Clinical Relevance of This Week’s Topic

Bioenergetics, Metabolism and Metabolic Syndrome

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Professor of Pathology
Session One

Balance of Metabolism
Transformation among Carbohydrates, Fats, and Proteins (Breads/Donuts, Cheese/Butter, Beef/Pork)

- Carbs (glucose)
- Fat (Fatty acids)
- Protein (Amino acids)

Catabolism

Anabolism
How Our Body utilizes Carbohydrates, Fats and Proteins for Energy

Nicotinamide adenine dinucleotide/NAD, co-enzyme
Transformation among Carbohydrates, Fats, and Proteins

- Carbs (glucose)
- Fat (Fatty acids)
- Protein (Amino acids)

Anabolism
EXCESS CARBS = EXCESS INSULIN = FAT STORAGE

Blood sugar levels rise, insulin is released which communicates to the body to store blood glucose. Excess blood glucose is converted to FAT!

Fat storage may be a few grams each meal, but this adds up over weeks/months and after years there can be a few extra kilos/pounds!

In the morning you wake, you haven’t eaten all night so your blood sugar levels are low. Meal is consumed.

Low blood sugar, hungry tired, irritable, poor choice food is eaten, cycle continues.
Waist circumference
Miss Jumbo Contest in Thailand
Transformation among Carbohydrates, Protein, and Fat

- **Carbs** (glucose)
- **Protein** (Amino acids)
- **Fat** (Fatty acids)

Catabolism: Another kind

Anabolism: Another kind
Anatomy: Human Muscles
Bodybuilding

• **Cutting**
  – Reduce body fat
  – Oxidize fat
  (calorie deficit)

• **Bulking**
  – Muscle
  – A State of Anabolism
Transformation among Carbohydrates, Protein, and Fat

Carbs (glucose)

Catabolism

Fat
Fatty acids

Protein
(Amino acids)
Session Two

Metabolic Syndrome
Definition of Metabolic Syndrome

- A disorder of energy utilization and storage, diagnosed by a co-occurrence of 3 out of 5 of the following medical conditions:
  - (High) Abdominal (central) obesity
  - (High) Elevated blood pressure
  - (High) Elevated fasting plasma glucose (FPG)
  - (High) Elevated blood triglycerides
  - (Low) Decreased high-density cholesterol (HDL-C) level.
A morbidly obese male. Weight 146 kg/322 lbs, height 177 cm/5 ft 10 in. The BMI is 46 kg/m2.
# Metabolic Syndrome NCEP ATP III Definition

Subjects having 3 of the following criteria

<table>
<thead>
<tr>
<th>Condition</th>
<th>Men</th>
<th>Women</th>
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<tbody>
<tr>
<td>Abdominal obesity</td>
<td>waist circumference &gt;102 cm</td>
<td>waist circumference &gt;88 cm</td>
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<td>Hypertriglyceridemia</td>
<td>&gt;150 mg/dL</td>
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NCEP=National Cholesterol Education Program; ATP=adult treatment panel; HDL-C=high-density lipoprotein cholesterol.
Definition of the metabolic syndrome

(A)
- ↑ ApoB
- ↓ HDL
- ↑ TG
- Small LDL
- ▫ Visceral obesity
- ▫ Insulin resistance
- ▫ Blood pressure
- ▫ Thrombosis
- ▫ Inflammation
- ☐ Dysfunctional adipose tissue
- ☐ Ectopic fat

Tools for clinical diagnosis of the metabolic syndrome

(B)
- • ↑ Waist circumference
  - ≥102 cm in men
  - ≥88 cm in women
- • ↑ Triglycerides
  - ≥1.7 mmol/L
- • ↓ HDL-cholesterol
  - <1.03 mmol/L in men
  - <1.29 mmol/L in women
- • ↑ Blood pressure
  - ≥130 mmHg or
  - ≥85 mmHg
- • ↑ Glucose
  - ≥5.6 mmol/L
Table 1: The new International Diabetes Federation (IDF) definition

According to the new IDF definition, for a person to be defined as having the metabolic syndrome they must have:

**Central obesity** (defined as waist circumference* with ethnicity specific values)

**plus any two of the following four factors:**

<table>
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<tr>
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<tr>
<td><strong>Raised triglycerides</strong></td>
<td>$\geq 150$ mg/dL (1.7 mmol/L) or specific treatment for this lipid abnormality</td>
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<td><strong>Reduced HDL cholesterol</strong></td>
<td>$&lt; 40$ mg/dL (1.03 mmol/L) in males $&lt; 50$ mg/dL (1.29 mmol/L) in females or specific treatment for this lipid abnormality</td>
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<td><strong>Raised blood pressure</strong></td>
<td>systolic BP $\geq 130$ or diastolic BP $\geq 85$ mm Hg or treatment of previously diagnosed hypertension</td>
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<td><strong>Raised fasting plasma glucose</strong></td>
<td>(FPG) $\geq 100$ mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes If above 5.6 mmol/L or 100 mg/dL, OGGT is strongly recommended but is not necessary to define presence of the syndrome.</td>
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* If BMI is $> 30$ kg/m$^2$, central obesity can be assumed and waist circumference does not need to be measured.
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<th>Defining Level</th>
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*Metabolic syndrome is diagnosed when ≥3 risk factors are present.*

NCEP indicates National Cholesterol Education Program; HDL-C, high-density lipoprotein cholesterol; BP, blood pressure.

*Source: Adapted with permission from Reference 9.*
Central Obesity

Waist circumference* - ethnicity specific
Plus any two:

**Raised Triglycerides**
>1.7 mmol/l (150 mg/dl)
Specific treatment for this lipid abnormality

**Reduced HDL Cholesterol**
<1.03 mmol/l (40 mg/dl) in men
<1.29 mmol/l (50 mg/dl) in women
Specific treatment for this lipid abnormality

**Raised Blood Pressure**
Systolic ≥130 mmHg
Diastolic ≥85 mmHg
Treatment of previously diagnosed hypertension

**Raised Fasting Plasma Glucose**
Fasting plasma glucose ≥5.6 mmol/l (100 mg/dl)
Previously diagnosed type 2 diabetes
If above 5.6 mmol/l or 100 mg/dl, oral glucose tolerance test is strongly recommended, but is not necessary to define presence of syndrome

*If BMI is over 30 kg/m², central obesity can be assumed and waist circumference does not need to be measured.

**In clinical practice, impaired glucose tolerance is also acceptable, but all reports of prevalence of metabolic syndrome should use only fasting plasma glucose and presence of previously diagnosed diabetes to define hyperglycemia. Prevalences also incorporating 2-h glucose results can be added as supplementary findings.
Table 1: The new International Diabetes Federation (IDF) definition

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Epidemiology of Metabolic Syndrome

• In the US: 34% of the adult population

• In the World: (US, Europe, India) >25% of adults

• In China: 13.2% of adult urban population (Han ethnic majority)
  – Kazakh ethnic population in Xinjiang: 33%
Risk Factors of Metabolic Syndrome

- Complex and under investigation
  - Older age (most patients but many young adults)
  - Overweight and obesity
  - Sedentary (inactive) behavior
  - Diet (sugar-sweetened beverage, e.g., Coke)
  - Stress
  - Genetics
  - Schizophrenia (32% and 51% patients meet MS criteria)
  - Molecules: Fibrinogen, interleukin 6, tumor necrosis factor-α, C-reactive protein, etc.
Major Associated Diseases with MS

• Cardiovascular diseases, particularly coronary heart disease

• Type 2 diabetes (diabetes mellitus type 2)
Treatment of MS

• The first line treatment is change of lifestyle
  – Diet, physical activity

• If no improvement in 3-6 months, the individual disorders that compose the metabolic syndrome are treated separately
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Prevention of MS

• Physical activity (such as walking 30 minutes every day)

• Healthy, reduced calorie diet

• Sociopolitical interventions to reduce development of metabolic syndrome in populations (like anti-smoking campaign in preventing lung cancer and awareness campaign in preventing AIDS, etc.)
FDA TO RETOOL FOOD GUIDE PYRAMID, CITING CONSUMER CONFUSION
The End