Components of the Cardiometabolic Syndrome: NCEP ATP Guidelines Designate Any 3 of the Following:

- **Abdominal Obesity**
  - Waist Circumference
  - > 30 cm (> 120 in) 🅰️
  - ≥ 102 cm (> 40 in) ♂️
  - ≥ 88 cm (> 35 in) ♀️

- **Triglycerides**
  - ≥ 150 mg/dL
  - ≥ 1.7 mmol/L

- **High-density Lipoprotein Cholesterol**
  - < 40 mg/dL
  - < 1.036 mmol/L
  - < 50 mg/dL ♂️
  - < 1.295 mmol/L ♂️

- **[Pre]Hypertension**
  - ≥ 130 / ≥ 85

- **Insulin Resistance/Impaired Fasting Glucose**
  - ≥ 110 mg/dL
  - ≥ 6.2 mmol/L

---

**The Stockholm Spinal Cord Injury Study**

<table>
<thead>
<tr>
<th>Risk Variable</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-hypertension: SBP ≥ 130 - ≤139 mm Hg or DBP ≥ 85 - ≤89 mm Hg and/or antihypertensive medication</td>
<td>44</td>
<td>33%</td>
</tr>
<tr>
<td>Stage 1: SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg and/or antihypertensive medication</td>
<td>53</td>
<td>40%</td>
</tr>
<tr>
<td>Stage 2: SBP ≥ 160 mm Hg or DBP ≥ 100 mm Hg and/or antihypertensive medication</td>
<td>28</td>
<td>21%</td>
</tr>
<tr>
<td>On antihypertensive medication</td>
<td>10</td>
<td>14%</td>
</tr>
<tr>
<td>On antihypertensive medication; SBP ≥ 140 mm Hg or DBP ≥ 90 mm Hg</td>
<td>14</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Note: Risk factors include high blood pressure, high cholesterol, and diabetes.*
National Cholesterol Education Project Adult Treatment Panel III Guidelines: A Four-step Sequential Algorithm for Customized Management of Dyslipidemia and CVD

1. Eliminate Drugs and Biologicals that worsen the lipid/glycemic profile
2. Undertake Dietary Modification
3. Incorporate Exercise
4. Adopt Pharmacological Intervention


Candidate Drugs and Biologicals that Worsen Cardiometabolic Risks

- Tobacco (Nash and Mendez, 2007)
- Corticosteroids
- Receptor-selective adrenergic antagonists
  - ‘Beta-blockers’
- Thiazide Diuretics
- Antipsychotics / Anti-Depressant ‘Add-Ons’
  - Zyproxa (Olanzapine)
  - Clozaril (Clozapine)
- Double-Inhibitor Antidepressants (SNRI’s)
- Cymbalta (Duloxetine)

Little in the typical pharmacopeia of SCI that explains risk.

What do we know about effects of SCI on dietary habits?

- Excessive in calories and saturated fat
- Worsened by lower metabolic rates associated with injuries above T1 (i.e., functional sympathectomy)
- Overfeeding begins during rehabilitation and often becomes habit: Weight gain greatest in months 2-7 post-SCI
- Impudent diet is not offset by exercise activity
- Combination strategies of exercise and diet are needed for weight and cardiometabolic disease management


Or, waist circumference > 92 cm

- 375 kcal/day


Combination of Aggressive Lifestyle Intervention
Exercise, Mediterranean Diet (1500-1800 kcal/day), and Behavioral Intervention

- Body mass 85 kg → 76 kg
- 10.6% Mass reduction > 7% needed for Db Prevention
- Improved Insulin Sensitivity
- Stopped Metformin

Fitness Deficits After SCI

- Persons with SCI occupy the lowest segment of the human fitness continuum.
- Physical deconditioning commonly follows initial injury and often never recovers to pre-injury levels.
- The population is aging, which worsens the already poor fitness prognosis.
- Deconditioning poses financial, caregiver, and societal challenges that can be reduced through positive health behaviors.

Common Endurance Exercise Conditioning Modes

- Improves strength, anaerobic power, endurance, and flexibility
- Achieves musculoskeletal balance, while sparing shoulder pain and upper extremity decline
- Improves “function”
  - Enhance task performance and ease of ADLs
  - Restore homeostatic functions
- Addresses CVD risk and cardiometabolic secondary complications
- Generates interest and compliance

What is the ‘Best’ Exercise Prescription

Circuit Resistance Training
Adapted for Persons with SCI

- 6 Resistance Maneuvers
- 10 repetitions; 6 Second lifts; 3 seconds concentric, 3 seconds eccentric
- Interposed periods of arm spinning after every 2 resistance maneuvers
- Maneuver changes within 10 seconds...very little rest
- Repeat 3 times ≈ 43 minutes

Effects of CRT on Peak Arm Endurance of Subjects with Paraplegia (mean ± s.d.)

