Cardiovascular Aging: Clinical Implications

Michael W. Rich, M.D.
Associate Professor of Medicine
Washington University School of Medicine
St. Louis, MO
Estimated Prevalence of Cardiovascular Diseases in Americans Age 20 and Older by Age and Sex
United States: 1988-94

Source: NHANES III (1988-94) CDC/NCHS and the American Heart Association
## Admissions for Cardiovascular Disease

<table>
<thead>
<tr>
<th>Condition</th>
<th>Total</th>
<th>Age ( \geq 65 )</th>
<th>Age ( \geq 75 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute MI</td>
<td>783</td>
<td>500 (63.9%)</td>
<td>284 (36.3%)</td>
</tr>
<tr>
<td>Coronary disease</td>
<td>1412</td>
<td>790 (55.9%)</td>
<td>378 (26.8%)</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>670</td>
<td>464 (69.3%)</td>
<td>288 (43.0%)</td>
</tr>
<tr>
<td>Heart failure</td>
<td>978</td>
<td>773 (79.0%)</td>
<td>529 (54.1%)</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>1010</td>
<td>746 (73.9%)</td>
<td>493 (48.8%)</td>
</tr>
</tbody>
</table>

# Hospital Mortality for Cardiovascular Causes

<table>
<thead>
<tr>
<th>Condition</th>
<th>Total deaths (in thousands)</th>
<th>Age ≥ 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute MI</td>
<td>78</td>
<td>68 (87.2%)</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>17</td>
<td>12 (70.6%)</td>
</tr>
<tr>
<td>Heart failure</td>
<td>42</td>
<td>37 (88.1%)</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>65</td>
<td>49 (75.4%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Total</th>
<th>Age ≥ 65</th>
<th>Age ≥ 75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac catheterization</td>
<td>1202</td>
<td>597 (49.7%)</td>
<td>243 (20.2%)</td>
</tr>
<tr>
<td>PCI/stent</td>
<td>926</td>
<td>456 (49.2%)</td>
<td>180 (19.4%)</td>
</tr>
<tr>
<td>Coronary bypass</td>
<td>553</td>
<td>304 (55.0%)</td>
<td>117 (21.2%)</td>
</tr>
<tr>
<td>Pacemaker implant</td>
<td>364</td>
<td>309 (84.9%)</td>
<td>211 (58.0%)</td>
</tr>
</tbody>
</table>

Reasons for Increasing Prevalence of Cardiovascular Disease with Age

- Normative cardiovascular aging
- Cumulative effects of cardiovascular risk factors
- Improved survival of middle-aged patients with cardiovascular disease
Principal Effects of Aging on Cardiovascular Structure and Function

- Increased vascular stiffness
- Increased myocardial stiffness
- Decreased β-adrenergic responsiveness
- Impaired mitochondrial ATP production
- Decreased baroreceptor responsiveness
- Impaired sinus node function
- Impaired endothelial function

Net effect: marked reduction in CV reserve
Age and VO$_2$max in Healthy Subjects

Source: Circulation 2000;102(Suppl II):II-602
Effects of Aging on Other Organ Systems

- **Kidneys**
  - Reduced GFR (8 cc/min/decade)
  - Impaired Na/H₂O excretion
  - Impaired electrolyte homeostasis

- **Lungs**
  - Reduced vital capacity
  - Increased V/Q mismatching

- **Nervous system**
  - Diminished reflex responsiveness
  - Reduced CNS autoregulatory capacity
  - Impaired thirst mechanism
Risk Factors for Cardiovascular Disease

- Increasing age
- Family history
- High blood pressure
- High cholesterol
- Diabetes
- Smoking
- Obesity
- Physical inactivity
Blood Pressure Ranges

Normal < 120/80 mmHg
Pre-hypertension 120-139/80-89 mmHg
Stage 1 140-159/90-99 mmHg
Stage 2 ≥ 160/≥ 100 mmHg
Mean systolic and diastolic blood pressures in the United States by age, gender, and race

Source: National Health and Nutrition Examination Survey
Hypertension as a Risk Factor

- Systolic blood pressure is a potent risk factor for fatal and non-fatal cardiovascular events (incl. stroke) in persons over 65 years of age.
- The importance of elevated diastolic blood pressure as a risk factor declines with age.
- Widened pulse pressure, a marker of vascular aging, is also associated with increased cardiovascular risk in the elderly.
### Trials of Antihypertensive Treatment in the Elderly

