Metabolic Syndrome and Type 2 Diabetes Mellitus

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Patricia Kluding, PT, PhD
Yvonne Searls, PT, PhD
Irina V. Smirnova, PhD
Outline

• Metabolic Syndrome (Lisa Stehno-Bittel)
• PT Interventions for Metabolic Syndrome (Yvonne Searls)
• Diabetes (Lisa Stehno-Bittel)
• Complications of Diabetes (Irina V. Smirnova)
• PT Interventions in Diabetes (Patricia Kluding)
• Summary (Patricia Kluding)
The Diabetes Mellitus Epidemic

- 2700 newly diagnosed diabetic patients each day
- 3rd leading cause of death in US
- Costs $132 billion/year
- Americans with diabetes increased 33% in 8 years
- Fastest growing group 33-39 year old
The Diabetic Mellitus Epidemic

Diabetes affects 20.8 million people in the United States, or 7% of the population

**Diagnosed:** 14.6 million people  
**Undiagnosed:** 6.2 million people  
**Insulin Resistance Syndrome (IRS):** 41 million

ADA 2006
The Diabetic Mellitus Epidemic

In 2005, 7% of adults in Kansas were diagnosed with diabetes

In 2005, 683 Kansans died of diabetes

Estimated that 48,000 Kansans have diabetes and don’t know it

[Kansas Behavioral Risk Factor Surveillance System, KDHE, 2005]
The Diabetic Mellitus Epidemic

1,244,635 Kansans are at increased risk for undiagnosed diabetes because of risk factors

That’s nearly 50% of the population

[Kansas Behavioral Risk Factor Surveillance System, KDHE, 2005]
Mr. Jones

• 35 years old
• 6’’’ tall, weighs 240 pounds
• Does no regular exercise since leaving the military
• Early doctor’s visit: Fasting Plasma Glucose 115 mg/dL
• Diagnosed with Metabolic Syndrome
What is Metabolic Syndrome?

“consists of multiple interrelated risk factors, increases the risk for atherosclerotic cardiovascular disease by 1.5-3 fold, and raises the risk for type 2 diabetes by 3-5 fold. It affects over 26 percent of adults, or over 50 million Americans”

American Heart Association and the National Heart, Lung, and Blood Institute
Metabolic Syndrome: Historical Perspective

• Syndrome X
  – Identified in 1988 (Dr. Reaven, Diabetes paper)
  – Glucose intolerance
  – Hyperinsulinemia
  – Increased triglyceride levels
  – Decreased high density lipoproteins
  – Hypertension

Reaven, Diabetes, 1988, 1565
Metabolic Syndrome

• Diagnostic criteria
  – elevated waist circumference (abdominal obesity)
  – elevated triglycerides
  – reduced high-density lipoprotein cholesterol (HDL-C or “good” cholesterol)
  – elevated blood pressure
  – elevated fasting glucose

3 of the above criteria = Metabolic Syndrome

AHA
Metabolic Syndrome

• Diagnostic criteria
  – Central obesity (waist circumference > 40 inches in men and 35 inches in women)
    • Mr. Jones’ waist = 40 inches
  – BMI
    • Underweight = <18.5
    • Normal weight = 18.5-24.9
    • Overweight = 25-29.9
    • Obese = 30 or greater
    • Mr. Jone’s BMI = 32.5
Metabolic Syndrome

• Diagnostic criteria
  – High Blood Pressure
    • 130/85 mm Hg or higher
  – Mr. Jones’ Blood Pressure = 140/92
## Metabolic Syndrome

- **Dyslipidemia**

<table>
<thead>
<tr>
<th>Risk</th>
<th>LDL Cholesterol</th>
<th>HDL Men</th>
<th>HDL Women</th>
<th>Triglycerides</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt;130</td>
<td>&lt;35</td>
<td>&lt;45</td>
<td>&gt;400</td>
</tr>
<tr>
<td>Borderline</td>
<td>100-129</td>
<td>35-45</td>
<td>45-55</td>
<td>150-399</td>
</tr>
<tr>
<td>Low</td>
<td>&lt;100</td>
<td>&gt;45</td>
<td>&gt;55</td>
<td>&lt;150</td>
</tr>
</tbody>
</table>

Mr. Jones: LDL = 148 (high), HDL = 45 (borderline), triglycerides = 388 (borderline)
Prevalence of Metabolic Syndrome?

[Ford 2002]
Global Projections 2003 - 2025

- North America: 57%
- South America: 85%
- Europe: 21%
- Africa: 111%
- Asia: 108%
Prevalence of Insulin Resistance Depending on Risk Factors
Metabolic Syndrome

- Adult use of medications for Metabolic Syndrome up 36% (2002 to 2004)
- Annual prescription costs for people with Metabolic Syndrome averaged $4,116 last year
- ICD-9 Code 277.7 (Dysmetabolic Syndrome X)
- Over 5000 research articles have been published about metabolic syndrome
Metabolic Syndrome

• All criteria are not equal
• Abdominal obesity greater risk than high blood pressure or changes in the HDL
• Arbitrary cut offs in many of the criteria


• More predictive of diabetes than CVD

[Wilson, Circulation, 2005]
Is there such a thing as Metabolic Syndrome?

A key question is whether the presence of the metabolic syndrome, by any definition, shows a greater risk for heart disease than the risks posed by each of the health factors individually.
Metabolic Syndrome

According to a joint statement by the American Diabetes Association and the European Association for the Study of Diabetes, the answer is "no."
Metabolic Syndrome

The authors stated there was no solid evidence that any of the metabolic syndrome health factors contributed more together than they did individually. In other words, the whole is not greater than the sum of its parts.

ADA
Metabolic Syndrome

- Has not been properly defined
- Should not be treated as a unique syndrome
- Each of the health factors put people at risk for heart disease
- The combination of risk factors should not be considered, or treated as, a separate disease
- This may change with more research

ADA
Insulin Resistance Syndrome

• American College of Endocrinology and the American Association of Clinical Endocrinologists

• Useful to recognize the clustering of factors that increases the risk of an individual being insulin resistant as a “syndrome”.

