Disclosure

• The contents of this presentation were developed with support from educational grants from the Department of Education, NIDRR grant numbers H133B090005, H133B970011 and H133G010160. However, those contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.
Rehabilitation and Research Training Center on Secondary Conditions in Individuals with SCI

James S. Krause, PhD
Rehabilitation Research and Training Center on Aging with Spinal Cord Injury

Cardiovascular Disease in Women with Spinal Cord Injury and Its Affects on Participation in Community Activities.
Rehabilitation and Research Training Center on Secondary Conditions in Individuals with SCI

Rehabilitation Research and Training Center on Aging with Spinal Cord Injury

Cardiovascular Disease in Women with Spinal Cord Injury and Its Affects on Participation in Community Activities
Continuing Education

- **Continuing Nursing Education (CNE) credit:**
  - The Center for Professional Development of MUSC Health is an approved provider of continuing nursing education by the South Carolina Nurses Association, an accredited approver by the American Nurses Credentialing Center's Commission on Accreditation.
  - Only RN’s are eligible to receive nursing contact hours.
  - Each RN participant will receive two forms for CNE:
    - Verification of Attendance
    - Individual Evaluation Form
  - For all CNE sessions, in order to receive full contact hour credit for the CNE activities you must:
    - Be present no later than five (5) minutes after starting time
    - Remain until the scheduled ending time
    - Complete and return all the evaluation form at the end of the session

- **Conflict of Interest**
  - A conflict of interest occurs when an individual has an opportunity to affect educational content about health care products or services of a commercial interest with which she/he has a financial relationship.
  - The planners and presenters of this CNE activity have disclosed relevant financial relationships with any commercial interests pertaining to this activity. A list of the event sponsors and vendors may be found in your handouts.
  - The Center for Professional Development has conflict of interest disclosures on file for all presenters and planners.

- **Non-Endorsement of Products**
  - Provision of this education activity by the Center for Professional Development, Medical University of South Carolina Hospital Authority does not imply endorsement by the Center or SCNA of any commercial products displayed in conjunction with this activity. Commercial support does not influence the design and scientific objectivity of any Center educational activity.

- **Off-Label Product Use**
  - The Center does not endorse the off label use of any products for a purpose other than for which it was approved by the FDA.
Approved for 1 contact hour of CME which will automatically approve it for SC PT CEUs. Activity will provide 1.0 ANCC contact hour.
Metabolic Syndrome
&
Spinal Cord Injury
Rehabilitation and Research Training Center on Secondary Conditions in Individuals with SCI

Risk of Metabolic Syndrome: A 17 year longitudinal study

Follow-up
Rehabilitation Research and Training Center on Aging with Spinal Cord Injury
Metabolic Syndrome
Risk of Metabolic Syndrome: A 17 year longitudinal study

Risk Factors for Cardiovascular Disease associated with Metabolic Syndrome: A 17 year longitudinal study
Metabolic Syndrome, or

- Reaven’s Syndrome
- Metabolic Syndrome X
- Syndrome X
- Insulin Resistance Syndrome
“…metabolic syndrome, the constellation of symptoms including high cholesterol, hypertension and diabetes that are associated with excessive weight gain.”
General definition of Metabolic Syndrome:

A combination of risks factors for cardiovascular disease and type 2 diabetes
What Risk Factors?
Metabolic Syndrome Risk Factors

1. Central Obesity
2. Abnormal Carbohydrate Metabolism
3. Hypertension
4. Abnormally High Triglycerides
5. Abnormally Low HDL Cholesterol
• European Group for the Study of Insulin Resistance (EGIR) (1999)
• World Health Organization (WHO) (1999)
• American Heart Association/National Heart Blood and Lung Institute (AHA/NHBLI/NCEP)(2004)
• International Diabetes Federation (IDF) (2006)
IDF — requires central obesity (defined as waist circumference with ethnicity specific values*) AND any two of the following…