<table>
<thead>
<tr>
<th>Trial</th>
<th>N</th>
<th>Age</th>
<th>CVA</th>
<th>CAD</th>
<th>CHF</th>
<th>All CVD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian</td>
<td>582</td>
<td>60-69</td>
<td>33%</td>
<td>18%</td>
<td>NR</td>
<td>31%</td>
</tr>
<tr>
<td>EWPHE</td>
<td>840</td>
<td>&gt; 60</td>
<td>36%</td>
<td>20%</td>
<td>22%</td>
<td>29%</td>
</tr>
<tr>
<td>Coope</td>
<td>884</td>
<td>60-79</td>
<td>42%</td>
<td>-3%</td>
<td>32%</td>
<td>24%</td>
</tr>
<tr>
<td>STOP-HTN</td>
<td>1627</td>
<td>70-84</td>
<td>47%</td>
<td>13%</td>
<td>51%</td>
<td>40%</td>
</tr>
<tr>
<td>MRC</td>
<td>4396</td>
<td>65-74</td>
<td>25%</td>
<td>19%</td>
<td>NR</td>
<td>17%</td>
</tr>
<tr>
<td>HDFP</td>
<td>2374</td>
<td>60-69</td>
<td>44%</td>
<td>15%</td>
<td>NR</td>
<td>16%</td>
</tr>
<tr>
<td>SHEP</td>
<td>4736</td>
<td>&gt; 60</td>
<td>33%</td>
<td>27%</td>
<td>55%</td>
<td>32%</td>
</tr>
<tr>
<td>Syst-Eur</td>
<td>4695</td>
<td>&gt; 60</td>
<td>42%</td>
<td>26%</td>
<td>36%</td>
<td>31%</td>
</tr>
<tr>
<td>STONE</td>
<td>1632</td>
<td>60-79</td>
<td>57%</td>
<td>6%</td>
<td>68%</td>
<td>60%</td>
</tr>
<tr>
<td>Syst-China</td>
<td>2394</td>
<td>&gt; 60</td>
<td>38%</td>
<td>33%</td>
<td>38%</td>
<td>37%</td>
</tr>
</tbody>
</table>
Treatment of Hypertension in the Elderly

• Lifestyle modifications
  – Weight loss (if applicable)
  – Salt restriction
  – Regular exercise
  – Avoidance of excess alcohol
  – Smoking cessation

• Medications
  – Diuretics
  – Beta blockers
  – Calcium channel blockers
  – ACE inhibitors
  – Angiotensin receptor blockers
# Cholesterol

<table>
<thead>
<tr>
<th>Cholesterol Type</th>
<th>Value Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>Desirable</td>
<td>&lt; 200 mg/dl</td>
</tr>
<tr>
<td>Borderline high</td>
<td>200-239 mg/dl</td>
</tr>
<tr>
<td>High</td>
<td>≥ 240 mg/dl</td>
</tr>
<tr>
<td><strong>LDL cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>Optimal</td>
<td>&lt; 100 mg/dl</td>
</tr>
<tr>
<td>Near optimal</td>
<td>100-129 mg/dl</td>
</tr>
<tr>
<td>Borderline high</td>
<td>130-159 mg/dl</td>
</tr>
<tr>
<td>High</td>
<td>160-189 mg/dl</td>
</tr>
<tr>
<td>Very high</td>
<td>≥ 190 mg/dl</td>
</tr>
<tr>
<td><strong>HDL cholesterol</strong></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>&lt; 40 mg/dl</td>
</tr>
<tr>
<td>High</td>
<td>≥ 60 mg/dl</td>
</tr>
</tbody>
</table>
# Cholesterol Levels in Men and Women in the U.S.

