndrome
  - ECGs consistent with acute myocardial infarction

- Coronary vasospasm
  - “Pure” coronary vasospasm, in absence of obstructive coronary artery disease, much less common
  - Usually not associated with typical atherosclerotic risk factors
Differential diagnosis (continued)

• Pericarditis
  – Symptom history, pattern and fluctuations in the ST changes seen on ECG do not fit this diagnosis well.

• Aortic dissection with occlusion of right coronary artery (RCA)
  – RCA is the coronary artery most commonly involved in dissections involving the ascending aorta.
  – However, she does not have risk factors for dissection (including the most common antecedent condition, hypertension)
  – Quality of her chest discomfort would be atypical for aortic dissection
  – Chest x-ray showed a normal mediastinum
Framingham risk score in this patient

**Risk score results:**
- Age: 54
- Gender: female
- Total Cholesterol: 217 mg/dL
- HDL Cholesterol: 29 mg/dL
- Smoker: No
- Systolic Blood Pressure: 120 mm/Hg
- On medication for HBP: No

**Risk Score**: 2%

*The risk score shown was derived on the basis of an equation. Other NCEP materials, such as ATP III print products, use a point-based system to calculate a risk score that approximates the equation-based one.*

To interpret the risk score and for specific information about CHD risk assessment as part of detection, evaluation, and treatment of high blood cholesterol, see [ATP III Executive Summary](#) and [ATP III At-a-Glance](#).
Framingham Risk Estimation in HIV-Infected Adults: Is HIV an independent Risk Factor??

Observed and Predicted MI Rates According to ART Exposure (D:A:D Study)

- Duration of cART Exposure (Years):
  - None
  - < 1
  - 1-2
  - 2-3
  - 3-4
  - > 4

- Rates per 1000 Person-Years:
  - Observed rates
  - Best estimate of predicted rates

Risk of MI higher in HIV infected adults than age-matched uninfected adults

Acute MI rates in 3851 HIV-infected and 1,044,589 HIV-uninfected patients from 1996-2004 (11.1 vs 7.0 events/1000 years)

Should HIV be considered a CAD risk equivalent in a manner similar to diabetes mellitus?

FRAM: After adjustment for other risk factors, HIV infection and DM had similar risk for subclinical atherosclerosis

Veterans Cohort: risk for acute MI was similar in among those with HIV and DM

HIV: HR 1.9 (CI 1.6 to 2.4)
DM: HR 2.0 (CI 1.7 to 2.5).

Freiberg M Abstract #809, CROI 2011.
Why is this happening?
Traditional risk factors (age, gender, DM, HTN) are major predictors for MI (D:A:D)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Adjusted Model 1</th>
<th>Adjusted Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relative Rate</td>
<td>P Value</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td></td>
</tr>
<tr>
<td>Exposure to PIs (per year)</td>
<td>1.16 (1.10-1.23)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age (per 5 yr)</td>
<td>1.39 (1.31-1.46)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Male sex</td>
<td>1.91 (1.28-2.86)</td>
<td>0.002</td>
</tr>
<tr>
<td>BMI &gt;30 kg/m²</td>
<td>1.70 (1.08-2.69)</td>
<td>0.02</td>
</tr>
<tr>
<td>Family history of CHD</td>
<td>1.56 (1.10-2.23)</td>
<td>0.01</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
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</tr>
<tr>
<td>Current</td>
<td>2.83 (2.04-3.93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Former</td>
<td>1.65 (1.12-2.42)</td>
<td>0.01</td>
</tr>
<tr>
<td>Previous cardiovascular event</td>
<td>4.30 (3.06-6.03)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Hypertension</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total cholesterol (per mmol/liter increase)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HDL cholesterol (per mmol/liter increase)</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Cumulative exposure to protease inhibitors independent increase risk of an MI (D:A:D)

PI: Adjusted RR = 1.16 (1.10-1.23, P < .001)
NNRTI: adjusted RR = 1.05 (0.98 – 1.13, P = .17)

Current or recent abacavir use associated with increased risk of CAD

Highest risk in individuals at high predicted risk (defined as > 20% predicted risk of CVD over 10 years)

Untreated HIV infection associated with increased risk of CAD as compared to treated infection (SMART)