*Body Mass Index (BMI) >30 kg/m²

• Europids, South Asians, Chinese, Japanese
   Women 80cm (88cm)
   Men 94cm (102cm) 90cm

• Ethnic South & Central Americans, Sub-Saharan Africans, and Eastern Mediterranean & Middle East (Arab) populations
Central Obesity

- **WHO** - Central obesity: waist/hip ratio > 0.90 (male); > 0.85 (female), and/or BMI > 30 kg/m²
- **EGIR** - central obesity: waist circumference ≥ 94 cm (male), ≥ 80 cm (female)
- **NCEP & AHA** central obesity: waist circumference ≥ 102 cm or 40 inches (male), ≥ 88 cm or 36 inches {35 inches AHA} (female)
Insulin/Glucose abnormalities

• WHO – requires the presence of diabetes mellitus, impaired glucose tolerance, impaired fasting glucose or insulin resistance, AND two of the following ...

• EGIR - requires insulin resistance defined as the top 25% of the fasting insulin values among non-diabetic individuals AND two or more of the following ...
Insulin/Glucose abnormalities

- IDF - fasting plasma glucose: (FPG) > 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes; if FPG > 5.6 mmol/L or 100 mg/dL, an oral glucose tolerance test is strongly recommended but is not necessary to define presence of the Syndrome
- NCEP - fasting plasma glucose $\geq 6.1$ mmol/L (110 mg/dl)
- AHA - fasting glucose: Equal to or greater than 100 mg/dL (5.6 mmol/L) or use of medication for hyperglycemia
- EGIR - fasting plasma glucose $\geq 6.1$ mmol/L
Other Risk Factors common to all Definitions (and 2 of the following…or at least 3 of the following…)

- IDF - Raised blood pressure: systolic BP > 130 or diastolic BP > 85 mm Hg, or treatment of previously diagnosed hypertension.
- WHO - Blood pressure: ≥ 140/90 mmHg
- EGIR - Hypertension: blood pressure ≥ 140/90 mmHg or antihypertensive medication
- NCEP - Blood pressure: ≥ 130/85 mmHg
- AHA - Blood pressure ≥ 130/85 mmHg or use of medication for hypertension
Other Risk Factors common to all Definitions (and 2 of the following…or at least 3 of the following…)

- WHO - triglycerides (TG): $\geq 1.695 \text{ mmol/L}$ and high-density cholesterol (HDL-C) $\leq 0.9 \text{ mmol/L}$ (male), $\leq 1.0 \text{ mmol/L}$ (female)

- EGIR - dyslipidemia: TG $\geq 2.0 \text{ mmol/L}$ and/or HDL-C $< 1.0 \text{ mmol/L}$ or treated for dyslipidemia
Other Risk Factors common to all Definitions (and 2 of the following…or at least 3 of the following…)

- NCEP/AHA - TG $\geq 150$ mg/dl (1.695 mmol/L)
- IDF - triglycerides : $> 150$ mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality
- NCEP/AHA - HDL-C
  $< 40$ mg/dL (male), $< 50$ mg/dL (female)
- IDF - HDL cholesterol:
  $< 40$ mg/dL (males) (1.03 mmol/L),
  $< 50$ mg/dL (females) (1.29 mmol/L)
or specific treatment for this lipid abnormality
PubMed search last 2 years

- Metabolic Syndrome
  7200
- Reaven’s Syndrome
  3170
- Metabolic Syndrome X
  3170
- Syndrome X
  7158
- Insulin Resistance Syndrome
  10759
Major Components of Metabolic Syndrome

1. Central Obesity (definition?)
2. Abnormal Carbohydrate Metabolism
   - fasting plasma glucose $\geq 100$ mg/dl
   - or use of medication for hyperglycemia
3. Hypertension
   - $\geq 130/85$ mmHg
   - or use of medication for hypertension
4. Abnormally High Triglycerides
   - $\geq 150$ mg/dl
   - or specific treatment for this lipid abnormality
5. Abnormally Low HDL Cholesterol
   - $< 40$ mg/dL (men), $< 50$ mg/dL (women)
   - or specific treatment for this lipid abnormality
Working Definition – any combination of three of the following:

1. Central Obesity
2. Abnormal Carbohydrate Metabolism
3. Hypertension
4. Abnormally High Triglycerides
5. Abnormally Low HDL Cholesterol
Spinal Cord Injury
Central Obesity

Waist Measurement

SCI – Labor Intensive & probably inaccurate

Indicator for Abdominal Fat & more specifically for Inter-Abdominal or Visceral Fat – cardiometabolic risk

In people without SCI correlations range from .35 to .56
Central Obesity

BMI

SCI – Labor Intensive & Height measurement may be inaccurate

Indicator for Abdominal Fat & more specifically for Inter-Abdominal or Visceral Fat – cardiometabolic risk

In people without SCI correlation .53
Central Obesity

DXA – DEXA as an indicator of Visceral Fat
In people without SCI correlations range from .65 to .79

BMI & DXA in people with SCI (N=165)

<table>
<thead>
<tr>
<th>BMI &amp; Fat Correlations</th>
<th>Total</th>
<th>Trunk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Tetraplegia</td>
<td>.64</td>
<td>.71</td>
</tr>
<tr>
<td>Complete Paraplegia</td>
<td>.65</td>
<td>.71</td>
</tr>
<tr>
<td>Incomplete Tetraplegia</td>
<td>.07</td>
<td>.18</td>
</tr>
<tr>
<td>Incomplete Paraplegia</td>
<td>.47</td>
<td>.59</td>
</tr>
<tr>
<td>Overall</td>
<td>.48</td>
<td>.55</td>
</tr>
</tbody>
</table>
BMI > 30 kg/m²

% of Cases

Aging Study

Women’s Study

- Inc Para
- Com Para
- Inc Tetra
- Com Tetra
Percent of Trunk Fat by DXA

%
Percent Abdominal Fat (DXA) by HDL in Men with SCI

$r = -0.42, p < 0.001$
BMI by HDL in Women with SCI

$r = -.18, p < .021$
Percent Abdominal Fat by Triglycerides in Men with SCI

$r = .32, p<.001$
BMI by Triglycerides in Women with SCI

$r = .33, p<.001$
Blood Pressure & SCI

Hypertension
A common problem for people with Tetraplegia due to SCI is persistent Hypotension, often with bouts of uncontrolled, extreme Hypertension.

Systolic BP
Impairment by BMI Category

Effect of Deficit on Exercise ($F=9.9$, $p=.003$)

Deficit Overall ($F=19.1$, $p<.0001$), Deficit by BMI ($F=8.9$, $p=.005$)
BMI by Maximum Systolic BP

Paraplegia ($r=+.46$, $p<.01$) Tetraplegia ($r=-.78$, $p<.05$)
Abnormal Carbohydrate Metabolism
Fasting Plasma Glucose $\geq 100$ mg/dl

- Aging Study 20.1%
- Women’s Study 23.9%

- Bauman & Spungen
  - SCI 22% Controls 6%

Aging Study

OGTT                     N=201
28.8% (56) Impaired Glucose Tolerance
13.4% (27) DM (OGTT-WHO)

Of the 27 meeting the OGTT criteria for DM, 19 (70%) had Normal Fasting Glucose

Abnormally Low HDL Cholesterol
< 40 mg/dl (men), < 50 mg/dl (women)

Aging Study: 52.0%

Women's Study: 47.9%
HDL < 40 mg/dl (men), < 50 mg/dl (women)
Abnormally High Triglycerides
≥ 150 mg/dl