• Insulin resistance underlies many of these conditions (of Metabolic Syndrome) and may therefore be considered to have a key explanatory role.
Insulin Resistance Syndrome (IRS)

- IRS
  - blood glucose levels that are higher than normal but not yet high enough to be diagnosed as diabetes.
- 41 million people in the United States, ages 40 to 74, have IRS.
Insulin Resistance Syndrome (IRS)

- San Antonio Heart Study
  - Subjects with IRS had increased risk of CV
- Nurses Health Study
  - Increased cardiovascular disease
- IRS Atherosclerosis Study
  - IRS has greater inflammation
Diagnostic Tests for IRS: Oral Glucose Tolerance Test

- Fast overnight
- Typically first do a fasting plasma glucose test
- Patient take 75 gm of glucose (in liquid) – 100 gm for pregnant women
- Blood glucose taken up to 5 times in 4 hours
## Diagnostic Tests

<table>
<thead>
<tr>
<th>OGTT (2 hour plasma glucose)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 140 mg/dl</td>
<td>Normal</td>
</tr>
<tr>
<td>140-200 mg/dl</td>
<td>IRS</td>
</tr>
<tr>
<td>Above 200 mg/dl</td>
<td>Diabetes</td>
</tr>
</tbody>
</table>
# Diagnostic Tests

## Insulin Resistance Syndrome

<table>
<thead>
<tr>
<th>Fasting Plasma Glucose</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 100 mg/dL</td>
<td>Normal</td>
</tr>
<tr>
<td>100-125 mg/dL</td>
<td>IRS</td>
</tr>
<tr>
<td>Above 126 mg/dL</td>
<td>Diabetes</td>
</tr>
</tbody>
</table>

Should be completed on two different days prior to diagnosis.
## Insulin Resistance Syndrome

**Prevalence**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>US</td>
<td>27%</td>
</tr>
<tr>
<td>Italy</td>
<td>75-92%</td>
</tr>
<tr>
<td>China</td>
<td>13%</td>
</tr>
<tr>
<td>African American</td>
<td>21%</td>
</tr>
<tr>
<td>Mexican American</td>
<td>32%</td>
</tr>
<tr>
<td>Whites</td>
<td>23%</td>
</tr>
<tr>
<td>Native Americans</td>
<td>42%</td>
</tr>
</tbody>
</table>

[Reynolds 2005]
Insulin Resistance Syndrome

• Prevalence

<table>
<thead>
<tr>
<th>Weight</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight</td>
<td>4.6%</td>
</tr>
<tr>
<td>Overweight</td>
<td>22.4%</td>
</tr>
<tr>
<td>Obese</td>
<td>59.6%</td>
</tr>
</tbody>
</table>

[Reynolds 2005]
Insulin Resistance Syndrome

- **Prevalence - children**
  - Youngest person diagnosed, Latino, 4 yo
  - Increased in prevalence 50% in 12-19 yo
  - More prevalent in young women
  - Prevalence > 30% in overweight adolescents
  - At least 2 million adolescents currently have IRS

[National Health and Nutrition Examination Survey]
IRS: Current Perspective

Body Size
BMI
Central obesity

Insulin resistance
Hyperinsulinemia

Glucose Metabolism

Uric Acid Metabolism

Dyslipidemia

Hemodynamic

Risk Factors

Glucose Intolerance

Uric Acid Metabolism

Hypertension

Sympathetic stimulation
Sodium ret

Fibrinogen
CRP

Coronary Artery Disease
Recent Truce?

• **Wrote a combined article**
  
  – "To clarify and reinforce the notion that our organizations remain unified and committed to reducing the burden of diabetes and CVD"

  – Little clinical evidence to establish the need for a “syndrome"
Pre-Diabetes

• Metabolic Syndrome and IRS both describe a pre-diabetic state.

• If something doesn’t change, the person will get diabetes, which leads to cardiovascular disease.
Abdominal Obesity

- Single most important factor in determining the pre-diabetic state

Metabolic Syndrome consists of excess abdominal body fat, high triglycerides, low HDL, and often hypertension.
Lean

Subcutaneous Fat

Subcutaneous and Intra-abdominal Fat

Intra-abdominal Fat
Fat in Liver
Obesity Trends* Among U.S. Adults
BRFSS, 1994
(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1998
(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2001

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)

Obesity Trends* Among U.S. Adults

BRFSS, 2005

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Diabetes Trends* Among Adults in the U.S.,
(Includes Gestational Diabetes)

BRFSS, 1990, 1995 and 2001

Adipose Tissue is Endocrine

- Fat is the LARGEST endocrine organ
- Fat secretes:
  - Leptin
  - Angiotensinogen
  - Resistin
  - Adiponectin
  - CRP
- Fat near the portal circulation may be more dangerous
Adipose Tissue in the US

- Government policy has failed to halt the increase in obesity in 31 states in the past year
- Report by Trust of American Health: called *F as in Fat: How Obesity Policies are Failing America*
- Mississippi worst (obesity – 30%)
- Not focusing on families and schools
- “Individual behavior change will not work in isolation”
- Kansas ranked 26th, Missouri 14, Nebraska 20, Oklahoma 13, Colorado 50

www.healthyamericans.org
Dissociation between BMI and BF

• Same BMI might be 9% BF in Caucasian and 22% in Indian
• Perhaps should lower the BMI cut off level for Asians (Hong Kong Chinese, Indonesians, Singaporeans)
• Suggested cut off level from 30 (overweight to obese for Caucasians) to 25 for Asians
• 4/5 countries with the greatest number of diabetics are Asian
Insulin Sensitivity by Ethnic Group

Caucasians  African American  Asian American  Mexican American  South Asia Indian

[Adapted from Chiu et al., Diabetes Care, 2000]
Abdominal Adipose

- **Most active** endocrine organ
- Like an endocrine tumor
- Malignant in that fat will enhance the growth of fat in other places – skeletal muscle and liver
Genetics and Environment

- Pima Indians
- Arizona/Mexico (Gilo River)
- US Pima = Highest rate of DM in the world
- 80% obese, 60% DM
- Mexican Pima = 10% Obese
- US diet 40% fat
- Mexican diet 15% fat, High in fiber
Walk to get water to the house
Wash clothes in stream
Grind corn and wheat by hand
Gatherers and farmers
Satiation = when you feel full

- **Volume**
  - When your stomach and intestines expand

- **Viscosity**
  - Speed of digestion
  - Fat is small volume/ high calorie
  - Donut absorbed in first 6 inches of small intestines

Mexican Pima Indians eat corn, squash, tomatoes, beans, chicken
Pathophysiology of Insulin Resistance Syndrome
How is Insulin Released?
Physiology of Insulin Release

• Stomach fills
• Stomach releases hormones sensed by pancreas, liver, and gallbladder
• Pancreas releases enzymes and bicarbonate factors through duct to digest food
• Pancreas releases insulin into the blood stream to allow glucose to enter all cells
What Does Insulin Do?
Defective Glucose Transport in Type 2 Diabetes

![Bar chart showing glucose transport in control and type 2 diabetic patients.](www.images.md)
Insulin Resistance

• May be too much insulin in the blood
• When it gets to target cell, it can’t bind or can’t have an effect
• Glucose can’t get into the cell
• Glucose builds up in the blood
• Hyperglycemia
• Diabetes
Type 2 Diabetes

Lisa Stehno-Bittel, PT, PhD
Type 2 Diabetes

- Insulin resistant and relative insulin deficiency
- Plasma insulin levels may be normal
- No autoimmune destruction of $\beta$ cells
- Obesity common (or high % body fat)
- Hyperglycemia develops slowly
- Genetic predisposition
Type 1 Diabetes

- Auto-immune disease
- Auto-antibodies (80-90% of patients with fasting hyperglycemia)
  - islet cells
  - insulin
  - GAD (glutamic acid decarboxylase)
  - IA-2 and 2B (phosphatases)
- Rate of $\beta$ cell destruction - varies
- Rarely obese, prone to other autoimmune diseases
Mixture of Type 1 and Type 2