N=5472 HIV-infected patients with a CD4+ cell count >350 mm$^3$

Major Cardiovascular, Renal, or Hepatic Disease

Hazard ratio, 1.78; 95% CI, 1.1-2.5; P=0.009

Cumulative Probability of Event

Hazard ratio (95% CI) for CVD 1.6 (1.0-2.5)

No. at Risk
Treatment Interruption
2720 2070 1663 1292 1041 867 693 543 443 375 273 157

Continuous Treatment
2752 2077 1692 1307 1070 899 713 563 462 380 282 165

Initiation of combination antiretroviral therapy rapidly improves vascular function

- Treatment naive HIV pts – randomized to 3 different regimens
- Regardless of regimen, FMD improvement was similar in each arm
- FMD increased by 1.48% (P < .001), but does not restore FMD to normal

Torriani F JACC 2008
Although antiretroviral improves vascular function and reduces risk of MI, it does not completely restore vascular health

Hsue et al (CROI 2010)
Summary of Case

- Despite being a relatively young woman with low Framingham risk score, she has many potential novel risk factors for CAD
  - Prior untreated HIV infection
  - Prolonged exposure to protease inhibitors
  - HCV co-infection (controversial)
- Low CD4+ T cell nadir and presumed chronic inflammation
- Some common HIV-associated risk factors not present, including current or recent abacavir, high BMI and metabolic syndrome
HIV-associated chronic inflammation despite effective HAART as a cause of premature cardiovascular disease
...Over the past decade, it has become widely accepted that inflammation is a driving force behind chronic diseases that will kill nearly all of us (Cancer, Diabetes and obesity, Alzheimer’s disease, Atherosclerosis,...)

...Mediating inflammation in chronic diseases is a new frontier, its success still uncertain...

Science, 2010
Higher CRP levels predict increased risk for heart disease in women (n=27,939; Women’s Health Study)

Pathogenesis of atherosclerosis

Libby, Ridker and Hanson, Nature 2011
Among those with undetectable viral load (<400 copies/mL), hsCRP was 40% higher, IL-6 was 60% higher, and D-dimer was 49% higher, compared with controls from MESA.

### Biomarker Associations Across Outcomes

**SMART/ESPRIT control arms with HIV RNA <500 at entry (n=3227)**

**HR (4th/1st quartile)**

- **AIDS**: P = 0.69, 0.32, 0.43
- **Non-AIDS Cancer**: P = 0.54, 0.02, 0.21
- **CVD**: P = 0.01, 0.005, 0.02
- **All-Cause Mortality**: P = 0.002, < 0.001, < 0.001

**Test of Heterogeneity Across Outcomes**

- hsCRP: P = 0.002
- IL-6: P = 0.005
- D-dimer: P = 0.18
T cell activation declines during long-term HAART, but remains abnormal, even after many years of viral suppression.

WIHS: A Higher Frequency of Activated T Cells Is Associated with Lower Arterial Distensibility (or, More “Stiffness”) in Treated HIV Disease

After adjustment for age and treatment exposure, the change in distensibility per SD of CD4+ T-cell activation was -1.9 (95% CI = -3.2, -0.6, p < 0.01) and per SD of CD8+ T-cell activation was -1.6 (95% CI = -2.9, -0.2, p = 0.02)

Kaplan et al, JID 2011
Higher CMV-specific CD8 IFN-g Production Associated with More Atherosclerosis

Spearman’s rho: 0.49, P<0.001

Hsue et al, AIDS, 2006
HIV Causes Disruption of the Gastrointestinal Tract

HIV-

- Gut lumen
- Gut parenchyma

HIV+

- Enterocyte apoptosis
- Loss of CD4+ T cells
- Loss of tight junctions
- Microbial translocation

Intestinal fatty acid binding protein (I-FABP)

Lipopolysaccharide

Brenchley & Douek, Mucosal Immunol, 2008
Among treated individuals, markers of microbial translocation (LPS, sCD14) are correlated with atherosclerosis (cIMT)
Soluble CD163, a Novel Marker of Activated Macrophages, Is Elevated and Associated With Noncalcified Coronary Plaque in HIV-Infected Patients

Tricia H. Burdo,¹,⁸ Janet Lo,²,³ Suhny Abbara,³ Jeffrey Wei,² Michelle E. DeLelyst,⁴ Fred Preffer,⁴ Eric S. Rosenberg,⁵ Kenneth C. Williams,¹ and Steven Grinspoon²