Aging Study

24.1%

Women’s Study

21.4%
Any Combination of 3 of 4 of the Major Components of Metabolic Syndrome

1. Central Obesity – BMI >30 kg/m²
2. Abnormal Carbohydrate Metabolism
   - Fasting plasma glucose ≥ 100 mg/dl
3. Hypertension
   - ≥ 130/85 mmHg
4. Abnormally High Triglycerides
   - ≥ 150 mg/dl
5. Abnormally Low HDL Cholesterol
   - < 40 mg/dL (men), < 50 mg/dL (women)
Any Combination of 3 of 4 of the Major Components of Metabolic Syndrome

% of Cases

Aging Study

Women’s Study

- Inc Para
- Com Para
- Inc Tetra
- Com Tetra
Any Combination of 3 of 4

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td>84%</td>
<td>86%</td>
</tr>
<tr>
<td>Dead</td>
<td>16%</td>
<td>14%</td>
</tr>
</tbody>
</table>
Intima/Medial Thickness of Carotid Artery wall (CIMT)

- Surrogate for CVD in epidemiologic studies
- Non-invasive
- Reliable & Reproducible
Intimal-medial thickness of common carotid artery is the distance between the green lines.
Factors Associated with CIMT in Women with SCI

- Age
- Carbohydrate Metabolism
- Triglycerides
AGE & CIMT

$r = .65, p < .0001$
IMT & HbA1c

$r = .21, p=.0049$
IMT & Triglycerides

$r = .17, p=.0261$
Change in Fasting Glucose

Baseline One Year

Normal
Treated
Change in HDL

Baseline One Year

Normal
Treated
Change in CIMT

Baseline One Year

Normal
Treated
Change in Triglycerides

Baseline One Year

Normal
Treated
Annualized Percent Change

- IMT
- Glucose
- HDL
- Triglyc

Normal
Treated

[Diagram showing annualized percent change for different parameters with categories IMT, Glucose, HDL, and Triglyc, comparing Normal and Treated groups.]
IMT & SWL

\[ r = -0.26, \ p = 0.0038 \]
BMI & SWL

\[ r = -0.20, \ p = 0.0185 \]
Results (cont.)

However, no predictors of IMT and BMI were correlated directly with SWL.

SWL &

- Age, \( r = -.07, \) n.s.
- HbA1c, \( r = -.01, \) n.s.
- Triglycerides, \( r = -.12, \) n.s.
- Fasting Glucose, \( r = -.10, \) n.s.
SWL & MaxVO²

\[ r = 0.312, p < 0.0064 \]
SWL & IMT
Among Those with MaxVO\textsuperscript{2}

$r = -.308, p<.0071$
Results (cont.)

The Primary Significant Predictor of MaxVO$_2$ was impairment ($p=0.0088$). However, differences in SWL scores between impairment groups did not approach significance.

The only other Significant Predictor of MaxVO$_2$ was BMI ($p=0.0179$)
BMI & MaxVO²

$r = -.28, p=.0179$
Diet

Exercise

Fat

Abdominal

Glucose
Metabolism
Triglycerides

Cardiovascular Health

IMT
MaxVO2

SWL
Evidence for CVD in SCI

Agency Healthcare Research and Quality

Prevalence of CVD in the General Population based on CIMT

<table>
<thead>
<tr>
<th>CVD – CIMT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>White Women</td>
<td>.77 mm</td>
</tr>
<tr>
<td>Black Women</td>
<td>.78 mm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MI – CIMT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>White Women</td>
<td>.82 mm</td>
</tr>
<tr>
<td>Black Women</td>
<td>.83 mm</td>
</tr>
</tbody>
</table>

Intimal-medial thickness of common carotid artery is the distance between the green lines.
### Prevalence Estimates

<table>
<thead>
<tr>
<th>Condition</th>
<th>Burke’s Highest Study</th>
<th>Women’s Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVD</td>
<td>13.0%</td>
<td>25.2% p&lt;.01</td>
</tr>
<tr>
<td>MI</td>
<td>4.9%</td>
<td>10.6% p&lt;.03</td>
</tr>
</tbody>
</table>
Thank you for your Time, Attention and Interest