- Subset of patients with Type 1 without autoantibodies
- Type 2 adults with autoantibodies
- MODY
- Type 1.5
Gestational Diabetes

• Glucose intolerance with pregnancy
• If it continues after pregnancy (> 6 weeks), no longer GDM
• 4% of all pregnancies in US
• Increased risk of cesarean and chronic hypertension
• Increased risk of diabetes later
Diabetes Diagnoses

- Diseases of exocrine pancreas (pancreatitis, neoplasia, trauma)
- Drug or chemical-induced (glucocorticoids, thiazides, dilantin)
- Infections (cytomegalovirus)
- Genetic defects (congenital)
Mr. Jones, continued

- 4 years after diagnosis of Metabolic Syndrome
- Drinking a lot, not feeling well
- Mother suggested blood work
- Diagnosed with Type 2 DM
  - Fasting Plasma Glucose 145 mg/dL
  - Oral Glucose Tolerance Test 220 mg/dL
  - Hemoglobin A1C = 8%
  - BMI 33
What’s the Goal?
Tight control

Close to normal to (nondiabetic) plasma glucose levels

70 and 120 mg/dl before meals and < 180 mg/dl after meals

Glycated hemoglobin A1C level < 7 %

Keeping normal levels all the time is not practical
The Diabetes Control and Complications Trial

1,441 people with diabetes from 1983-1993
Half of the people continued standard diabetes treatment
The other half followed an intensive-control program.

- 75% decrease - Diabetic eye disease
- 50% decrease - Kidney disease
- 66% decrease - Nerve damage

- Far fewer people who already had early forms of these complications got worse.
Positive Effects of Tight Control

- Lower risk of microvascular disease
- Felt better, more energy
- Patients had more control
- Reduced risk of birth defects in babies of pregnant women
The Diabetes Control and Complications Trial

Macrovascular diseases were not improved by tight glycemic control

1. Heart attack
2. Stroke
3. High blood pressure
Negatives of Tight Control

1. Three times more likely for hypoglycemic state

2. Weight gain more likely (average 10 pounds)
Contraindications of Tight Control

• Children need glucose for brain development (7 – 13 years old)
• Hypoglycemia = strokes and heart attacks
• Those with severe complications
• Hypoglycemia unawareness
Tools for Tight Control
Self Monitoring

Plasma glucose testing
- Requires sticks
- Expensive

• Urine glucose testing
  - Semiquantitative measurements
  - Ketones – normally present but too low to be detected. Ketones should be tested when blood glucose > 300 mg/dl

• Glycated hemoglobin
New Tools for Self Monitoring

Forearm measurements for blood glucose are less-painful than finger tip

Forearm glucose lags behind the fingertip by about 34 minutes
Glycated Hemoglobin

- Glycated Hemoglobin (HbA1C)
- HbA1C < 7%
- History of the plasma glucose levels
- Hemoglobin lasts 120 days
- Can be done at home or in office
Non-invasive Glucose Testing

Blood viscosity
GlucoOnline, relatively reliable

Glucose through infrared light or a near UV. Measures blood glucose levels by detecting spectral patterns on the skin. Sufficiently accurate compared to conventional methods.
New Tools for Self Monitoring

New glucose readers that are digital planners

Store and plot glucose levels over time of day and related to what is eaten

Pull-down menu in meter for food intake and activity level
Continuous Monitoring

- Continuous Glucose Monitor
- Placed under the skin
- Reads every 10 sec. – reports every 5 min
- Pt records food intake, exercise
Next Generation

• Implanted pumps
• Like pacemaker
• Physiological control with continuous monitoring
Tools for Administering Insulin

• Inhaled insulin
  – a chemically stabilized protein
  – a dry powder formulation exhibiting required aerosol physical characteristics
  – low-dose powder filling and packaging technology
  – a mechanical device for powder dispersal and reliable dosing to the patient
Exubera

– Pfizer (New York) and Aventis (Paris)
– Short-acting (at meals) insulin
– Will not replace long-acting insulin
– Must inhale about seven times as much insulin as injected to get the same effect.
– Still concern about long-term effects on the lungs
– Limited testing in smokers and children
# Tools for Reducing Glucose - Drugs

<table>
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<tr>
<th>Class</th>
<th>Generic</th>
<th>Brand</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>α-glucosidase inhibitors</td>
<td>Acarbose/Miglitol</td>
<td>Precose</td>
<td>No weight gain – take when eating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glysert</td>
<td></td>
</tr>
<tr>
<td>Biguanides</td>
<td>Metformin</td>
<td>Glucophagae</td>
<td>Improves cholesterol levels</td>
</tr>
<tr>
<td>Meglitinides</td>
<td>Nateglinide</td>
<td>Starlix</td>
<td>Take only with meals</td>
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<tr>
<td></td>
<td></td>
<td>Prandin</td>
<td></td>
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<tr>
<td>Sulfonylureas</td>
<td>Chlorpropamide</td>
<td>Diabinese</td>
<td>Long-acting, safe with kidney disease</td>
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<tr>
<td></td>
<td></td>
<td>Glucotrol</td>
<td></td>
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<tr>
<td>Thiazolidinediones</td>
<td>Pioglitazone</td>
<td>Actos</td>
<td>Takes 4-6 weeks to see effect</td>
</tr>
<tr>
<td></td>
<td>Rosiglitazone</td>
<td>Avandia</td>
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</table>
Sites of Action of Drugs Used to Treat Type 2 Diabetes

- Metformin
- Food intake
- Gut
- Alphaglucosidase inhibitors
- Gluconeogenesis and glycogenolysis
- Liver
- Glucophage
- Glycertain
- Thiazolidinediones
- Muscle
- Fat
- Glucose uptake and utilization
- Insulin
- Pancreas
- Glucotrol
- Sulfonylureas
- Meglitinides
- Prandin
- www.images.md
Islet Transplantation

- Islets isolated from pancreas
- Injected into portal vein (liver)
- Islets infuse and attach in liver and produce insulin
- Takes 2-3 donors to treat one diabetic
Islet Transplantation

![Graph showing insulin requirement before and after islet transplantation.](www.images.md)
Large Islet – Dead in the Middle
Large vs. Small Islet Transplantation

Blood Glucose mg/dl vs. Days

Graph showing the comparison of blood glucose levels over time for large vs. small islet transplantation.
Day 60 After Transplantation

Plasma Glucose mg/dl

- large
- small

Day 60 After Transplantation
Diabetic Complications

Irina V. Smirnova, MS (Hon), PhD
Clinical Manifestations of Diabetes
Complications

~ 4 million deaths every year are attributable to complications of diabetes

- Cardiovascular disease (CVD)
- Diabetic retinopathy
- Diabetic nephropathy
- Peripheral arterial disease (PAD)
- Diabetic neuropathy
Epidemiology of Diabetes Complications

At diagnosis of type 2 diabetes

- 20% have retinopathy
- Up to 50% have underlying heart disease
- 8% have nephropathy
- 9% have neuropathy
Complications: Retinopathy