- CD163 (a macrophage “scavenger” receptor) is shed during cell activation
- sCD163 associated with presence of non-calcified plaque (after adjustment for other factors)
Increased tissue factor expression on circulating monocytes in chronic HIV infection: relationship to in vivo coagulation and immune activation

*Nicholas T. Funderburg,1 *Elizabeth Mayne,2 Scott F. Sieg,1 Robert Asaad,1 Wei Jiang,1 Magdalena Kalinowska,1 Angel A. Luciano,1,3 Wendy Stevens,2 Benigno Rodriguez,1 Jason M. Brenchley,4 Daniel C. Douek,5 and Michael M. Lederman1

1Department of Medicine, Division of Infectious Diseases, Case Western Reserve University/University Hospitals of Cleveland, OH; 2National Health Laboratory Services and University of the Witwatersrand, Witwatersrand, South Africa; 3Rainbow Babies and Children’s Hospital, Case Medical Center, Department of Pediatrics, Cleveland, OH; and 4Laboratory of Molecular Microbiology and 5Human Immunology Section, Vaccine Research Center, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, MD

![Figure 2c](image-url)
Untreated HIV Infection

- Thymic Dysfunction and Loss of Regenerative Potential
- CMV Replication
- HIV Replication
- Loss of Gut Mucosal Integrity and Microbial Translocation

HAART

Persistent Defects in T Cell Regenerative Potential and Decreased but Persistent CMV Replication, HIV Production and Microbial Translocation

Chronic Inflammation

- T Cell Maturation
- Progenitor Cell Exhaustion
- T Cell Dysfunction

Immunosenescence and Clinical Disease

Deeks, Ann Rev Med 2010
Ageing faster with AIDS in Resource-constrained settings

…the proportion of elderly people in Africa infected with HIV/AIDS is increasing. This increase brings both good and bad news:

*good news because increased access to treatments means that patients are living with longer life expectancy;*  
*bad news because meeting the complexities of geriatric care for HIV-infected adults will further challenge overwhelmed health systems*
Conclusions

• HIV infection is independently associated with CVD
• Antiretroviral therapy partially reverses the risk associated with HIV infection
• Certain antiretroviral drugs are associated with increased risk; this effect may be mediated via inflammatory changes (abacavir)
• HIV-associated inflammation persists in absence of viremia (HAART, elite controllers) and this inflammatory process predicts and presumably causes CVD
Clinical diagnosis

• Coronary artery disease and myocardial infarction in an HIV+ woman
Diagnostic test

• Coronary angiography revealed:
  – No significant disease of the left coronary system.
  – Right coronary artery: mild diffuse disease
  – Posterior descending artery had a 30% ostial stenosis.
  – Posterior left ventricular artery was a long vessel with a 90% focal proximal stenosis.
Coronary Stenting

She underwent placement of 2.5 X 12 mm bare-metal stent in the PLV.
Coronary angiography after stenting

... with excellent angiographic results, with TIMI III flow and no residual stenosis.
Hospital course

• Initial troponin I and CK-MB were negative.

• On hospital day #2, the patient’s creatinine kinase (CK) was 140 IU/L (reference range 40-150), CK-MB positive (index of 16.6%)
Cardiac Markers

Old MGH “Rule Out” AMI Protocol

At presentation: Troponin, CK-MB
8 and 16 hours: Troponin

Current MGH “Rule Out” AMI Protocol

At presentation: Troponin
8 and 16 hours: Troponin

Changing troponin cutoff values
Old troponin T cutoff: <0.1 ng/ml
Current troponin T cutoff: <0.03 ng/ml
Cardiac Markers Available At The MGH At The Time Of The Current Case

Whole blood rapid point-of-care testing in the emergency department at the time of the case
Troponin I
CK-MB without total CPK (Note CK-MB has been discontinued and a new TnI has been implemented)

Central laboratory testing
Troponin T (4\textsuperscript{th} generation)
CK-MB with total CPK (Note CK-MB has been discontinued in the new “rule out” AMI protocol)
Hospital course (continued)

