**Cholesterol and Glucose**

**Terminology**
- Hyperlipidemia – elevated blood cholesterol and triglycerides
- Hypercholesterolemia – elevated cholesterol concentrations only
- Hypertriglyceridemia – elevated blood triglycerides only

**Definitions**
- **Cholesterol** - alcohol steroid found in animal fats, not found in plant products
- **Lipoproteins** – (protein packets) proteins that carry blood lipids which by themselves are insoluble in the blood
- **Apolipoproteins** – protein part of the lipoprotein that carries the lipid
  - Binds to cell membranes
  - Activate or inhibit enzymes
  - Apo-A-1 and Apo A-II on HDL
  - Apo B on LDL

**Three Major Lipoproteins**
- **High-density lipoprotein (HDL)**
- **Low-density lipoprotein (LDL)**
- **Very-low density lipoprotein (VLDL)**

*classified by the type and ratio of protein and fats they contain which determines their size and density

**Chylomicrons**
- Transport dietary fats and cholesterol from the intestine to body
- Large particles
- Formed in the intestine and transported into circulation by the lymphatic system
- Highest after a meal
- Metabolized and cleared from blood rapidly
- Contain 90% triglycerides and 10% cholesterol

**VLDL**
- Liver transports triglycerides to the peripheral tissues in the core of VLDL
  - Carries FA from plasma
  - Carries FA synthesized de novo
  - Transports 20% of triglycerides
  - Atherosclerotic lipoprotein
**LDL**
- Formed after VLDL gives up its triglycerides to body cells
- High levels contribute to buildup of atherosclerosis
- Most medical laboratories do not measure LDL, calculate it:
  \[ \text{LDL} = \text{TC} - \left[ \text{HDL} + (0.20 \times \text{TRI}) \right] \]

**HDL**
- High in protein
- Smallest, most soluble particles
- Synthesized by liver and intestine
- Cholesterol scavenger carrying surplus cholesterol from the tissues to the liver where it is used to form bile acids and excreted
- Prevents lipid accumulation in arterial walls

**HDL**
- HDL (HDL₃) is synthesized in a nascent (immature) form (mostly protein)
- Mature form – HDL₂
- Higher in women than men
- Changes little with increasing age
- Higher in blacks than whites
- 1% rise associated with a 2-3% reduction in CAD
Enzymes Important in Lipid Metabolism and Formation

**Lipoprotein Lipase**
- LPL – breaks down fats in VLDL, LDL, and chylomicrons which are delivered to peripheral tissues – located in capillary endothelium
- LPL activity increases, promoting fat storage
- Activity increases with release of insulin (fat storage)

**Lipoprotein Lipase**
- LPL activity decreases, promoting release of fats from storage
  - Decreases with prolonged fasting (prevents storage of fats)
  - Decreases last trimester of pregnancy and during lactation, facilitating loss of fat in hips and thighs

**Lecithin Cholesterol Acyl Transferase**
- LCAT – secreted by liver
- Facilitates uptake of cholesterol by HDL

**Hepatic Lipase**
- Facilitates removal of HDL from circulation by liver

**Exercise**
- Increases LPL – decrease triglycerides and VLDL
- Increases LCAT – increases HDL₂
- Decreases HL – increases HDL levels (keeps HDL in circulation longer)
The Effect of Exercise Only on Lipids

- Aerobic exercise (minimum of 90 min/week or 1,000-1,200 kcal/wk)
- More exercise for women than men
- Weight reduction and leanness (increase 1 mg/dL per pound lost)
- Smoking cessation
- Moderate alcohol consumption

Effect of Diet Only on Cholesterol Levels

- Increasing HDL Levels

Increasing HDL Levels

- HDL levels can be increased by exercise and weight reduction

Changes in Blood Lipids and Lipoproteins in Response to Exercise When Diet and Weight Loss Are Controlled
Lowering LDL

- Reduction of dietary saturated and trans fatty acid intake
- Reduction of body weight
- Reduction in dietary cholesterol intake
- Increase in polyunsaturated and monounsaturated fats vs saturated
- Increase in CHO and soluble fiber (fruits, oats, vegetables)
- Control stress

Fats

- Saturated – raise TC and LDL
- Polyunsaturated – decrease TC, LDL and HDL
- Monounsaturated – decrease TC, LDL, and no effect HDL
- Omega-3 FA – decrease TRI
- Trans fatty acids – decrease HDL, increase LDL (hydrogenated or partially hydrogenated)

If All Lipids Within NL
Repeat every 5 years
Unless RF or Health Status Changes
**Factors Affecting Cholesterol**
- Age
- Gender – females < males 20-50 yr
- Diet
- Alcohol
- Exercise
- Drugs
- Fasting – most effect on triglycerides and calculated LDL

**Factors Affecting Cholesterol**
- Pregnancy – increase LDL and VLDL by 20-35%

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**NCEP Recommendations of NHLB Inst and NIH**
- Optimal
  - LDL < 100 mg/dL
  - HDL ≥ 40 mg/dL

**Glucose**
- Hyperglycemia – high blood sugar
- Hypoglycemia – low blood sugar

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**Glucose Levels**
Glucose Guidelines (fasting –no caloric intake for at least 8 hours)
- < 110 mg/dL - normal
- 110 - 125 mg/dL - impaired fasting glucose
- > 126 mg/dL - diagnosis with confirmation
- Oral glucose tolerance test - > 200 mg/dL in 2- hr sample (bolus of 75 g of glucose)

