Taking Care of Your Heart: *Chemistry and Heart Disease*

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Metabolism is life!

- Review the role of cholesterol and obesity in heart disease

- Discuss the role of nutrition and activity in prevention

- Discuss common clinical and public health problems with cholesterol, metabolism, and obesity
Heart Disease

• Heart disease risk factors
  – Men and Women at similar risk – long term

• Lifestyle Change Works!

• Take Your Medicine…
  – The Internet - Friend or Foe?
Leading Causes of Death in the United States

CDC / NCHS and NIH Statistics

American Heart Association Heart Disease and Stroke Statistics

www.americanheart.org
Good News!
A Significant Decrease in Heart Disease and Stroke

In the past 30 years:
• Stroke decrease by 70%
• Heart attack decrease by 50%
• Decrease in heart disease and stroke has led to over 4 years of prolongation in life expectancy
• Total increase in life expectancy is 6 years
• Improvement = 2/3 lifestyle and 1/3 medicine
Scope of the Problem

U.S. Heart Disease

Patients (Millions)

Year


Foot DK et al. JACC 2000;35:1067-81
What Are We Treating?

Atherosclerosis

(“Blockages or plaques”)

Evolution of Heart / Blood Vessel Blockages

Davies MJ. *Heart* 2000;83:361-366
Libby P. *Circulation* 2001;104:365-72
Is This Reversible?
Heart and Stroke Risk Factors

- Age
- High cholesterol
- Low HDL cholesterol
- High blood pressure
- Lack of physical activity
- Tobacco
- Diabetes
- Obesity (especially central)
- Stress (including loss)
- Family History of heart disease or stroke
- Genetics…other?
How Do I Know My Risk?

- Risk assessment tool:

www.healthdecision.org

Gives 10 year and longer heart risk –
And handouts to reduce risk

www.heart.org
Cancer risk factors

• Tobacco use / smoking
• High fat intake
• Low intake of vegetables and fruits
• Physical inactivity
• Lack of appropriate screening
Physical Activity and Breast Cancer

Thune et al. NEJM 1997; 336:1269-75.
Reducing Risk of heart disease and stroke

- Activity daily
- Healthy eating
- Avoiding tobacco
- Maintain optimal weight
- Aspirin if your clinician recommends
- Control blood pressure and cholesterol
- Take your medicine!
Cholesterol

“Bad” (only if high in our blood)
- LDL – cholesterol
- Triglycerides

“Good cholesterol”
- HDL - cholesterol
Cholesterol Management – Normal Levels

- LDL-C < 130 mg/dL (lower if we have heart disease or stroke)
- Triglycerides < 150 mg/dL
- HDL-C > 40 mg/dL (> 50 mg/dL for females)
Cholesterol Guidelines

- HDL > 40 (women > 50)
- Triglycerides < 150
- LDL cholesterol depends on condition:
  - LDL 30 - 40% reduction if no heart disease
  - LDL 50% or more reduction if heart disease / stroke / diabetes
  - Lifestyle is the cornerstone of therapy...

Cholesterol guidelines  www.heart.org
Net Cholesterol Balance in Humans

Intestine
- Dietary cholesterol (300 mg/d)

Liver
- Excreted cholesterol
- Absorbed cholesterol
- Synthesized cholesterol (800 mg/d)

Extrahepatic tissues
- VLDL-C
- LDL-C
- HDL-C

Fecal sterols (1100 mg/d)
Lipid Metabolism - Metabolic Pathway

- **PRODUCTION**
  - Liver

- **CLEARANCE**
  - Other sites

- **CONVERSION**
  - HDL catabolism

- **LIPOLYSIS**
  - LPL
  - HDL

- **SHUNT PATHWAY**

- **apo B-100**
- **apo C**
- **apo E**
**Key Facts - Cholesterol**

**Genetics and lifestyle** play a significant role in our cholesterol pattern.

**Major influences for LDL-C are:**
- Dietary saturated fat, trans-fats and genetics

**Major influences for VLDL (triglycerides) are:**
- Dietary carbohydrates and fats (excess converted to triglycerides / VLDL and stored in adipose)
- Alcohol intake
- Body weight / fat distribution
- Physical activity

**HDL cholesterol** — reduces risk / removes cholesterol from blood vessel / affected by genetics / exercise, weight, weight distribution, alcohol
Types of Dietary Fat

- Saturated
- Trans – fats
- Monounsaturated
- Polyunsaturated
Clinical Effects of dietary fats on serum lipids