- Patient ruled in for an acute MI
- Treated with aspirin, clopidogrel, metoprolol and isordil with resolution of her symptoms and improvement in her clinical status
- Started on atorvastatin
- An echocardiogram on the day of discharge showed normal left ventricular systolic function and no wall motion abnormalities.
Management of HIV+ Patient with CAD

- Identifying and reversing CAD risk factors
  - Lipid management
  - Antiretroviral Management

- CAD Prevention
Guideline: Third report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Executive Summary

**LDL Cholesterol**
- <100: Optimal
- 100-129: Near optimal
- 130-159: Borderline high
- 160-189: High
- ≥190: Very high

**Triglycerides**
- <150: Normal
- 150-199: Borderline high
- 200-499: High
- >500: Very High

**Total Cholesterol**
- <200: Desirable
- 200-239: Borderline high
- ≥240: High

**HDL Cholesterol**
- <40: Low
- >40: High

**Current Case**
- Triglycerides: 278 mg/dl
- Total cholesterol: 217
- LDL cholesterol: 132 mg/dl
- HDL cholesterol: 27 mg/dl

Kent Lewandrowski, M.D.
MGH Pathology
Dyslipidemia in HIV+ Patients

- Dyslipidemia common in HIV+ patients, particularly in those with fat redistribution

- Multiple lipid abnormalities in untreated HIV+ pts:
  - Increased TGs; associated with greater immune activation
  - Lipoprotein particles more atherogenic; higher proportions of small, dense LDL particles
  - HDL lower in HIV+ pts compared with non-HIV

HIV+ with lipodystrophy vs. healthy control subjects from Framingham Study, matched for age and BMI

<table>
<thead>
<tr>
<th>ART-Naive</th>
<th>Post-ART</th>
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<tbody>
<tr>
<td>Total cholesterol</td>
<td>↓</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>↓</td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td>↓</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>↑</td>
</tr>
</tbody>
</table>

Hadigan, CID 2001; Riddler et al. JAMA, 2003
Dyslipidemia in African HIV+ Patients

- 12,513 treatment-naïve HIV+ patients in urban Tanzania
- Non-fasting lipid measurements
- Low HDL and high TGs associated with low CD4 count
In DAD study, LPV/r and IDV associated with increased incidence of MI, even when accounting for lipid levels. ATV not assessed.
HIV and Dyslipidemia: Switching agents

- Switching LPV/r to raltegravir associated with improved lipids; however, higher rate of virologic failure in patients with extensive NRTI experience

- Switching LPV/r to ATV/r improves lipids; decreases abdominal visceral adipose tissue; decreases fasting glucose

Eron, Lancet, 2010
Stanley, AIDS, 2009
Soriano, JAC, 2008
Mallolas, JAIDS, 2009
Managing Dyslipidemia

• Screening: Check fasting lipids at diagnosis, start or change of ART, and every 6-12 months
• Treatment
  – Check drug interactions
  – PIs variably inhibit cytochrome P450 CYP3A4, which is the route of metabolism for most statins
  – NNRTIs may decrease some statin levels
• Manage lipids according to NCEP guidelines, HIV lipid guidelines
  – Statin if LDL above goal or TG 200-500 mg/dL with elevated non-HDL-C
  – Fibrate if TG>500 mg/dL

<table>
<thead>
<tr>
<th>Statin</th>
<th>Level with PI</th>
<th>Use</th>
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<tbody>
<tr>
<td>Pravastatin</td>
<td>--</td>
<td>Can use safely</td>
</tr>
<tr>
<td>Atorvastatin</td>
<td>↑</td>
<td>Use with caution/low dose</td>
</tr>
<tr>
<td>Simvastatin</td>
<td>↑↑</td>
<td>Contraindicated</td>
</tr>
<tr>
<td>Lovastatin</td>
<td>↑↑</td>
<td>Contraindicated</td>
</tr>
<tr>
<td>Rosuvastatin</td>
<td>?</td>
<td>Accruing data</td>
</tr>
</tbody>
</table>
Statins and Inflammation

- Decrease pro-inflammatory cytokine levels and acute phase proteins
- Decrease cellular markers of immune activation
  - RCT of 8 weeks of high-dose (80 mg) atorvastatin or placebo in HIV+ patients not on ART

Ganesan, JID, 2011
Statins Associated with Decreased Mortality in Johns Hopkins Clinical Cohort