- a.k.a. vascular disease of the retina
- highly specific microvascular complication
- prevalence is strongly related to the duration of diabetes
- affects >60% of type 2 diabetes patients after 20 years of diabetes
Complications: Retinopathy

- serious threat to vision
- the most frequent cause of new cases of blindness among adults aged 20-74 years
- research: association of poor glucose control and retinopathy
Complications: Retinopathy

- Progression is orderly
  - mild nonproliferative abnormality
    - Increased vascular permeability
  - moderate and severe nonproliferative retinopathy
    - Vascular closure
  - proliferative diabetic retinopathy
    - Growth of new blood vessels on the retina and posterior surface of the vitreous
Complications: Retinopathy

Nonproliferative diabetic retinopathy

Proliferative diabetic retinopathy

www.images.md
Complications: Retinopathy

- Systemic Factors Potentially Increasing Risk of Diabetic Retinopathy
  - Glycemic control
  - Hypertension
  - Dyslipidemia
  - Pregnancy
  - Smoking
  - Anemia

- Renal disease
Complications: Retinopathy

- Correlation between retinopathy, mortality and CVD incidence in type 2 diabetes
  - EURODIAB Prospective Complications Study (Diabetes Care, 2005)

What’s Good For the Eyes is Good For the Heart
Complications: Retinopathy

Diabetes Prevention Program (DPP) Outcome Study

Diabetic retinopathy occurs in pre-diabetes
- 8% of DPP participants with pre-diabetes
- 12% of participants who developed diabetes during the study
  - earlier (within 3 years of diagnosis)
  - at lower plasma glucose level

Recommendation: newly diagnosed type 2 diabetes patients should be screened for retinopathy
Complications: Retinopathy

Diabetes Prevention Program (DPP) Outcome Study

How it was studied –
• detailed look at the retina using special camera  
  – small changes in the vessels  
    • microaneurysms  
    • hemorrhages

What was found –
• participants with pre-diabetes and retinopathy  
  – had a small number of microaneurysms  
    • early, mild retinopathy that is not yet linked to vision loss
• participants who had developed diabetes in the previous 1 to 5 years  
  – had slightly more severe retinopathy
Complications: Retinopathy

Diabetes Prevention Program (DPP) Outcome Study

- Correlation between the presence of retinopathy and
  - Higher blood pressure
  - Higher glycated hemoglobin A1C
Complications: Retinopathy

Diabetes Prevention Program (DPP) Outcome Study

DPP study chair David Nathan, MD:
“The complications of diabetes may begin before diabetes is diagnosed, at least by the current-day standards”.

NIH News, June 12, 2005
Complications: Retinopathy

Diabetes Control and Complications Trial (DCCT) Study

• Intensive vs conventional insulin therapy:
  • reduced or prevented development of retinopathy by 27%
  • reduced progression of retinopathy by 34-76%
  • early treatment was most effective
Complications: Retinopathy

NIH sponsored trials, DRS and ETDRS

Laser photocoagulation surgery
- beneficial in reducing the risk of further visual loss
- can prevent blindness in more advanced cases
- not beneficial in reversing already diminished acuity

Importance of early screening to detect retinopathy
Complications: Retinopathy

ADA recommendations:

- Optimal glycemic control and blood pressure control
- Comprehensive eye exam shortly after diagnosis
Complications: Nephropathy

• 20-40% of patients with diabetes develop evidence of nephropathy

• Diabetes is the single leading cause of end-stage renal disease (ESRD) in the US and Europe

• Accounts for 40% of new cases of ESRD
Complications: Nephropathy

• **Microvascular** complication
  
  – Characterized by
    
    • Albuminurea
    
    • Progressive loss of renal function
Complications: Nephropathy

• Clinical stages
  – **Microalbuminurea** - appearance of low but abnormal levels ($\geq 30$ mg/day or $20 \, \mu g/\text{min}$) of albumin in urine
  – **Macroalbuminurea** - $\geq 300$ mg/day or $200 \, \mu g/\text{min}$ of albumin in urine
  – **ESRD**
Complications: Nephropathy

- Risk factors for development

- Poor glycemic control
- Hypertension

- Genetics
  - Chromosomal region around angiotensin
  - II type I receptor
  - Angiotensinogen gene
  - Angiotensin-converting enzyme gene
  - Sodium/lithium exchange activity
  - Sodium/proton exchange activity

- Smoking
Complications: Nephropathy

• Annual screening
  – for the presence of microalbuminuria
    • a marker for increased risk for cardiovascular morbidity and mortality
  – serum creatinine level measurement to estimate glomerular filtration rate (GFR)
Complications: Nephropathy

• Methods to screen for microalbuminuria:
  – Random spot collection to measure albumin-to-creatinine ratio
    • preferred screening method
      – is easy to carry out in an office setting
      – provides accurate information
  – 24-hour collection with creatinine
    • allows simultaneous measurement of creatinine clearance
  – Timed collection (e.g., 4-hour or overnight)
Complications: Nephropathy

• Treatment and prevention
  – tight glycemic control
  – blood pressure control
    • life style changes
      – weight loss
      – sodium restriction
      – alcohol and tobacco avoidance
      – regular exercise
    • medications
      – ACE inhibitors
      – angiotensin receptor blocker (ARBs)
  – protein restriction
  – kidney transplantation
  – dialysis
Complications: Nephropathy

• Glycemic control (DCCT and UKPDS trials)
  – Intensive insulin therapy can significantly reduce the risk of the development of microalbuminuria and overt nephropathy

• Hypertension control (UKPDS trial)
  – Antihypertensive interventions can significantly
    • increase life expectancy, with a reduction of mortality from 94 to 45%
    • reduce need for dialysis and transplantation from 73 to 31%
      (16 yrs after development of overt nephropathy)
Complications: **Peripheral Arterial Disease (PAD)**

- a.k.a. poor circulation
- most common and important type of PVD
- occurs when blood vessels in the legs are narrowed or blocked by fatty deposits
- blood flow to feet and legs decreases
- affects diabetic foot integrity
  - major risk factor for lower-extremity amputation
- increases nerve ischemia resulting in worsened neuropathy
- people with PAD face a 6-7 times higher risk of heart attack or stroke

**Diagnosis - critical!**
Complications: Peripheral Arterial Disease (PAD)

• 4 times higher risk in patients with diabetes

• one out of every three people with diabetes over the age of 50 have this condition
  – 78% asymptomatic

• people with PAD and diabetes (compared to PAD alone) demonstrate slower gait velocity and decreased function [Dolan 2002]
Complications: Peripheral Arterial Disease (PAD)

- **Atherosclerosis** – major contributor

Pathophysiology of atherosclerosis
- Dyslipidemia
- Hyperglycemia
- Altered platelet and coagulation function
- Presence of adhesion molecules
Complications: Peripheral Arterial Disease (PAD)

- Other causes
  - blood clots or embolisms
  - congenital heart disease
  - inflammation of the blood vessels (vasculitis)
  - aortic dissection
Complications: Peripheral Arterial Disease (PAD)