<table>
<thead>
<tr>
<th>Age</th>
<th>Total, mg/dl (Men)</th>
<th>Total, mg/dl (Women)</th>
<th>LDL, mg/dl (Men)</th>
<th>LDL, mg/dl (Women)</th>
<th>HDL, mg/dl (Men)</th>
<th>HDL, mg/dl (Women)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-34</td>
<td>189</td>
<td>185</td>
<td>120</td>
<td>110</td>
<td>47</td>
<td>56</td>
</tr>
<tr>
<td>35-44</td>
<td>207</td>
<td>195</td>
<td>134</td>
<td>117</td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>45-54</td>
<td>218</td>
<td>217</td>
<td>138</td>
<td>132</td>
<td>47</td>
<td>57</td>
</tr>
<tr>
<td>55-64</td>
<td>221</td>
<td>237</td>
<td>142</td>
<td>145</td>
<td>46</td>
<td>56</td>
</tr>
<tr>
<td>65-74</td>
<td>218</td>
<td>234</td>
<td>141</td>
<td>147</td>
<td>45</td>
<td>56</td>
</tr>
<tr>
<td>≥ 75</td>
<td>205</td>
<td>230</td>
<td>132</td>
<td>147</td>
<td>45</td>
<td>57</td>
</tr>
</tbody>
</table>

Source: National Health and Nutrition Examination Survey (NHANES)
Lipids as a Risk Factor

• Strength of association between lipids and cardiovascular disease declines with age
• Preponderance of evidence indicates that LDL and HDL levels predict CV risk at least up to age 80
• Although relative risk declines with age, the population attributable risk of dyslipidemias for the development of coronary artery disease may be higher in the elderly
<table>
<thead>
<tr>
<th>Study</th>
<th>Placebo</th>
<th>Active</th>
<th>Relative Risk</th>
<th>Events Prevented</th>
</tr>
</thead>
<tbody>
<tr>
<td>4S</td>
<td>&lt; 65</td>
<td>26.4%</td>
<td>0.66</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>&gt; 65</td>
<td>33.4%</td>
<td>0.66</td>
<td>98</td>
</tr>
<tr>
<td>CARE</td>
<td>&lt; 65</td>
<td>25.6%</td>
<td>0.81</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>&gt; 65</td>
<td>28.1%</td>
<td>0.68</td>
<td>84</td>
</tr>
<tr>
<td>LIPID</td>
<td>&lt; 65</td>
<td>13.4%</td>
<td>0.77</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>&gt; 65</td>
<td>19.7%</td>
<td>0.79</td>
<td>42</td>
</tr>
</tbody>
</table>
Fig 3. Kaplan-Meier survival curves for all-cause mortality in patients ≥65 and <65 years of age.
UK Heart Protection Study

- 20,536 patients, age 40-80
- High risk due to:
  - Angina or prior myocardial infarction
  - Prior stroke
  - Significant peripheral arterial disease
  - Diabetes mellitus
  - Hypertension
- Randomized to simvastatin 40 mg or placebo
- Followup 5 – 5 1/2 years
UK Heart Prevention Study

Results

- 24% reduction in major vascular events (MI, CVA, revascularization procedures, death)
- 28% reduction in MIs and CVAs in diabetics
- 17% reduction in CV mortality (791 vs. 943)
- 12% reduction in all-cause mortality
UK Heart Protection Study

Results (continued)

- Benefits evident in all subgroups
  - Age $\geq 75$ years
  - Women
  - Total chol $< 200$, LDL $\leq 115$ mg/dl

- Excellent safety profile
  - Adverse events similar to placebo
SIMVASTATIN: VASCULAR EVENT by AGE & SEX

<table>
<thead>
<tr>
<th>Baseline feature</th>
<th>STATIN (10269)</th>
<th>PLACEBO (10267)</th>
<th>Risk ratio and 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group (years)</td>
<td></td>
<td></td>
<td>STATIN better STATIN worse</td>
</tr>
<tr>
<td>&lt; 65</td>
<td>838</td>
<td>1093</td>
<td></td>
</tr>
<tr>
<td>65 - 69</td>
<td>516</td>
<td>677</td>
<td></td>
</tr>
<tr>
<td>70-74</td>
<td>550</td>
<td>628</td>
<td></td>
</tr>
<tr>
<td>≥ 75</td>
<td>138</td>
<td>208</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1676</td>
<td>2148</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>366</td>
<td>458</td>
<td></td>
</tr>
<tr>
<td>ALL PATIENTS</td>
<td>2042 (19.9%)</td>
<td>2606 (25.4%)</td>
<td></td>
</tr>
</tbody>
</table>

Het $\chi^2_3 = 4.4$
Het $\chi^2_1 = 0.4$
24%SE 2.6 reduction (2P<0.00001)
Treatment of Dyslipidemias in the Elderly

