Epidemiology of Cardiovascular Diseases

TRANSMED Course, 01.04.2014
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Types of CVD

- The main types of CVD are:
  - Coronary Heart Disease (CHD) – acute coronary syndrome (ACS)
    - myocardial infarction (MI)
  - Stroke
  - Peripheral Arterial Disease – intermittent claudication
  - Heart failure (HF)
  - Hypertension

- There are other forms of CVD, mainly of infectious, immunologic, congenital or genetic origin but they are less common and will not be discussed in this presentation.
Clinical manifestations - CHD

• Blood flow to the heart muscle is limited or blocked by an obstructive process in the coronary artery resulting in:
  – Angina pectoris
  – Unstable angina
  – Acute myocardial infarction
  – Coronary death

• The last three are often grouped together and called Acute Coronary Syndrome (ACS)

• Coronary death is often sudden and can be the first manifestation of CHD

• Two thirds of CHD deaths are sudden, out-of-hospital deaths, about one third occur in hospital
Clinical manifestations - stroke

- Stroke is an umbrella name for various catastrophes in intracranial blood circulation. They can be divided to ischemic and hemorrhagic strokes.
- In western populations about 80% of strokes are ischemic and 20% hemorrhagic. In oriental populations the proportion of hemorrhagic strokes is larger.
- Ischemic strokes can be further divided to thrombotic and embolic strokes. This division is often not possible in epidemiologic materials.
- Hemorrhagic strokes can be further divided to subarachnoid hemorrhage (SAH) and intracerebral hemorrhage (ICH), which are different disease entities.
Clinical manifestations - PAD

- Usually an obstructive atherosclerotic process in conduit arteries impeding the blood flow to leg muscles.
- Intermittent claudication: typically pain in a calf muscle at exertion, relieves at rest.
- In epidemiological surveys usually screened using the ankle brachial index (ABI).
Clinical manifestations - HF

- HF (sometimes called congestive heart failure) can be the end result of several disease processes affecting the heart
  - Most common causes in western populations are CHD and hypertension
- HF is a common cause for hospitalization and death in elderly individuals. Therefore, it is of considerable public health importance.
- Nevertheless, HF is a difficult entity in epidemiological surveys, because of the lack of sensitive and reliable tests which would be feasible in an epidemiological scale.
  - Echocardiography is the best noninvasive way to diagnose HF but usually cannot be done in the epidemiological scale.
Hypertension (elevated blood pressure)

- Usually defined as elevated BP: SBP ≥140 mmHg or DBP ≥ 90 mmHg or antihypertensive treatment
- "The silent killer"
- Hypertension is associated with increased risk of MI, Stroke, heart failure and kidney dysfunction
- Globally the most important risk factor for health problems in middle-aged adults
- About a quarter of world adult population have elevated BP and it causes annually about 7 M deaths.
Etiology: Most CVD are due to atherosclerosis

Source of the figure: NHLBI web-site
Proportion of CVD and CHD of all-cause mortality

- CVD are the most common causes of death. In Finland, CVD constituted 40% (38.7% among men 41.7% among women) of all cause mortality in 2010 (Source: Statistics Finland)

- CHD is the single most common cause of death in western populations. In Finland, it constituted 23% (24.1% in men and 22.0% in women) of all deaths in 2010.
Cardiovascular disease (CVD) and other major causes of death in males: total, <85 years of age, and ≥85 years of age.

et al. Circulation 2012;125:e2-e220

Copyright © American Heart Association
Cardiovascular disease (CVD) and other major causes of death in females: total, <85 years of age, and ≥85 years of age.
Percentage breakdown of deaths attributable to cardiovascular disease (United States: 2008).

- Coronary Heart Disease, 49.9%
- Stroke, 16.5%
- Heart Failure*, 7.0%
- High Blood Pressure, 7.5%
- Diseases of the Arteries, 3.4%
- Other, 15.6%

et al. Circulation 2012;125:e2-e220
Age-standardized CHD mortality in men and women aged 35-64 years in Finland during 1952-2009

Mortality/100 000
Time trends in CHD mortality and morbidity

- The age-standardized CHD mortality in working-aged population has declined in Finland by > 80% from the top level in the early 1970s
- Similar declines have been seen in all western countries
- Incidence has also declined but somewhat less than mortality
- Age-standardization makes an important difference here. Due to the aging of the population, crude numbers of CHD patients have declined less and concerns of increasing trends have been presented.

et al. Circulation 2012;125:e2-e220
Effect of age and sex

- CHD mortality and morbidity increase with age approximately in a log-linear manner
- Strokes occur mainly in elderly individuals,
  - SAH can occur in young individuals, increases with age and peaks about at age 50 years
- Women are relatively protected from CVD until menopause but ultimately have as much CVD as men
  - On average, women develop CVD almost 10 years older than men
Prevalence of CHD and stroke

- Based on the Health 2000 Survey, the prevalence of CHD in the population of Finland aged ≥30 years was 9.4% in men and 5.4% in women.
- The prevalence of stroke was 2.3% in men and 1.3% in women.
Modelled prevalence of acute coronary syndrome survivors until 2050 in Finland among men (blue line) and women (red line) aged >35 years.