• Warning signs

– Many people with diabetes and PAD do not have any symptoms

– Some people may experience mild leg pain or trouble walking and believe that it’s just a sign of getting older

– Others may have the specific symptoms related to the organ or part of the body deprived of adequate circulation
Complications: Peripheral Arterial Disease (PAD)

• **Symptoms**
  – Claudication – pain, fatigue, cramping or tingling in the leg(s) brought on by exercise that goes away when resting
  – Numbness of the legs or feet at rest
  – Cold legs or feet
  – Loss of hair on the legs and/or feet
  – Paleness or blueness of the legs
  – Weak or absent pulse in the leg
  – Sores, injury, or infection of the feet and legs that heal slowly
  – Uncontrollable hypertension (high blood pressure)
  – Slurred speech
  – Loss of sight in one or both eyes
Symptoms of severe PAD:

- Foot pain that does not go away when a person stops exercising
- Foot or toe wounds that will not heal or heal very slowly
- Gangrene
- Marked decrease in the temperature of lower leg or foot particularly compared to the other leg or to the rest of the body
Complications: Peripheral Arterial Disease (PAD)

- **Risk factors**
  - smoking
  - high blood pressure
  - abnormal blood cholesterol levels
  - already have heart disease, or have had a heart attack or a stroke
  - overweight
  - not physically active
  - over age 50
  - family history of heart disease, heart attacks, or strokes
Complications: Peripheral Arterial Disease (PAD)

• How is PAD diagnosed?
  – The ankle brachial index (ABI)
    • inexpensive test
    • takes only a few minutes
    • compares the blood pressure in an ankle to the blood pressure in an arm (determines how well the blood is flowing)

Normally, the ankle pressure is at least 90% of the arm pressure, but with severe narrowing it may be less than 50%

• Thus, if the blood pressure in the lower part of a leg is lower than the pressure in an arm, the patient may have PAD
Complications: Peripheral Arterial Disease (PAD)

• How is PAD diagnosed?

  – Other tests:

    • Angiogram
      – dye is injected into the blood vessels using a catheter and X rays are taken to show whether arteries are narrowed or blocked

    • Ultrasound
      – uses sound waves to produce images of the blood vessels on a viewing screen
Complications: Peripheral Arterial Disease (PAD)

• How is PAD diagnosed?
  
  – Other tests:
    
    • MRI (magnetic resonance imaging)
      
      – uses special scanning techniques to detect blockages within blood vessels
Complications: Peripheral Arterial Disease (PAD)

• How is PAD treated?

Lifestyle Changes
- Smoking cessation
- Glycemic control
- Blood pressure control
- Low-saturated-fat, low-cholesterol diet
- Weight loss
- Increased physical activity
  • Exercise, such as walking, can be used both to treat PAD and to prevent it
- Attentive foot care
  • Shoes that fit properly
  • Proper treatment of all foot injuries—healing is slowed when circulation is poor, and the risk of infection is higher
Complications: Peripheral Arterial Disease (PAD)

• How is PAD treated?

Medication
– Antiplatelet agents such as aspirin to thin blood
– Medicines to reduce leg pain
– Cholesterol-lowering agents (statins)
– Medicines to enlarge or dilate the affected artery(ies)
Complications: Peripheral Arterial Disease (PAD)

• How is PAD treated?
  – in some cases, surgical procedures are used to treat PAD:
    • balloon angioplasty
      – inflate within the obstruction, pushing the material aside
    • stents
      – metal tubes that expand once in place, forming a rigid framework to hold the artery open
    • artery bypass graft
Complications: **Cardiovascular Disease (CVD)**

- **Major complication** and leading cause of premature death in diabetic population
  - accounts for approximately 2/3 of all deaths among people with diabetes

- 1.5-fold risk of CVD compared to people with normal blood glucose

- 2-4 fold increase in heart disease or stroke
Complications: Cardiovascular Disease (CVD)

- Congestive heart failure (CHF)
- Coronary artery disease (CAD)
- Stroke
- Myocardial infarction (MI)
- Diabetic cardiomyopathy (DC)

Pathogenesis
- Not fully understood
Complications: Cardiovascular Disease (CVD)

- Insulin Resistance is a risk factor for CVD

San Antonio Heart Study, 2002
Complications: Cardiovascular Disease (CVD)

Framingham Heart Study
(18yr follow-up) 42/239 CHD deaths

• 2 to 3 fold increased risk of clinical arteriosclerotic disease in diabetes
Complications: Cardiovascular Disease (CVD)

Multiple Risk Factor Intervention Trial (MRFIT)
(12yr follow-up) 5,000 diabetic and 350,000 non-diabetic individuals

• 3 times higher absolute risk of CVD in men with diabetes
Complications: Cardiovascular Disease (CVD)

East/West Study
(7yr follow-up) 3,000 patients

• Diabetic patients without previous MI had as high risk of MI as nondiabetic patients with previous MI
Complications: Cardiovascular Disease (CVD)

• Diabetes heart risk “equivalent to 15 years aging”
  – Men with diabetes go from moderate to high risk at ~ 41 yr; women – at ~ 48 yr

Complications: Cardiovascular Disease (CVD)

ADA survey of people with diabetes: The Diabetes-Heart Disease Link

People with Diabetes Do Not Link Cardiovascular Complications With Their Disease

• More than two-thirds (68%) of people with diabetes do not consider CVD serious complication of diabetes.
• People with diabetes are more likely to be aware of serious diabetes complications causing disability such as blindness (65%) or amputation (36%) rather than complications that may result in premature death such as heart disease (17%), heart attack (14%) or stroke (5%).
• Awareness of CVD disease risks is much lower among older adults and Hispanics, with 3/4 not naming any cardiovascular condition as a serious complication of diabetes.
• Nearly one in 10 people with diabetes could not name one serious complication of the disease.
Complications: Cardiovascular Disease (CVD)

ADA survey of people with diabetes: The Diabetes-Heart Disease Link

People with Diabetes Unaware of Ways to Reduce CVD Risks

• Few people with diabetes could name important methods to reduce their risk of heart attack or stroke, such as
  – taking prescription medications (18%)
  – lowering cholesterol (8%)
  – quitting smoking (7%)
  – reducing blood pressure (5%)
  – taking aspirin (1%)

• 16% could not name any way to reduce their CVD risk.
• 20% of African Americans compared with 15% of Caucasians and 11% of Hispanics could not name any way to reduce their risk of heart attack or stroke.
Complications: Cardiovascular Disease (CVD)

• Prevention and management
  – Tight glycemic control
  – Blood pressure control
  – Lipid management
  – Aspirin therapy
  – Use of ACE inhibitors
  – Smoking cessation
  – CHD screening and treatment
  – Exercise
Benefits of Exercise on Diabetic Cardiac Muscle – Study on Diabetic Rats
Benefits of Exercise on Diabetic Cardiac Muscle –