- 1538 patients virologically suppressed on ART
- 15.5% received a statin (1/2 prior to ART)
  - 69% atorvastatin, 24% pravastatin, 7% rosuvastatin
- 85 deaths (7 on statins, 78 not on statins)
- Statin use associated with a lower mortality hazard
  - Relative hazard 0.33
  - Adjusted for demographics, cholesterol at start of ART, hemoglobin, CD4, viral load, ART use by year and class, viral hepatitis, AIDS-defining illness
- Unable to specifically assess CVD mortality because of small numbers (2 in statin users, 10 in non-statin users)
- Analysis of antihypertensives showed no association with survival
What would I do for this patient?

- Start her on a statin, e.g. atorvastatin
  - Because of drug interactions with ritonavir, generally start at low-dose (10 mg/d), increase dose if tolerated
- Switch LPV/r to more lipid-friendly agent, e.g. ATV/r
  - Given h/o persistent viremia while receiving prior regimens, would not switch LPV/rtv to raltegravir because of increased risk of virologic failure if she has previous, archived NRTI resistance
- Avoid abacavir if other choices (controversial)
- Goal: optimal suppression of viremia and optimal management of her lipids
Prevention: An Aging Population

• Aging HIV+ population in US
  – In U.S., about 30% of HIV+ adults are >45 yo
  – In Baltimore, 2/3 of HIV+ patients are 45-64 yo
  – By 2015, half of those living with HIV will be > 50 yo

• In South Africa
  – 10% of adults >50 years of age are HIV+
  – 13% of all HIV+ adults are >50 yo

CDC
Negin J, Cumming RG, Bull WHO, 2010
Prevention: Cardiac Risk Factors

- Many HIV+ patients have multiple CAD risk factors
  - Hypertension
  - DM
  - Dyslipidemia
  - Smoking
  - Insulin resistance
  - Endothelial dysfunction

- Critical to identify and treat reversible risk factors

Triant JCEM 2007;92:2506-2512.
HIV and CVD: A Tale of 2 Continents

<table>
<thead>
<tr>
<th></th>
<th>Botswana</th>
<th>Tennessee, US</th>
</tr>
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<tbody>
<tr>
<td>Adjusted incidence, NADE</td>
<td>18.7</td>
<td>12.4</td>
</tr>
<tr>
<td>CV events (1000 py)</td>
<td>8.4</td>
<td>5</td>
</tr>
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- CV events were most common Non-AIDS-Defining Event (NADE) in both Gaborone and Tennessee
- 11 of 37 (30%) deaths in Botswana attributable to NADEs, mostly CV, vs. 3 of 69 (4%) deaths in the US

HIV and CVD: 2030 (WHO Projections)

2030 global mortality
1. Ischemic heart disease (13%)
2. Cerebrovascular disease (11%)
3. HIV/AIDS (9%)

2030 low-income country mortality
1. Ischemic heart disease (13%)
2. HIV/AIDS (13%)
3. Cerebrovascular disease (8%)

Prevention

• “Million Hearts” Initiative
  • Launched on September 13 in the U.S.
  • Goal: prevent 1 million heart attacks and strokes in the next 5 y
• ABCS:
  A spirin for high risk patients,
  B blood-pressure control,
  C holesteral management
  S moking cessation

Frieden and Berwick, NEJM, 2011
• HIVMA/IDSA Guidelines:
  – Close monitoring of lipids and treatment of dyslipidemia
  – Screening for diabetes and hypertension
  – Smoking cessation
  – Estimate 10 yr risk of a CVD using Framingham Risk Score (FRS) and consider screening for CAD in those with high scores

• IAS-USA recognizes CVD or high risk for CVD as a criterion for initiating ART regardless of CD4 count
Patient follow-up

- A pre-cardiac rehab stress test 3 weeks later showed excellent exercise tolerance and no evidence of ischemia or infarction.
- She completed cardiac rehabilitation.
- Her lopinavir/ritonavir was changed to the more lipid-friendly protease inhibitor, atazanavir/ritonavir—and continued cardiac medications, inc. atorvastatin.
- She was admitted 2 years later with atypical chest pain, and ruled out for MI. Stress test showed excellent exercise capacity, normal perfusion and normal left ventricular systolic function.
- Medical management has been continued and she is doing well.