To demonstrate the effect of the aging of the population, the prevalence is not age-standardised. The thin dotted line indicate the 50% and 95% credible interval.
Socioeconomic differences

- In industrialized countries persons with low socioeconomic position have higher CVD mortality and morbidity.
- Reasons are unclear but it seems that smoking explains a large part of the difference.
Trends in Age-standardized Incidence and 28-day Mortality Rates by Education

Men

FINAMI

Circulation 2000;101:1913-8
Case-Fatality of First MI Events by Income

Men aged 35-64 years

<table>
<thead>
<tr>
<th>Prehospital</th>
<th>0-1 days</th>
<th>0-27 days</th>
<th>0-365 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>35.5</td>
<td>38</td>
<td>43.6</td>
</tr>
<tr>
<td>Middle</td>
<td>23</td>
<td>25.7</td>
<td>30.3</td>
</tr>
<tr>
<td>High</td>
<td>17.6</td>
<td>19.5</td>
<td>24</td>
</tr>
</tbody>
</table>

FINAMI
Table 1. The age-standardized incidence and 28-day mortality of 35–99-year-old men and women by marital status in the FINAMI register in 1993–2002

<table>
<thead>
<tr>
<th></th>
<th>35–64 years</th>
<th>65–74 years</th>
<th>75–99 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>269 (254–284)</td>
<td>1140 (1071–1209)</td>
<td>2661 (2471–2851)</td>
</tr>
<tr>
<td>Unmarried</td>
<td>442 (411–473)</td>
<td>1888 (1725–2051)</td>
<td>4196 (3846–4546)</td>
</tr>
<tr>
<td>Previously married</td>
<td>472 (427–517)</td>
<td>1914 (1712–2116)</td>
<td>4324 (3934–4714)</td>
</tr>
<tr>
<td>Never married</td>
<td>437 (389–485)</td>
<td>1838 (1562–2114)</td>
<td>3503 (2652–4354)</td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>109 (99–119)</td>
<td>866 (806–926)</td>
<td>3049 (2841–3257)</td>
</tr>
<tr>
<td>Unmarried</td>
<td>292 (266–318)</td>
<td>1792 (1633–1951)</td>
<td>4843 (4467–5219)</td>
</tr>
<tr>
<td>Previously married</td>
<td>297 (262–332)</td>
<td>1772 (1578–1966)</td>
<td>4891 (4478–5304)</td>
</tr>
<tr>
<td>Never married</td>
<td>291 (251–331)</td>
<td>1816 (1542–2090)</td>
<td>4353 (3413–5293)</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried</td>
<td>90 (78–102)</td>
<td>765 (706–824)</td>
<td>2733 (2624–2812)</td>
</tr>
<tr>
<td>Previously married</td>
<td>103 (87–119)</td>
<td>807 (736–878)</td>
<td>2821 (2698–2944)</td>
</tr>
<tr>
<td>Never married</td>
<td>69 (51–87)</td>
<td>648 (540–756)</td>
<td>2342 (2108–2576)</td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>16 (12–20)</td>
<td>247 (216–278)</td>
<td>1577 (1397–1757)</td>
</tr>
<tr>
<td>Unmarried</td>
<td>44 (36–52)</td>
<td>493 (446–540)</td>
<td>2667 (2561–2773)</td>
</tr>
<tr>
<td>Previously married</td>
<td>47 (36–58)</td>
<td>520 (464–576)</td>
<td>2759 (2639–2879)</td>
</tr>
</tbody>
</table>

Rates are expressed per 100,000 persons per year (95% CI).
Table 2. Case fatalities of incident events among 35–64-year-old men and women at different time points according to marital status and household size in the FINAMI register during 1993–2002