• **Saturated and trans - fats:** Increase LDL – C
• **Polyunsaturated fats:** Decrease LDL – C
• **Monounsaturated fats:** (e.g. olive oil)
  – Decrease LDL – C
  – Increase HDL – C

• **Note:** all may increase TGs if patient is susceptible, and all are caloric dense
Trans Fatty Acids

• Created when liquid oils are hydrogenated.
• Very stable at room temperature.
• Are monounsaturated fats, but act like saturated.
• May decrease HDL.
• Average US intake is about 3% of total calories.
• Major sources – cookies, crackers, microwave popcorn, donuts, margarine, pie crust, fried foods BANNED COMPLETELY IN 2018
Natural Ways to Lower Cholesterol

- Low-saturated fat
- High soluble fiber (oats, psyllium)
- Fish oils and flax
- Nuts
- Olive oil or canola oil (in place of saturated)
- Sterols
- Soy
- Exercise and weight loss

Lifestyle Guidelines: www.heart.org
## Dietary Adjuncts: Efficacy at Reducing LDL-C

<table>
<thead>
<tr>
<th>Therapy</th>
<th>Dose (g/day)</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary soluble fiber</td>
<td>2-8</td>
<td>↓ LDL-C 5-10%</td>
</tr>
<tr>
<td>Soy protein</td>
<td>20-30</td>
<td>↓ LDL-C 5-7%</td>
</tr>
<tr>
<td>Sterols</td>
<td>1.5-4</td>
<td>↓ LDL-C 10-15%</td>
</tr>
</tbody>
</table>

*Jones PJ. Curr Atheroscler Rep 1999;1:230-235*
*Lichtenstein AH. Curr Atheroscler Rep 1999;1:210-214*
*Rambjor GS et al. Lipids 1996;31:S45-S49*
*Ripsin CM et al. JAMA 1992;267:3317-3325*
Carbohydrates and Cholesterol
### Simple Sugar in Foods

**US Dietary Guidelines recommend no more than 10 teaspoons per day.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Sugar (teaspoons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cola, 12 oz</td>
<td>10 teaspoons</td>
</tr>
<tr>
<td>Pancake syrup, 1/4 cup</td>
<td>10</td>
</tr>
<tr>
<td>Hostess Lemon Fruit Pie</td>
<td>11</td>
</tr>
<tr>
<td>McDonald’s Vanilla Shake</td>
<td>12</td>
</tr>
<tr>
<td>Fruitopia, 20 oz</td>
<td>18</td>
</tr>
<tr>
<td>Dairy Queen Mr. Misty, 32 oz</td>
<td>28</td>
</tr>
<tr>
<td>Mountain Dew, 44 oz</td>
<td>37</td>
</tr>
</tbody>
</table>
Foods containing carbohydrates from whole grains, fruits, vegetables, and low-fat milk should be included.

Total amount of carbohydrate is more important to the total glycemic effect than type of carbohydrate.

The use of restrictive diets should not be a primary strategy in food/meal planning, but an overall strategy is needed to reduce diabetes complications.

Triglyceride Disorders

• Highly diet responsive: fat, alcohol, simple carbohydrates, total cals.
• Very low-fat and low carbohydrates
• Physical Activity and Weight Loss
• Medications:  
  – Fibrates  
  – Niacin  
  – Fish oils
American Heart Association Dietary Guidelines

Include foods from each of the major food groups:

• 5 or more fruits and vegetables per day
• 6 or more grains per day, including whole grains

Achieve and maintain a healthy body weight:

• Match energy intake to energy needs
• Participate in physical activity that achieves fitness and matches or exceeds energy intake

www.heart.org
Healthy Lifestyle
Multiple Lifestyle Trials Show Heart Disease is Reversible

- Lifestyle Heart Study (Ornish) – 60% reduction in progression of heart disease and twofold increase in regression
- STARS trial – health lifestyle reduced atherosclerosis progression by 85%
- CLAS trial – atherosclerosis progression was related to higher consumption of total and saturated fat; increasing protein and lower saturated fat had lowest progression
Mediterranean Diet

- Complex carbohydrates
- Nuts and legumes
- Daily fruit and vegetables
- Fish
- Less red meat (use poultry)
- Olive oil
- 2 studies show decrease in heart disease by 50%