Conclusions

• Exercise improved ultrastructure
• Exercise reduced fibrosis
• Exercise corrected diastolic and systolic abnormalities caused by diabetes
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ysearls@kumc.edu
Complications Continued: Neuropathy

Patricia Kluding, PT, PhD
Neuropathy

- One of the most common complications of diabetes and least understood
- Cost of diabetic peripheral neuropathy (DPN) and associated ulcers/amputations:
  - $0.8 billion Type 1
  - $10.1 billion Type 2

[Gordois 2003]
Neuropathy

Generalized symmetric polyneuropathy:
- Acute sensory
- Chronic sensorimotor
- Autonomic

Focal and multifocal neuropathies:
- Cranial
- Truncal
- Coexisting CIDP

Focal limb
Proximal motor

[Boulton 2005]
Focal Neuropathies

Interfascicular infarction
Focal Neuropathies

• Symptoms:
  – May be severe
  – Short duration
  – Good prognosis for recovery

[Vinik 2000]
Chronic Sensorimotor Neuropathy

- Prevalence 28.5% in US adults over 40 years old with diabetes [Gregg 2004]
  - 62% of these asymptomatic: no report of numbness or pain
- Subclinical neuropathy
- Progression
  - NCV slows 1 m/s per year [Vinik 2000]
Chronic Sensorimotor Neuropathy

• Symptoms:
  – Numbness in feet and lower limbs
  – Neuropathic pain
    • Up to 50%
    • Burning, stabbing, aching, paresthesia
    • Worse at night
  – Mild motor involvement
Chronic Sensorimotor Neuropathy

• Risk factors
  – Hyperglycemia
  – Lipid and blood pressure abnormalities
  – Diabetes duration
  – Height
Chronic Sensorimotor Neuropathy

• Pathogenesis:
  – Unclear?
  – Heterogeneous?
  – Type 1 vs Type 2?
Screening for Neuropathy

- Any patient with diabetes or suspected diabetes: [Rahman 2003]
  - Monofilament testing
  - Vibration testing
  - Michigan Neuropathy Screening Instrument [Feldman 1999]
Monofilament Tests

• 10 g monofilament
• Plantar aspect of 1\textsuperscript{st} and 5\textsuperscript{th} metatarsal
• 8/10 normal

• Screen for “protective sensation”
LEAP Filament

• Lower Extremity Amputation Prevention
• Up to 50 available for free from US DHHS
• www.bphc.hrsa.gov/leap/LEAPfilament.htm
Vibration Testing

- Demonstrate with a 128 Hz tuning fork
- Place on a bony prominence.
- How long does patient feel vs therapist?
MNSI

- 15 questions: patient symptom report
- Physical exam:
  - Appearance of feet
  - Ulceration
  - Ankle reflexes
  - Vibration perception
  - Monofilament test
- Neuropathy if >8/10 points
Neuropathy Examination

• Neurologist Examination
  – Clinical exam
  – Nerve conduction velocity
    • Amplitude
    • Latency
    • Conduction velocity
  – Quantitative sensory testing
    • Cooling detection threshold
    • Pain threshold
    • Vibratory detection threshold
Neuropathy Examination

- PT Exam findings:
  - Sensory loss / Absent ankle reflexes
    - Decreased ankle proprioception
      [Van den Bosch 1995]
  - Mild motor weakness
    - Decreased isokinetic strength of PF and DF
      [Andersen 1996]
    - Decreased rate of torque development [Gutierrez 2001]
    - Muscle atrophy on MRI [Andersen 1997]
Neuropathy Examination

• Balance
  – Increased sway in standing [Cavanaugh 1993]
  – Postural instability when eyes closed, head back [Simoneau 1994]
  – Decreased unipedal stand, tandem stand, balance walk, coordination (foot taps) [Resnick 2002]
  – Elderly diabetics more likely to fall than people without diabetes [Maurer 2005]
Neuropathy Examination

• Gait
  – Shorter 6 minute walk distance and gait velocity [Dolan 2002]
  – Decreased ankle movement, ankle power, stride length [Mueller 1994]
  • Plantar flexor strength and muscle stiffness [Salsich 2000]
Medical Management

- Prevent and treat with improved glucose control
- Tricyclic drugs (e.g. Amitriptyline): RCTs confirm effectiveness in neuropathic pain. Inexpensive but anticholinergic and fatigue side effects
- Anticonvulsants (e.g. Gabapentin): RCTs confirm usefulness in neuropathic pain

[Boulton 2005]
Autonomic Neuropathy

• Disorder of all parts of ANS
• May result in significant morbidity and mortality for people with diabetes
• Types: cardiovascular, gastrointestinal, genitourinary
Autonomic Neuropathy

- **Symptoms:**
  - Limited exercise capacity
  - Constipation
  - Erectile dysfunction
- **Subclinical dysfunction can occur within 1 year of diabetes diagnosis**
- **Symptoms often do not occur for several years**
Cardiovascular Autonomic Neuropathy

- Diagnostic tests / Screening: [Vinik 2003]
  - Resting tachycardia (>100 bpm)
  - Orthostasis (>20 mm Hg fall in systolic BP on standing)
  - Decreased heart rate variability (measured on ECG)
    - Deep breathing
    - Valsalva
    - Sit to stand
Cardiovascular Autonomic Neuropathy

- Reduced heart rate / blood pressure response to exercise
- Exercise stress test recommended for patients with CAN
  - ACSM Guideline: diabetes is automatically a high-risk test
Central Neuropathy?

• Elderly subjects with type 2 DM:
  – decreased scores on cognitive tests [Gregg 2000]
  – smaller hippocampal and amygdalar volume on MRI [Den Heijer 2003]

• Middle age subjects:
  – intact learning, memory, problem solving but slowed psychomotor responses [Ryan 2000]
Central Neuropathy?

• Relationship of diabetes and Alzheimer’s disease?
• Are deficits reversible?
  – Cognitive training
  – Exercise
Physical Therapy Role in Treatment of Type 2 Diabetes

Patricia Kluding, PT, PhD
Chronic Care Model

• CCM is paradigm shift towards prevention rather than acute management

• Primary care application for diabetes care:
  – Partnership between community, academic, clinical organizations
  – Self-management emphasis and education
  – Establish goals for providers (benchmarks for adherence to ADA standards), encourage alternate strategies for delivery of care
Chronic Care Model

- Piatt et al 2006: Primary care practices randomly assigned to CCM, usual care, or provider education
- 1 year follow up:
  - Patients in CCM group had significantly improved A1C%, blood pressure, score on diabetes knowledge test, self-monitoring of glucose, empowerment score
  - No change in usual care and provider education
Guide to PT Practice

Multiple system involvement:
  4D Connective tissue dysfunction
  4J Amputation
  7A Primary prevention integumentary
  7B Impaired integumentary
  5G Polyneuropathy
  6A Primary prevention cardiovascular
  6B Deconditioning
Medical Screening

• Purpose of screening:
  – Identify health risk factors
  – Recognize atypical signs and symptoms
  – Review of systems