NCEP: ATP-III

- Primary prevention
  - Therapeutic lifestyle changes
  - Drug therapy in high risk patients

- Secondary prevention
  - Similar to younger patients
  - Target LDL-C < 100 mg/dl
Prevalence of Diabetes in the U.S. Population

Source: National Health and Nutrition Examination Survey III
Age-Adjusted Incidence Rates for Coronary Heart Disease Based on Diabetic Status

Framingham Study. 30-Year Follow-Up.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Male</th>
<th>Female</th>
<th>RR</th>
</tr>
</thead>
<tbody>
<tr>
<td>35-64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18%</td>
<td>10%</td>
<td>1.7**</td>
</tr>
<tr>
<td></td>
<td>35%</td>
<td>5%</td>
<td>3.8***</td>
</tr>
<tr>
<td>65-94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>5%</td>
<td>1.4*</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>10%</td>
<td>2.1***</td>
</tr>
</tbody>
</table>
SIMVASTATIN: MAJOR CORONARY EVENTS and STROKE by prior DIABETES

Vascular event & disease group

<table>
<thead>
<tr>
<th>Vascular event</th>
<th>SIMVASTATIN</th>
<th>PLACEBO</th>
<th>Rate ratio &amp; 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major coronary events</td>
<td>(10269)</td>
<td>(10267)</td>
<td>STATIN better PLACEBO better</td>
</tr>
<tr>
<td>Diabetes</td>
<td>279 (9.4%)</td>
<td>377 (12.6%)</td>
<td>27% SE 4 reduction (2P&lt;0.00001)</td>
</tr>
<tr>
<td>No diabetes</td>
<td>619 (8.5%)</td>
<td>835 (11.5%)</td>
<td></td>
</tr>
<tr>
<td>All patients</td>
<td>898 (8.7%)</td>
<td>1212 (11.8%)</td>
<td></td>
</tr>
</tbody>
</table>

Strokes

<table>
<thead>
<tr>
<th>Vascular event</th>
<th>SIMVASTATIN</th>
<th>PLACEBO</th>
<th>Rate ratio &amp; 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>149 (5.0%)</td>
<td>193 (6.5%)</td>
<td>25% SE 5 reduction (2P&lt;0.00001)</td>
</tr>
<tr>
<td>No diabetes</td>
<td>295 (4.0%)</td>
<td>392 (5.4%)</td>
<td></td>
</tr>
<tr>
<td>All patients</td>
<td>444 (4.3%)</td>
<td>585 (5.7%)</td>
<td></td>
</tr>
</tbody>
</table>
MICRO-HOPE: Effects of Ramipril on Primary Endpoints and Total Mortality

- CV Death: 37% reduction, *P = 0.0001
- Nonfatal MI: 22% reduction, **P = 0.01
- Stroke: 33% reduction, ***P = 0.0074
- Total Mortality: 25% reduction, ****P = 0.0004

## Smoking Status of Adults: 1998

<table>
<thead>
<tr>
<th>Age, yrs</th>
<th>Never</th>
<th>Former</th>
<th>Current</th>
<th>Advised To Quit</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 55</td>
<td>40.4%</td>
<td>22.7%</td>
<td>36.9%</td>
<td>71.7%</td>
</tr>
<tr>
<td>55-64</td>
<td>31.5%</td>
<td>37.8%</td>
<td>30.7%</td>
<td>72.4%</td>
</tr>
<tr>
<td>65-74</td>
<td>41.5%</td>
<td>43.4%</td>
<td>15.1%</td>
<td>72.7%</td>
</tr>
<tr>
<td>75-84</td>
<td>49.5%</td>
<td>41.4%</td>
<td>9.1%</td>
<td>66.3%</td>
</tr>
<tr>
<td>≥ 85</td>
<td>64.8%</td>
<td>30.7%</td>
<td>4.5%</td>
<td>56.1%</td>
</tr>
</tbody>
</table>

Source: MMWR 2000;49:797-801
Risk of Continued Smoking: The CASS Registry

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Relative Risk for Death*</th>
<th>Relative Risk for Death or MI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>55-59</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>60-64</td>
<td>2.0</td>
<td>1.4</td>
</tr>
<tr>
<td>65-69</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>≥ 70</td>
<td>3.3</td>
<td>2.9</td>
</tr>
</tbody>
</table>