The Use of Mediterranean Diet & Olive Oil

DASH Diet: Dietary Approach to Stop Hypertension

- High intake of vegetables and fruits
- Low salt (sodium)
- Modest alcohol intake
- High intake of low-fat dairy products (calcium and vitamin D)
- Appropriate calorie intake to improve body weight
- Can drop BP by 12 / 8
Practical Approach

- There are no good or bad foods, just good or bad meal plans.
- Use the 3 X 3 approach - at least three meals per day and at least three food groups at each meal.
- Liquid calories can be trouble.
- Vegetables every day - the more the better.
- Live life in balance.
Statins and other cholesterol Medicines

• Safe!
• Effective!
• Low side effects
• Reductions in heart disease and stroke of 30 – 45%
• Highest effect in highest risk

www.heart.org  http://circ.ahajournals.org/content/129/25_suppl_2/S1
Can Artery Blockages Reverse? The Effects of Cholesterol Treatment

From: Impact of Statins on Serial Coronary Calcification During Atheroma Progression and Regression  *J Am Coll Cardiol.* 2007;49(2):271-273

**Figure Legend:**
Plaque Calcification in the Setting of No-Statin Therapy or High-Intensity Statin Therapy

Natural plaque progression likely involves lipid-pool expansion coupled with microcalcifications within lipid pools. Following long-term high-intensity statin therapy, plaque regression manifests as delipidation and probable vascular smooth muscle cell calcification, promoting plaque stability.
From: Efficacy and Safety of Statin Therapy in Children With Familial Hypercholesterolemia: A Randomized Controlled Trial

Figure Legend:
IMT indicates intima-media thickness. Error bars indicates SE. P values for the difference between the 2 groups in change from baseline were calculated using analysis of covariance adjusted for baseline values.
Can Blockages (Plaque) in Arteries Reverse? Atherosclerosis Regression, Vascular Remodeling, and Plaque Stabilization

- Significant change in plaques are noted by 2 years with statin treatment – also with aggressive lifestyle change and treatment of blood pressure with ACE / Calcium Blockers
- Placebo groups in statin trials show plaque progression
- Statins diminish the lipid pool in plaques; the fibrous portion of plaques remains
- Plaques become far more stable and less likely to rupture = less heart attacks and strokes
- Plaques most likely to rupture – those with the most fat and most inflammatory cells – are most positively affected by lifestyle and statins

*J Am Coll Cardiol. 2007;49(2):271-273*
Obesity Among U.S. Adults
2013

*Prevalence estimates reflect BRFSS methodological changes started in 2011. These estimates should not be compared to prevalence estimates before 2011.
Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among U.S. Adults Aged 18 Years or older

Obesity (BMI ≥30 kg/m²)

- 1994
- 2000
- 2010

Diabetes

- 1994
- 2000
- 2010

Obesity and CHD Risk in Women
Nurses' Health Study - 8-year Follow-up

Manson et al. NEJM 1990;322:882-889

Relative Risk (adj. for age and smoking)

Body Mass Index

<21 21-<23 23-<25 25-<29 29+

1.3 1.3 1.8 3.3

Fatal and Non-fatal MI
The Increase In Diabetes Is Epidemic

- 33% from 1990-1998
- 76% in patients 30-39 y.o.

...With More to Come

- Obesity / weight gain are major risk factors
- 2 pounds of weight gain translated to a 9% increase in risk of developing diabetes*
- Higher rates of obesity will lead to more diabetes

Diabetes & Vascular Disease

Blockages in legs
- 2 - 4 times higher with Diabetes
- Leg pain 4 - 8 times higher w/ Diabetes
- Leading cause of leg amputation

Stroke
- Stroke risk 1.5 - 4 times more with Diabetes
- Stroke outcomes worse
- Even elevated blood sugar a risk!
“Metabolic Syndrome”

• Weight gain in middle

• Causes:
  – Increased blood sugar and diabetes risk
  – High blood pressure
  – Abnormal cholesterol levels (low HDL, high triglycerides, small LDL)
  – Inflammation in arteries
  – Increased risk of heart disease & stroke
Measuring waist circumference

- Locate upper hip bone and top of right iliac crest
- Place measuring tape horizontally around abdomen at level of iliac crest
- Tape should be snug without causing compression

Normal values:
- Women: ≤ 35 inches
- Men: ≤ 40 inches
How Common is the Metabolic Syndrome?