• More detailed exam if indicated

Boissonault, Umphred 2001
Medical Screening

Neurological
Integumentary
Cardiovascular
Pulmonary
Urogenital
Gastrointestinal
Endocrine
Depression / Psychological
PT Examination

- Sensory exam
- Motor exam
- Functional mobility
PT Examination

• Balance
  – Berg balance scale
  – Functional reach
  – Eyes open / closed

• Gait
  – Timed Up and Go
  – Dynamic Gait Index
  – Duke Mobility Skills Index
Connective Tissue (4D)

• Pathology: Glycation of collagen protein
• Contributes to increased stiffness and ROM loss
  – Hands
  – Feet
Charcot Joint (Neuroarthropathy)

• Insidious, chronic destruction of bones and joints
  – Pathological fractures
  – Joint subluxation and dislocation
  – Osteopenia

• Causes: Neurotrauma vs Neurovascular
  – Metabolic stress (hyperglycemia)
  – Mechanical stress
  – Neuropathy

[Sinacore 1999]
Charcot Joint
Charcot Joint Stages

• Stage 0: Local swelling, warm, painful foot
• Stage 1: Above + osteopenia, radiologic abnormalities
• Stage 2: Joint subluxation
• Stage 3: Joint dislocation, arch collapse
• Stage 4: Healed and stable deformity

• Immobilization, limit weight bearing, surgical fixation
Connective Tissue Research

- Decreased ankle dorsiflexion ROM in subjects with DPN compared to age-matched controls [Salsich 2000]
- Contribute to abnormal biomechanics:
  - Abnormal walking patterns [Mueller 1994]
  - Risk of foot ulcers [Mueller 1989]
- Peripheral neuropathy correlation?
  - Current research question
Connective Tissue

Interventions to Increase ROM:

– Stretching?

– Achilles tendon lengthening with Total Contact Cast to promote healing of ulcers [Mueller 2003]

– Joint mobilizations to ankle
  • [Dijs 2000]
  • Current research question
Integumentary (7A)

• Prevention of neuropathic ulcers:
  – Assessment of biomechanics
  – Screen for sensory neuropathy
  – Teach good foot care
Good Foot Care

• Inspect feet:
  – Daily
  – After each exercise session
  – May need assistance for this
• Have nails trimmed by professional
• Never go barefoot
• Socks:
  – Avoid seams
  – Avoid elastic tops
Good Foot Care

Recommendations for Shoes:

- Soft, flexible upper portion
- Removable inlay
- ¼ inch extra depth
- Padded collar (top of shoe)
- Arch support
- Flexible sole
Neuropathic Ulcers (7B)
Management of foot ulcers

- No infection
  - Strict non-weight bearing
  - Contact casts
  - Wound care

- Mild infection
  - Strict non-weight bearing
  - Antibiotics
  - Wound care

- Limb or life-threatening infection
  - Admit to hospital
  - Strict non-weight bearing
  - Antibiotics
  - Wound care
  - Surgery

Lifelong foot care
Neuropathic Ulcers

• Need to offload foot to allow healing
• Total Contact Casting: redistribute forces
  – Effective at promoting healing [Nabuurs-Franssen 2005]
  – In combination with ATL [Mueller 2003]
• Removable cast walkers vs. “Instant TCC” [Armstrong 2005]
Neuropathy (5G)

• Insensate feet:
  – Education
  – Compensation

• Painful feet:
  – TENS
  – Microcurrent
  – Research … ?
Neuropathy: MIRE?

- Monochromatic Infrared Energy
  - Approved by FDA 1994 to increase circulation and reduce pain
  - Neuropathy is “off-label” use
  - Local effects of increased circulation
Neuropathy: MIRE?

• Increase sensation?
  – Early results promising:
    • Increased sensation
    • No placebo control, small groups or case studies
  – Recent double blind placebo-controlled trial [Clifft 2005]:
    • Both active and placebo groups increased monofilament sensation
    • 30 min applied 3 days per week for 4 weeks
    • Hawthorne effect vs. free pamphlets on foot care
Neuropathy: Exercise?

- 3 RCTs on exercise and PN [Cochrane review 2004]
  - Resistance exercise may increase strength
  - Inadequate evidence for effect on function
- Recent RCT evaluated onset of neuropathy over 4 years in subjects who were asymptomatic [Balducci 2006]
  - 4 sessions per week (1 hour) brisk treadmill walking
Cardiovascular Deconditioning (6B)

• Research on exercise for diabetes:
  – Meta-analysis showed improved glycemic control [Boule 2001]
  – Decreased obesity [Agurs-Collins 1997]
  – Lower risk of cardiovascular events [Hu 2001]
  – No benefit [Tessier 2000]
Resistance Training

• Benefits
  – In combination with aerobic exercise, increased aerobic fitness [Maiorana 2002]
  – Alone, improved strength and metabolic profile [Honkola 1997]
Exercise Considerations for the Patient with Diabetes

DO NOT EXERCISE IF GLUCOSE BELOW 70 mg/dL

• Hypoglycemic response to exercise is rare in Type 2 Diabetes [ACSM 2000]
• Goal is weight reduction so taking snack will undermine exercise effects

DO NOT EXERCISE IF GLUCOSE ABOVE 250 mg/dL

• Exercise can decrease blood glucose
• BUT intensive exercise can raise blood glucose by signaling liver to convert glycogen to glucose
Exercise Considerations for the Patient with Diabetes

• Check for complications:
  – Cardiovascular status (autonomic neuropathy?)
  – Neuropathy or foot ulcer
  – Vision deficits
  – Advanced kidney disease
Aerobic Exercise Protocol

- Intensity: 60-85% maximal heart rate
  - Submax or max exercise test vs 220-age
- Use RPE [Colberg 2003]
- Monitor BP, HR
- Monitor glucose
Special Populations

Brittle Diabetes

- Glucose > 300 mg/dl, diabetes is in poor control
- Exercise with caution
- Recheck blood glucose every 10-15 min
Children and Adolescents

• Increasing prevalence of Type 2 Diabetes makes diagnosis difficult in children

• Clinical presentation of Type 1 Diabetes:
  – Not overweight, recent weight loss, polyuria, polydipsia

• Clinical presentation of Type 2 Diabetes:
  – Overweight or obese, glycosuria without ketonuria, no polyuria or polydipsia

[ADA consensus statement 2000]
Challenges in Children

• Growth / development
  – Insulin resistance naturally increases in puberty

• Obesity comorbidities

• Family dynamics
  – Especially important if encouraging lifestyle modifications

[Halvorson 2005]
# Age-Specific Challenges

<table>
<thead>
<tr>
<th>Activity</th>
<th>0-3 years</th>
<th>4-6 years</th>
<th>7-12 years</th>
<th>13-18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Testing</strong></td>
<td>Meter selection</td>
<td>Do own checks</td>
<td>Avoid test in public</td>
<td>Hectic lifestyle</td>
</tr>
<tr>
<td><strong>Hypo-hyperglycemia</strong></td>
<td>Unable to tell</td>
<td>Fear</td>
<td>Understand cause</td>
<td>Driving</td>
</tr>
<tr>
<td><strong>Exercise</strong></td>
<td>Rapid growth</td>
<td>In motion</td>
<td>Sedentary</td>
<td>Weekend weekday</td>
</tr>
</tbody>
</table>