* Compared to persons who stopped smoking, 6 year follow-up

*NEJM 1988;319:1365-9*
Coronary Artery Disease (CAD)

- Most common cause of death in U.S. in both men and women
- Narrowing of coronary arteries due to buildup of cholesterol plaque
- Arteries may be narrowed up to 75% without causing symptoms
Spectrum of CAD

Silent

→

Angina pectoris

→

Unstable angina

→

Myocardial infarction

| Heart failure | Death |
Prevalence of Coronary Heart Disease by Age and Sex in the U.S. from 1988-94

Source: National Health and Nutrition Examination Survey
Diagnosis of CAD

- Symptoms
- Electrocardiogram (ECG)
- Stress test
- Cardiac catheterization
ECG Waveforms
Normal 12-lead ECG
Angina Pectoris

- Chest tightness, pressure, heaviness
- Brought on by exertion, emotional stress
- May radiate to arm, throat, jaw
- May be associated with SOB, weakness
- Relieved by rest, nitroglycerin
Treatment of Coronary Artery Disease

• Lifestyle modifications
• Treatment of risk factors
• Medications
  – Aspirin/Clopidogrel
  – Nitrates
  – Beta blockers
  – Calcium channel blockers
  – ACE-inhibitors/ARBs
  – Statins
• Revascularization
  – PTCA/stenting
  – Coronary bypass surgery (CABG)
Mortality Following PTCA and CABG
Case 1: Prolonged chest pain

An 82 y.o. man with hypertension, elevated cholesterol, PUD, mild CRI, and stable exertional angina presents to the ED with a 2 hr h/o moderate chest pain radiating to the shoulders and upper arms and associated with SOB, weakness, and pallor. He took 3 “nitros” at home without relief. HR 90, regular. BP 160/80 mmHg. RR 22/min. Heart: RRR, normal tones, no murmurs. Lungs: bibasilar moist crackles.

What is the cause of this patient’s symptoms?
How should he be treated?
Acute Myocardial Infarction

- Death of heart muscle due to plaque rupture with sudden occlusion of artery by blood clot
- More severe and prolonged symptoms
- High risk of death in early hours
- Requires emergency hospitalization
Acute Anterolateral MI
Epidemiology of Acute MI in the United States

<table>
<thead>
<tr>
<th>Age, years</th>
<th>% of Population</th>
<th>No. of MIs (in 1000s)</th>
<th>% of MIs</th>
<th>% of MI Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-64</td>
<td>66.3%</td>
<td>320</td>
<td>38.6%</td>
<td>&lt; 20%</td>
</tr>
<tr>
<td>≥ 65</td>
<td>12.6%</td>
<td>509</td>
<td>61.4%</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>≥ 75</td>
<td>6.1%</td>
<td>305</td>
<td>36.8%</td>
<td>~ 60%</td>
</tr>
</tbody>
</table>

Source: 1999 National Hospital Discharge Survey
Prognosis after Acute MI by Age

Source: Circulation 1996;94:1826-33
Treatment of Acute MI

- Reperfusion therapy
  - Thrombolysis
  - PTCA/stenting
- Aspirin / anti-thrombotic therapy
- Beta blockers
- ACE inhibitors
Heart Valves

- Ensure proper direction of blood flow through the heart
- Right side: tricuspid, pulmonic
- Left side: mitral, aortic
- Valve disorders
  - Stenosis (narrowing)
  - Regurgitation (leakage)
Diagnosis of Valve Disorders

- Symptoms: fatigue, chest pain, dizziness, heart failure
- Signs: heart murmur, heart failure
- Echocardiogram
- Cardiac catheterization
Aortic Stenosis

- Prevalence: 15% of persons ≥ 75 years
- Second most common reason for heart surgery
- Symptoms: angina, shortness of breath, dizziness, syncope
- Diagnosis: physical exam, echocardiogram
- Treatment: aortic valve replacement
- Prognosis: favorable with surgery
Mitral Regurgitation

- Prevalence: 30% of persons ≥ 75 years
- Symptoms: shortness of breath, ankle swelling
- Diagnosis: physical exam, echocardiogram
- Treatment: medications, surgery
- Prognosis: variable; depends on severity, etiology, other factors (e.g. LV function)
Heart Failure

- Inability of the heart to pump a sufficient supply of blood to meet the body’s needs
- Quintessential disorder of cardiovascular aging
Case 2: Exertional shortness of breath

An 83 y.o. woman with hypertension, o/w healthy, c/o increasing SOB with walking. 2 yrs ago she could walk to the store (3 blks) without difficulty, but now she has to stop to “catch my breath”. She also reports difficulty climbing stairs. She denies CP or SOB at rest, but tires more easily. She smoked 1 PPD for 30 yrs but quit 20 yrs ago. Her husband died 1½ yrs ago from cancer; since then she “hasn’t felt like doing anything”.