- Adults > 20 years of age
- 24% all adults, 42% over age 60 yrs
- Similar for men and women!
- Mexican Americans 32%
- African American women >> men
- 47 million adults in the U.S.
Adipose Tissue - Adverse Endocrine Effects

- ↑ "Resistin"
  - Insulin Resistance
  - (↑ glucose)
- ↑ Sympathetic Nervous System
  - (? hypertension)
- ↑ Angiotensin
  - (? hypertension)
- ↑ Leptin
  - (↑ appetite)
- ↑ Fatty Acids
  - (↑ atherosclerosis)
- ↑ Inflammatory Mediators
  - (TNFα, IL-6, CRP)

Enlarged Adipose Cells
Does Weight Loss Work?

• 200 pounds $\times$ 5% = 10 pounds
• Total cholesterol down 15%
• Triglycerides down 20%
• HDL up 15%
• Systolic BP / Diastolic BP down 12/9 mmHg
• Improved blood glucose – Diabetes down 60 - 70% with weight loss of 5%
• Improved life expectancy
1 Pound Equals =

- 3500 calories per day for one week
- 100 calories per day for one month

- **Foods = 100 calories**
  - 10 potato chips
  - 20 corn chips
  - $\frac{1}{4}$ cup ice cream
  - $\frac{1}{4}$ cup pudding
  - $\frac{1}{2}$ cup frozen yogurt

- 1 gum drop per day for one year = 1 pound
UW Active Living and Learning Program

- Goal: 7% weight loss through lifestyle change
- Group program, multidisciplinary professionals
- Data show 5 - 7% weight loss at 3 months!
- Waist circumference decreased 3 inches
- Fasting glucose decreased from 131 to 119
- Average exercise time increased from less than 40 minutes per week to over 120 minutes per week
- Over 90% adherence to program at 11 months
- Covered by insurers, behaviorally based
Health Benefits of Exercise

- Reduce Cardiovascular Disease
- Reduce Cancer (breast, colon, bladder)
- Reduce diabetes mellitus
- Improve / prevent osteoporosis
- Reduce weight
- Improve blood lipoproteins
- Reduce systolic / diastolic BP
- Psychological well being
- Reduce total and cardiac mortality

Obesity Guideline:
http://circ.ahajournals.org/content/129/25_suppl_2/S102
Guidelines for Exercise Prescription

- **Frequency**: Most days (3-6 days/wk)
- **Intensity**: Just do it
- **Time**: 30-60 min total
- **Type**: Aerobic/Resistance
Summary

- Regular physical activity
- Healthy eating
- Weight reduction as appropriate
- Take your medicines as recommended by a doctor you trust
- Metabolism is life!
Thank You!

Questions?
Best Resources for Heart Disease and Prevention Information

• American Heart Association:  www.heart.org
• UW Health – Health Facts: www.uwhealth.org
• Heart Decision:  www.heartdecision.org
• Harvard Health Letter:  www.health.harvard.edu
• Mayo Clinic Newsletter
• Up To Date:  www.uptodate.com
• SHAPE Society:  www.shapesociety.org
AHA Nutrition Committee Dietary Recommendations

Recommendations for Cardiovascular Disease Risk Reduction

• Balance calorie intake and physical activity to achieve or maintain a healthy body weight
• Consume a diet rich in fruits and vegetables
• Consume whole-grain, high-fiber foods
• Consume fish, especially oily fish, at least twice a week
• Limit intake of saturated fat to <7%, trans fat to <1% of energy and cholesterol <300 mg/day by
  – Choosing lean meat and vegetable alternatives
  – Choosing fat free (skim), 1% fat and low-fat dairy products
  – Minimizing intake of partially hydrogenated fats
• Minimize intake of beverages and foods with added sugar
• Choose and prepare foods with little or no salt
• If alcohol is consumed, do so in moderation

AHA = American Heart Association; AHA Nutrition Committee. Circulation 2006;114:82-96
The Fat Cell (adipocyte) Is An Endocrine Gland

- Lactate
- Prostaglandin
- Angiotensinogen
- Prostacyclin
- Monobutyrin
- Free Fatty Acids
- Cholesterol Transfer Protein (CETP)
- Phospholipid Transfer Protein (PLTP)
- Leptin
- Adiponectin
- Galectin-12
- TNF-a
- IL-6
- Lipoprotein Lipase (LPL)
- Adipsin (ASP) (complement 3a,D)
- Plasminogen Activator Inhibitor (PAI-1)

Adapted from: Bray GA. Contemp Diagn Obes. 1998.