<table>
<thead>
<tr>
<th></th>
<th>Pre-Training</th>
<th>Post-Training</th>
<th>% Δ</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO₂ peak (L.min⁻¹)</td>
<td>1.45 +/- .22</td>
<td>1.88 +/- .31</td>
<td>+ 29.7</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Time to Fatigue (sec)</td>
<td>624 +/- 195</td>
<td>816 +/- 223</td>
<td>+ 30.8</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>


Effects of CRT on Peak Arm Anaerobic Power of Subjects with Paraplegia (mean ± s.d.)

<table>
<thead>
<tr>
<th></th>
<th>Pre-Training</th>
<th>Post-Training</th>
<th>% Δ</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power (Watts)</td>
<td>379 +/- 58</td>
<td>401 +/- 72</td>
<td>+ 5.8</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Mean Power (Watts)</td>
<td>254 +/- 43</td>
<td>276 +/- 50</td>
<td>+ 8.7</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

CRT Effects on Isoinertial One Repetition (1-RM) Maximal Strength in Subjects with Paraplegia (lb.)

<table>
<thead>
<tr>
<th>Maneuver</th>
<th>Month</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder Press</td>
<td>166.3</td>
<td>217.7</td>
<td>227.4</td>
<td>235</td>
<td>41.3</td>
<td>+ 41.3 **</td>
</tr>
<tr>
<td>Horizontal Row</td>
<td>190.5</td>
<td>206.1</td>
<td>231.0</td>
<td>238.3</td>
<td>25.1</td>
<td>+ 25.1 **</td>
</tr>
<tr>
<td>Horizontal Flexion</td>
<td>135.3</td>
<td>138.6</td>
<td>159.3</td>
<td>164.4</td>
<td>25.5</td>
<td>+ 25.5 **</td>
</tr>
<tr>
<td>Elbow Flexion</td>
<td>46.8</td>
<td>50.0</td>
<td>53.2</td>
<td>53.3</td>
<td>13.8</td>
<td>+ 13.8 *</td>
</tr>
<tr>
<td>Latissimus Pulldown</td>
<td>137.7</td>
<td>152.3</td>
<td>168.6</td>
<td>177.7</td>
<td>29.0</td>
<td>+ 29.0 **</td>
</tr>
<tr>
<td>Dips</td>
<td>142.3</td>
<td>152.3</td>
<td>161.7</td>
<td>167.9</td>
<td>38.0</td>
<td>+ 38.0 **</td>
</tr>
</tbody>
</table>

* p< 0.05
** p< 0.01


The “Middle-Aged” Circuit: Effects Of CRT On Monthly Changes In One Repetition Maximal Strength

<table>
<thead>
<tr>
<th>Maneuver</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Press</td>
<td>38.6*</td>
</tr>
<tr>
<td>Horizontal Row</td>
<td>59.7*</td>
</tr>
<tr>
<td>Horizontal Butterfly</td>
<td>41.6*</td>
</tr>
<tr>
<td>Biceps Curl</td>
<td>41.4*</td>
</tr>
<tr>
<td>Latissimus Pulldown</td>
<td>38.6*</td>
</tr>
<tr>
<td>Triceps Press</td>
<td>44.0*</td>
</tr>
</tbody>
</table>

* p< 0.01


Effects of CRT on Shoulder Pain in Persons with Paraplegia

<table>
<thead>
<tr>
<th>WUSPI Scores</th>
<th>Pre-Training</th>
<th>Post-Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Training</td>
<td>32.8 ± 23.5</td>
<td></td>
</tr>
<tr>
<td>Post-Training</td>
<td>5.0 ± 7.7</td>
<td></td>
</tr>
<tr>
<td>* p&lt; 0.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Effects of CRT on Lipid Profiles of Persons with Paraplegia (mean ± s.d., n=9)

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>183 ± 25.9</td>
<td>167 ± 32.7</td>
<td>-16.4%</td>
</tr>
<tr>
<td>HDL-C</td>
<td>40.5 ± 5.3</td>
<td>44.9 ± 5.6</td>
<td>+ 9.8%</td>
</tr>
<tr>
<td>LDL-C</td>
<td>118 ± 22.2</td>
<td>88 ± 22.7</td>
<td>-25.9%</td>
</tr>
<tr>
<td>TC/HDL</td>
<td>4.5 ± 1.1</td>
<td>3.7 ± 0.7</td>
<td>+ 8.8%</td>
</tr>
</tbody>
</table>

* p< 0.05

Circuit Resistance Training Adapted for Persons with Tetraplegia: Options

- Substitute lateral raise for military press
- Use wrist wraps and D rings for preacher curls using cables, or, use simple wrist weights
- Use pec dec instead of bench press

Resistance-Endurance Conditioning Exercise Improves Fasting and Postprandial Lipids, and Glycemic Regulation in 11 Men with Tetraplegia

- Lowered the TC:HDL ratio by 7%.
- Improved insulin sensitivity by 28%.
- Improved postprandial (AUC) triglycerides (52%), glucose (83%), and insulin (23%).
- Lowered 2-hour post-load glucose by 27%.