<table>
<thead>
<tr>
<th></th>
<th>Before hospital</th>
<th>≤1 day</th>
<th>0–27 days</th>
<th>0–364 days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>41 (36–47)</td>
<td>45 (39–50)</td>
<td>51 (46–57)</td>
<td>55 (50–60)</td>
</tr>
<tr>
<td>Previously married</td>
<td>34 (29–38)</td>
<td>36 (31–40)</td>
<td>42 (37–47)</td>
<td>44 (40–49)</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2 people</td>
<td>23 (20–27)</td>
<td>25 (22–29)</td>
<td>31 (28–35)</td>
<td>33 (29–37)</td>
</tr>
<tr>
<td>2 people</td>
<td>23 (20–26)</td>
<td>25 (22–28)</td>
<td>31 (28–34)</td>
<td>34 (31–37)</td>
</tr>
<tr>
<td>Living alone</td>
<td>41 (36–45)</td>
<td>43 (39–48)</td>
<td>49 (44–54)</td>
<td>52 (48–57)</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>9 (6–12)</td>
<td>11 (8–15)</td>
<td>20 (15–24)</td>
<td>23 (18–27)</td>
</tr>
<tr>
<td>Never married</td>
<td>35 (22–47)</td>
<td>36 (24–49)</td>
<td>43 (31–56)</td>
<td>45 (32–58)</td>
</tr>
<tr>
<td>Household size</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2 people</td>
<td>10 (5–16)</td>
<td>10 (5–16)</td>
<td>21 (14–28)</td>
<td>24 (16–32)</td>
</tr>
<tr>
<td>2 people</td>
<td>14 (9–18)</td>
<td>17 (11–22)</td>
<td>25 (19–31)</td>
<td>28 (21–34)</td>
</tr>
<tr>
<td>Living alone</td>
<td>32 (24–39)</td>
<td>37 (29–44)</td>
<td>43 (35–51)</td>
<td>45 (37–53)</td>
</tr>
</tbody>
</table>

Values are % (95% CI).
Coronary event rate
with 95% confidence interval, age standardized, age 35-64

WHO MONICA Project
Lancet, 1999; 353: 1547-1557
Figure 1.4a  Age-standardized death rates from CHD, men aged 0 to 64, latest available year

Source: Allender at al. EUCVD Statistics 2008
Figure 1.4b Age-standardized death rates from CHD, women aged 0 to 64, latest available year

Source: Allender at al. EUCVD Statistics 2008
AMI, miehet, insidenssi

AMI, naiset, insidenssi

Legend
KUNNAt2003
res_AMI_pooled_men_conv.SR

Legend
KUNNAt2003
res_AMI_pooled_women_conv.SR
Risk factors for CVD

- Multifactorial diseases
- The main ‘classical’ risk factors for atherosclerotic CVD are:
  - Age
  - Male sex
  - LDL cholesterol (often total cholesterol in practice)
  - Smoking
  - Elevated blood pressure
  - Diabetes
- Hundreds of other factors have been shown to associate with CVD risk
- Most important of the ‘emerging risk factors’ is CRP
- A clear genetic component also exist
The National FINRISK 2012 Survey

- Five areas in Finland
- 10 000 men and women, aged 25-74 years
- A random sample stratified by sex and 10-year age group
- The survey was conducted from January to April in 2012
  Additional data collection in Helsinki and Turku in May
- Participation rate was 64.9% (n=6424)
  Men 61.5%
  Women 68.3%
Cholesterol changes in 1982 - 2012
Men aged 25-64

Change 2007-2012:
- Year p=0.0054
- Age-standardized
- The cholesterol measurements have been standardized to match the United States Centers for Disease Control and Prevention (CDC) serum cholesterol reference measurement procedure
Change 2007-2012:
• Year p<0.0001
• Age-standardized
• The cholesterol measurements have been standardized to match the United States Centers for Disease Control and Prevention (CDC) serum cholesterol reference measurement procedure.
Systolic blood pressure in 1982 - 2012
Men aged 25-64

Change 2007-2012:
• Area p<0.001
• Year p<0.001
• Area*year p=0.035
• Age- and study area standardized
Systolic blood pressure in 1982 - 2012
Women aged 25-64

Change 2007-2012:
• Area p<0.001
• Year p<0.001
• Area*year p=0.001
• Age- and study area standardized
Daily smokers (%) in 1972 - 2012
Men aged 30-59
Daily smokers (%) in 1972 - 2012
Women aged 30–59
Modelling the decrease in CHD mortality in Finland 1982-1997

- Blood pressure: 7%
- Cholesterol: 37%
- Not explained: 22%
- Heart failure treatments: 2%
- Medical treatment of angina: 2%
- Invasive treatments: 8%
- Secondary prevention: 10%
- Treatment of AMI: 3%
- Smoking: 9%

Laatikainen et al. Am J Epid 2005
Observed and predicted decline in CHD mortality in men

-90 -80 -70 -60 -50 -40 -30 -20 -10 0


Observed
All risk factors
Cholesterol
Diastolic BP
Smoking
Association of metabolic syndrome and DM with incident CVD

Relative risk (RR) for incident cardiovascular events and clinically incident diabetes during follow-up.