What is the cause of this patient’s shortness of breath?

Differential diagnosis: heart failure, angina, depression, deconditioning, COPD, anemia, thyroid disease, cancer? Or could it be “normal aging” (as the patient believes)?
Epidemiology of Heart Failure in the United States

- Prevalence: 5.0 million (2.2%)
- Incidence: 550,000 new cases/year
- Hospitalizations: 999,000 in 2000
- Mortality: 47,000/220,000 per yr
- Cost: > $25 billion annually
- Median age: 75 yrs
  - 78% of men ≥ 65 years
  - 85% of women ≥ 65 years
- Incidence and prevalence increasing
Incidence of Heart Failure in the Elderly: The Cardiovascular Health Study

Gottdiener JS. JACC;35:1628.
Heart Failure in the U.S.: Impact of Gender

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>2.3M</td>
<td>2.4M</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admissions</td>
<td></td>
<td></td>
<td>438K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>540K</td>
<td></td>
<td></td>
<td>17.7K</td>
<td></td>
<td>29.3K</td>
</tr>
</tbody>
</table>
Numbers of Patients Hospitalized with Heart Failure

Age (Years)

<40  40-49  50-59  60-69  70-79  80-89  90-99  >99

0  10  20  30  40
Etiology of Heart Failure

- Coronary artery disease
- Hypertension
- Valvular heart disease
- Cardiomyopathy
  - Dilated
  - Hypertrophic
  - Restrictive
- Systolic vs. diastolic
How is Heart Failure Diagnosed?

- Symptoms
- Physical examination
- Chest X-Ray
- Echocardiogram
- Cardiac catheterization
What Are the Symptoms of Heart Failure?

- Exertional shortness of breath
- Decreased exercise tolerance
- Fatigue
- Orthopnea
- Paroxysmal nocturnal dyspnea (PND)
- Swelling of feet and ankles (edema)
<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No limitations; symptoms only with strenuous activities</td>
</tr>
<tr>
<td>II</td>
<td>Mild limitations; symptoms with moderate activity, e.g. climbing several flights of stairs</td>
</tr>
<tr>
<td>III</td>
<td>Marked limitations; symptoms with common daily activities, e.g. walking less than 2 blocks</td>
</tr>
<tr>
<td>IV</td>
<td>Severe limitations; symptoms at rest or with minimal activity, e.g. going to the bathroom</td>
</tr>
</tbody>
</table>
Pharmacotherapy of Systolic Heart Failure

- ACE inhibitors
- Beta blockers
- Diuretics: Thiazide, Loop
- Digoxin: ?
- Spironolactone
- Metolazone: As needed

New York Heart Association Class

Progression of Heart Failure
Management of Diastolic Heart Failure

- Optimize blood pressure control
- Treat ischemia (CAD)
- Medications
  - Diuretics
  - ACE inhibitors
  - Angiotensin receptor blockers
  - Beta blockers
  - Calcium channel blockers
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Age</th>
<th>Time</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gooding</td>
<td>1985</td>
<td>≥ 65</td>
<td>6 mo</td>
<td>36%</td>
</tr>
<tr>
<td>Rich</td>
<td>1988</td>
<td>≥ 70</td>
<td>3 mo</td>
<td>29%</td>
</tr>
<tr>
<td>Vinson</td>
<td>1990</td>
<td>≥ 70</td>
<td>90 da</td>
<td>47%</td>
</tr>
<tr>
<td>Krumholz</td>
<td>1997</td>
<td>≥ 65</td>
<td>6 mo</td>
<td>44%</td>
</tr>
<tr>
<td>Philbin</td>
<td>1999</td>
<td>mean 76</td>
<td>6 mo</td>
<td>46%</td>
</tr>
<tr>
<td>Cowie</td>
<td>2002</td>
<td>mean 75</td>
<td>19 mo</td>
<td>59%</td>
</tr>
<tr>
<td>DiLenarda</td>
<td>2003</td>
<td>mean 74</td>
<td>6 mo</td>
<td>45%</td>
</tr>
</tbody>
</table>
Why the Gap between RCTs and Clinical Practice?