Resistance-Endurance Conditioning Exercise in Men with Tetraplegia: Effects on Body Fat Utilization and Percentage of Kcals utilized as Fat

Acute Chronotropic, Metabolic, and Perceptual Responses to Multi-Gym* and Elastic-Gym** Exercise in Subjects with Paraplegia (n=14, mean +/- s.d.)

<table>
<thead>
<tr>
<th></th>
<th>Multi-Gym*</th>
<th>Elastic-Gym**</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (bpm)</td>
<td>124 +/- 12</td>
<td>117 +/- 12</td>
<td>ns</td>
</tr>
<tr>
<td>VO₂ (L/min)</td>
<td>0.64 +/- 0.1</td>
<td>0.56 +/- 0.1</td>
<td>ns</td>
</tr>
<tr>
<td>RPE (6-20)</td>
<td>12.6 +/- 1.8</td>
<td>13.5 +/- 1.5</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

* Helms ‘Equalizer’, ** Thera-Band®

Drug Therapy Options: Advantages and Disadvantages of Niacin ER (Niaspan™)

- **FDA Approved**
- **Long-recognized as the first-line drug for elevating low HDL-C (≈26% at 2g QHS)**
- **Lowers TG, LDL-C, and TG by ≈17-35%**
- **26% reduction in recurrent nonfatal myocardial infarction, 11% reduction in total mortality.**
- **Adverse Events (at 2g QHS)**
  - **Flushing**
  - **Glucose Elevation (~5 mg/dL)**
- **Requires pretreatment with ASA 325 mg**


### Randomized, Blinded, Placebo-controlled, Dose-escalation, 3-Center Clinical Trial

Study Withdrawals for Treatment and Non-Treatment Related Events; 10,243 Drug Dosings, 7482 (82%) 2 grams

<table>
<thead>
<tr>
<th>N.</th>
<th>Study Arm</th>
<th>Cause for Withdrawal</th>
<th>Study Week</th>
<th>IRB / DSMB Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ER-N</td>
<td>Loose Stool / Diarrhea</td>
<td>4</td>
<td>Probably Related (AE)</td>
</tr>
<tr>
<td>1</td>
<td>Placebo</td>
<td>Fearsome</td>
<td>36</td>
<td>Unrelated</td>
</tr>
<tr>
<td>1</td>
<td>ER-N</td>
<td>Flushing</td>
<td>4</td>
<td>Related (AE)</td>
</tr>
<tr>
<td>1</td>
<td>ER-N</td>
<td>Flushing / Transient Hypotension</td>
<td>1</td>
<td>Related (SAE)</td>
</tr>
<tr>
<td>1</td>
<td>ER-N</td>
<td>Pre-Syncope / Hypotension</td>
<td>24</td>
<td>Probably unrelated</td>
</tr>
<tr>
<td>1</td>
<td>ER-N</td>
<td>Pressure Uterus</td>
<td>8</td>
<td>Unrelated</td>
</tr>
<tr>
<td>1</td>
<td>ER-N</td>
<td>Requested Group Reassignment, Denied</td>
<td>36</td>
<td>Unrelated</td>
</tr>
<tr>
<td>4</td>
<td>5 Placebo</td>
<td>Transportation / Relocation / Logistics</td>
<td>4-48</td>
<td>Unrelated</td>
</tr>
<tr>
<td>14</td>
<td>9 ER-N, 4 Placebo</td>
<td>4/14 Related / Probably Related</td>
<td>Related</td>
<td></td>
</tr>
</tbody>
</table>

### Flushing and Insomnia: Intensity

- Flushing and Insomnia: Intensity $p<0.05$ for group and time effects. No dose-dependency.
**Effects of ER-N and Placebo on Lipids, Lipoprotein Cholesterols, and Global Risk Ratios:**

- $p's < 0.05$ for group, time, and group x time interaction
- no interaction effect for TC

**The Multidimensional Challenges of Spinal Cord Injury**

- Customized Care
- Evidence-based Approaches
- Guideline-Driven Practice
- Common Sense

Consortium of Spinal Cord Medicine: Clinical Practice Guidelines for Carbohydrate and Lipid Disorders after SCI

**Appreciation**

- Mr. Salih Alkholaifi, Director General of the Sultan Bin Abdulaziz Al Saud Foundation and President of the Conference Advisory
- Ms. Abeer Al Fouti, Executive Director and Conference Chair
- Section Leaders, Dr. Sabri Saqat
- Humanitarian City Physicians, Therapists, Nursing, and Administrative Staffs
- All in attendance