[Halvorson 2005]
Treatment of Children and Adolescents

• Goal is normalization of plasma glucose
  – Medical nutrition therapy
  – Exercise
  – Glucose-lowering oral agents
    • not approved by FDA for children

• Monitor for complications

• Treat comorbidities (hypertension, hyperlipidemia)
Patient Education
Education about Exercise

• Motivation is key
  – Individualize incentives
  – Keep log of sedentary and active time each day
  – Track activity
    • Set goals with Pedometer
    • ClubPed at ADA website
      – Virtual rewards
Education Resources


• Patient education material
  – Free, able to copy freely
  – Many different languages
  – Targeted to specific ethnic and age groups
Education Resources

• American Diabetes Association: www.diabetes.org

• For women: www.diabetes.org/women

• For Latino population: www.diabetes.org/latinohealthcare
Health Care Resources

- http://www.ndep.nih.gov/
- Tool kit
- Team care booklet and posters
- Foot exam kit
- Pocket reference guide
- Publications
Upcoming Conferences

• Diabetes/Cardiology Symposium 2006
  – October 20th in Overland Park KS
• ADA Annual Patient Education Seminar
  – October 21st in North Kansas City MO
• Seminar Supported by the Diabetes Freedom Foundation
  – November 11th in Overland Park KS
• ADA Annual Scientific Sessions
  – June 22-26th 2007 in Chicago IL
Take Home Messages

Lisa Stehno-Bittel, PT, PhD
Summary

• Nutrition and exercise are modifiable factors with a major impact on energy balance.

• Exercise training should be considered an essential part of therapeutic lifestyle change
  – improves insulin resistance
  – improves entire cluster of metabolic risk factors
The Magnitude of the Problem

Those entering our health care system annually

- 225,000 deaths per year from diabetes (ADA - 2005)
- $132 billion in direct and indirect annual medical costs for the treatment of diabetes (ADA - 2002)
The Magnitude of the Problem

Those who are waiting to enter the health care system

- Estimated 50 million that are pre-diabetic

AHA, 2005
Current Interventions

- What is our role?

<table>
<thead>
<tr>
<th>Diet</th>
<th>Exercise</th>
<th>Pharmacological Intervention</th>
</tr>
</thead>
</table>


What is our role?

ADA position statement (2006)

- Individuals at high risk for developing diabetes or with impaired glucose tolerance (IRS) need to become aware of the benefits of modest weight loss and participating in regular physical activity.
- Follow-up counseling appears important for success.
- Drug therapy should not be routinely used to prevent diabetes until more information is known about its cost-effectiveness.
Implications

• What evidence shows us:

• Lifestyle Program: 3.4 - 9.9 million cases of diabetes prevented

• Savings in preventing diabetes: $26.4 – 76.6 billion ANNUALLY

APPROXIMATE TOTAL ANNUAL SAVINGS: $74.5 – 139.3 BILLION
Keys to Long Term Success in Changing Lifestyle

- Set reasonable goals
- Raise awareness = educate
  - Contemplation
  - Planning
  - Action
  - Maintenance
- Confront barriers to change
Keys to Long Term Success in Changing Lifestyle

- Manage stress
  - Glucocorticoids
- Cognitive restructuring
- Self – Management
  - Daily weighing
- Prevent relapse
- Provide support
Isn’t This Our Piece of Pie?

• “Future work by nurses should include matching the precise exercise prescription (eg, intensity, frequency, duration, mode and continuous versus intermittent) to specific patient groups.”

Diabetes Education

• American Association of Diabetes Educators / National Diabetes Certified Educators
  – 57% RNs
  – 37% RDs
  – 6 % other (MD, PA, Pharmacists, SW, Psych)
• Physicians counsel only 34% of patients on physical activity [Wee 1999]
• Where are PTs?
ADA “Your Health Care Team”

- You
- Primary Care Doctor
- Nurse Educator
- Registered Dietician
- Eye Doctor
- Social Worker/Psychologist/Psychiatrist
- Podiatrist
- Dentist
- Exercise Physiologist (!!)
Exercise Physiologist

“The best person to help you and your doctor plan your fitness program is someone trained in the scientific basis of exercise. Your doctor can help you look for someone with a master’s or doctoral degree in exercise physiology or for a licensed health care professional who has graduate training in exercise physiology. Certification from the American College of Sports Medicine …”

www.diabetes.org
What Can We Do?

• More research to address frequency, intensity, duration and mode of activity needed to improve risk profiles and disease progression.
Traditional Treatment Settings

• Diabetes: lifestyle intervention is effective AND cost-effective [Sevick 2000, Orchard 2005]

• Relevant ICD-9-CM codes:
  – Diabetes 250.01-250.03
  – Cardiovascular disease 414-414.05
  – Metabolic Syndrome 277.7
  – Obesity 278-278.01
Change State Practice Act

• Diabetes is a disease of prevention
• PT MUST be involved
• Work without referral
Diabetes Care in the State of Kansas

- 1985 One of the first CDC grants for diabetes care
- Coordinated out of Wichita with diabetes network
- 2006 won national award by the National Chronic Care Directors for diabetes network
Initiatives in the State of Kansas

• Kansas Advisory Council on Diabetes Care
  – State Plan

• Kansas Coordinated School Wellness Program
  – Monitor BMI
  – Change lunches

• Healthy School Designation
Initiatives in the State of Kansas

• Model Workplace Wellness Designation
• Kansas Council of Physical Fitness Awards
• Local Community Health Heroes

• All part of the Healthy Kansas Initiative
  – Smoking, Lack of activity, Poor nutrition
Healthy Kansas Initiative

- 35% of Kansans undertake moderate activity now
- Goal is 50%
- 81% of Kansans do not get 5 servings of fruits or vegetables
Healthy Kansas Initiative

• What affects your health?
  • 51% Health behavior
  • 17% Genetic
  • 10% Medical Care
  • 22% Environment
What Can We Do?

• Think outside the typical clinical model
• Areas of wellness and prevention
• Public health programs
• Information dissemination
• Public health policy – Direct Access

  – Think past insurance reimbursement fee for service, consultation fees, community or government resources.
  – Diabetes Exercise Group
Diabetes Exercise Group

• Funded with local non-profit donations
• Costs $10 month
• Group and independent exercise
What Can We Do?

• Become more involved
  – Join ADA
  – Community Activities/Education
  – Other Health Care Professionals
  – Politics – State of Kansas Practice Act

• Become more educated
Funding Sources
University of Kansas Diabetes Research
Department of Physical Therapy

National Institutes of Health
  Center for Research Resources
  Institute of General Medical Sciences
  Institute of Heart, Lung and Blood
US Dept. of Education/NIDR
Juvenile Diabetes Research Foundation
Rosebud Diabetes Research Foundation
Diabetes Freedom Foundation
American Heart Association
US Department of Commerce
Thank You