- Underutilization of effective therapies
- Inadequate treatment of prevalent comorbidities
- Poor compliance with medications and diet
- Inadequate followup

“At least 50% of HF admissions are preventable.”
Objectives of HF Disease Management

- Maximize physician/provider compliance with established practice guidelines
- Optimize management of comorbidities
- Enhance patient compliance and self-efficacy
- Identify barriers and intervene pro-actively
- Improve well-being and quality of life
- Reduce resource consumption and cost of care
- Increase functional survival
HFDM Meta-analysis

- 18 RCTs from 8 countries (10 U.S.) involving 3304 in-patients with HF
- Mean age ≥ 70 yrs in 16/18 studies
- NYHA class, LVEF variable
- Mean follow-up 8 mo (range 3-12 mo)

JAMA 2004;291:1358-67
# HFDM Meta-analysis: Results

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Intervention</th>
<th>Control</th>
<th>RR</th>
<th>NNT</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Readmissions</td>
<td>34.9%</td>
<td>43.2%</td>
<td>0.75</td>
<td>12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Death or readmission</td>
<td>44.1%</td>
<td>60.3%</td>
<td>0.73</td>
<td>6</td>
<td>0.02</td>
</tr>
<tr>
<td>All-cause mortality</td>
<td>14.2%</td>
<td>16.5%</td>
<td>0.87</td>
<td>43</td>
<td>0.06</td>
</tr>
</tbody>
</table>

*JAMA 2004;291:1358-67*
HFDM Meta-analysis: Results

- 25.7% improvement in quality of life scores (p = 0.01; N = 6 studies)
- $536 lower overall cost of care/pt among U.S. trials (95% CI $115 to $956, p = 0.03; N = 4 studies)
- $359 lower overall cost of care/pt among non-U.S. trials (95% CI -$45 to $763, p = 0.10; N = 4 studies)

JAMA 2004;291:1358-67
Sick Sinus Syndrome

- Prevalence: increases progressively with age
- Etiology: degeneration of sinus node pacemaker cells
- Symptoms: dizziness, syncope, fatigue, effort intolerance, heart failure, angina
- Diagnosis: ECG -- brady and tachyarrhythmias
- Treatment: permanent pacemaker
- Complications: increased risk of stroke
Atrial Fibrillation

- Chaotic beating of upper chambers (atria)
- Prevalence: > 10% after age 80
- Symptoms: palpitations, shortness of breath, angina
- Diagnosis: physical exam, ECG
- Complications: heart failure, stroke
- Prognosis: good with proper treatment
Atrial Fibrillation with RVR
Management of Atrial Fibrillation

• Rate control
  – Beta-blockers
  – Diltiazem, verapamil
  – Digoxin
  – AV node ablation

• Restoration and maintenance of sinus rhythm
  – Electrical cardioversion
  – Anti-arrhythmic agents
  – Surgery

• Anticoagulation
  – Warfarin (68% reduction in stroke)
  – Aspirin (22% reduction in stroke)
Clinical Decision-Making: The Entropy of Aging

Patient factors
- Lifestyle
- Goals/expectations
- Quantity vs. quality of life

Clinician factors
- Avoidance of age bias
- Realistic appraisal
Take Home Message #1

- Aging is associated with extensive changes throughout the cardiovascular system that markedly reduce cardiovascular reserve and predispose older adults to the development of cardiovascular disease.
Take Home Message #2

- The prevalence of all major adult cardiovascular diseases increases with age due to the combined effects of cardiovascular aging and the cumulative effects of common cardiovascular risk factors.
Take Home Message #3

- In general, cardiovascular therapies are at least as effective in the elderly as in younger patients, and age per se is rarely a contraindication to the use of established treatments. However, due to the marked heterogeneity of the elderly population, management of older patients must be individualized.
Take Home Message #4

- Older patients with cardiovascular disease have a less favorable prognosis than younger patients, thus emphasizing the importance of preventive strategies, including aggressive management of major cardiac risk factors in persons of all ages.