<table>
<thead>
<tr>
<th>Incidence of cardiovascular events&lt;sup&gt;a,b&lt;/sup&gt;</th>
<th>At risk</th>
<th>Cases</th>
<th>RR</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harmonization criteria (men)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No history of MetS or diabetes</td>
<td>1338</td>
<td>53</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>MetS</td>
<td>1048</td>
<td>72</td>
<td>1.34</td>
<td>(0.90–2.01)</td>
</tr>
<tr>
<td>Diabetes&lt;sup&gt;c&lt;/sup&gt;</td>
<td>181</td>
<td>31</td>
<td>2.57</td>
<td>(1.56–4.22)</td>
</tr>
<tr>
<td><strong>Harmonization criteria (women)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No history of MetS or diabetes</td>
<td>1875</td>
<td>18</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>MetS</td>
<td>1033</td>
<td>48</td>
<td>2.11</td>
<td>(1.14–3.93)</td>
</tr>
<tr>
<td>Diabetes&lt;sup&gt;c&lt;/sup&gt;</td>
<td>168</td>
<td>19</td>
<td>4.56</td>
<td>(2.16–9.59)</td>
</tr>
</tbody>
</table>

Assessing CVD risk

- Several risk prediction equations based on the ‘classical’ risk factors and coefficients obtained from the Cox PH regression model or from a logistic regression model
  - Framingham equation (USA)
  - 2013 ACC/AHA Guideline on the assessment of cardiovascular risk
  - SCORE equation (Europe)
  - FINRISK equation (Finland)
Estimated 10-year coronary heart disease risk in adults 55 years of age according to levels of various risk factors (Framingham Heart Study).

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Pressure</td>
<td>120/80</td>
<td>140/90</td>
<td>140/90</td>
<td>140/90</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>200</td>
<td>240</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>HDL-C</td>
<td>50</td>
<td>50</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Diabetes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

et al. Circulation 2012;125:e2-e220
This phase assesses whether the candidate risk biomarker is associated with the outcome of interest. These early-stage studies usually have cross-sectional or case-control designs, and compare levels of the biomarker between individuals with and without the outcome, with the result usually begin reported as an odds ratio. Replication of the observed association in an independent population/samples is also necessary. Data from this state can also be useful for identifying critical values of the biomarker that can be used as cut-points indicating different risks, these suggested cut-points should also be replicated in different populations/samples.

**Fig. 1** Distribution of the REGICOR (Registre Giron del Cor - Girona Heart Registry) population into the 4 commonly used coronary risk categories, incidence of coronary artery disease in each risk category and proportion of cases proceeding from each risk category. Adapted from Marrugat et al. [6]
What Is Ideal Cardiovascular Health?

1. Absence of disease
2. Favorable levels of health factors
3. Favorable health behaviors
Life’s Simple 7

1. Never smoked or quit more than one year ago
2. Body mass index less than 25 kg/m²
3. Physical activity of at least 150 mins (moderate intensity) or 75 mins (vigorous intensity) each week
4. Four to five key components of a healthy diet consistent with current AHA guidelines
5. Total cholesterol of less than 200 mg/dL
6. Blood pressure below 120/80 mm Hg
7. Fasting blood glucose less than 100 mg/dL
Prevalence for CV Health Factors in U.S. Adults

- Current Smoking: 72.2%
  - Poor: 3.2%
  - Intermediate: 33.8%
  - Ideal: 35.2%

- Body Mass Index: 45.2%
  - Poor: 23.2%
  - Intermediate: 13.0%
  - Ideal: 12.0%

- Physical Activity: 22.9%
  - Poor: 76.8%

- Healthy Diet Score: 46.6%
  - Poor: 38.4%
  - Intermediate: 17.1%

- Total Cholesterol: 41.7%
  - Poor: 15.0%

- Blood Pressure: 30.4%
  - Poor: 8.2%

- Fasting Plasma Glucose: 61.4%
Figure 1. Lifetime Risk of Death from Cardiovascular Disease among Black Men and White Men at 55 Years of Age, According to the Aggregate Burden of Risk Factors and Adjusted for Competing Risks of Death.
Figure 2. Lifetime Risk of Death from Cardiovascular Disease among Black Women and White Women at 55 Years of Age, According to the Aggregate Burden of Risk Factors and Adjusted for Competing Risks of Death.
Summary of main points

- CVDs increased rapidly in all Western countries after the 2nd WW but have declined substantially since the beginning of the 1970’s
- Despite of the decline, CVDs still are the most common cause of death and hospitalizations
- The occurrence of CVD increases approximately log-linearly with increasing age
- Women are relatively protected from CVD until menopause and get their CVD on average 10 years older than men
- A few main risk factors (chol, BP, smoking, DM) explain the majority of CVD risk
- In most cases CVD is preventable by controlling the risk factor levels
Thank you!