**Glucose Levels**
Glucose Guidelines (nonfasting)
- Casual plasma glucose >200 mg/dL with S/S of diabetes
- Hypoglycemia – glucose < 50 mg/dL within a few hours off eating a regular meal
Diabetes

- Type 1 Diabetes – insulin dependent
  - Pancreas secretes little or no insulin
  - Often auto-immune disease
  - Exogenous insulin injections or pump
- Type 2 Diabetes – non-insulin dependent
  - Decreased cellular sensitivity to insulin
  - Oral hypoglycemics, sometimes insulin

S/S of Diabetes

- Polyuria – excessive urination
- Polyphagia – unsatisfied hunger
- Polydipsia – excessive thirst
- Glycosuria – glucose in urine
- Weight loss, drowsiness, irritability, cessation of growth in young persons
- Hyperglycemia or ketosis

Ketosis/Ketoacidosis

- Insufficient CHO
- CHO transport impaired
- Increase use of FFA
- Form ketone bodies (acid)
- pH decreases – coma and death

S/S Hypoglycemia

Sudden Onset

- Weakness
- Hunger
- Inability to concentrate
- Headache
- Trembling
- Dizziness
- Sweaty
- Tachycardia

Causes of Hypoglycemia

- Too little food
- Too much insulin
- Exercise
  - Inadequate food intake
  - Injection site
  - Timing of exercise
Response
- Administer sugar
  - oral if conscious
  - granules under tongue if unconscious
  - if not recovered within 1-2 min, activate EMS system

S/S Hyperglycemia Gradual Onset
- Confusion
- Nausea
- Headache
- Breathe – sweet, fruity odor
- Thirst
- Abdominal pain
- Vomiting
- Hyperventilation

Causes of Hypoglycemia
- Insufficient insulin

Response
Activate EMS
- Administer fluids if conscious
- Turn head to side if vomiting
- Can lead to diabetic coma

Type 2 Diabetes
- Not as prone to hypoglycemia as Type 1 diabetics
- Insidious onset that is often overlooked
- 80% are obese

Impaired Glucose Metabolism
- Impaired Fasting Glucose (IFG) –
  - 110-125 mg/dL fasting
  - 20 million persons
- Impaired Glucose Tolerance (IGT) –
  - ≥140 but <200 mg/dL for OGTT

Gestational Diabetes
- Development of hyperglycemia during pregnancy in someone without diabetes
- 3% of pregnancies
- Risk factors – previous large birth-wt baby and obesity
- Resolves post partum
- 50% of women with gestation diabetes develop Type 2 diabetes later in life
Factors Affecting Glucose Levels

- Fasting
- Weight – increases glucose levels in diabetics
- Diet
- Medication
- Exercise
- Alcohol intake

Diabetes and HbA\textsubscript{1C}

- Healthy - small percentage of the hemoglobin molecules in red blood cells become glycosylated
- The percent of glycosylation is proportional to time and to concentration of glucose
- Test measures blood sugar control over an extended period in individuals with diabetes mellitus (previous 120 days)

Diabetes and HbA\textsubscript{1C}

- The more glycosylated hemoglobin, the higher the risk that a patient will develop complications from the diabetes (eye disease, kidney disease, nerve damage, heart disease, and stroke)

Diabetes and HbA\textsubscript{1C}

- HbA\textsubscript{1C} - test every 3 months
- Normal values - 2.2 to 4.8% of total Hb
- ADA goal <7% HbA\textsubscript{1C}
- >8% % HbA\textsubscript{1C} – need to re-evaluate

Metabolic Syndrome (if at least 3 of RF listed)

- Abdominal Obesity (waist circumference)
  - Men \textgreater 102 cm
  - Women \textgreater 88 cm
- Triglycerides
  - \textgreater 150 mg/dL
- HDL
  - Men < 40 mg/dL
  - Women < 50 mg/dL

Metabolic Syndrome (if at least 3 of RF listed)

- Blood pressure
  - \textgreater 130/\textgreater 85 mm Hg
- Fasting glucose
  - \textgreater 110 mg/dL
Metabolic Syndrome

- Group of health risks that increase your chance of developing heart disease, stroke, and diabetes
- Syndrome X, insulin resistance syndrome, and dysmetabolic syndrome
- More than one in five Americans have metabolic syndrome
- Number of people with metabolic syndrome increases with age, affecting more than 40 percent of people in their 60’s and 70’s

Cause of Metabolic Syndrome

- Unknown - researchers believe it is caused by a combination of your genetic makeup and lifestyle

Health Risks Associated with Metabolic Syndrome

1. Damage to the lining of arteries
2. Changes in the kidneys’ ability to remove salt, leading to high blood pressure, heart disease and stroke
3. An increase in triglyceride levels
4. An increased risk of blood clot formation
5. A slowing of insulin production, which can signal the start of type 2 diabetes

Prevention of Metabolic Syndrome

- Lose weight—Moderate weight loss, in the range of 5 percent to 10 percent of body weight.
- Exercise—Increased activity alone can improve your insulin levels, facilitate weight loss, improve blood pressure and cholesterol levels.
- Consider dietary changes—Maintain a diet that keeps carbohydrates to no more than 50 percent of total calories. Eat complex CHO with fiber. Reduce your intake of red meats and poultry. As much as 30 percent to 45 percent of your daily calories can come from fat, but consume healthy fats, such as those in canola oil, olive oil, flaxseed oil and nuts.
- Limit alcohol intake—Consume no more than one drink a day for women or two drinks for men.