Role of Aerobic Exercise in Post-polio Syndrome

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Why is aerobic exercise important?

- Reduced aerobic capacity
- Impaired functional abilities
- Post-polio symptoms
Post-Polio Syndrome

- **Prevalance:** 25% - 80%
  - Denmark: 46%
  - Norway: 60%
  - Dutch: 63%

- **Clinical condition:**
  - Progressive muscle weakness
  - Unaccustomed and easy fatigability
  - Pain in muscles
  - Loss of function in daily activities
  - Hypoventilation

- **Caused by:**
  - Aging
  - Overuse and underuse
  - Inflammation of CNS; serum cytokines...

*E. Farbu, N. E. Gilhus; Post-polio Syndrome. European Handbook of Neurological Management: Volume 1, 2nd Edition 2011*
Why have PPS subjects cardiopulmonary deconditioning?

- Life Style modification:
  - Sedentary life and weight – gain
  - Pacing of activities is recommended?
    - Be careful about its’ duration !
- Joint Problems
- Ventilatory limitations
- Aging
- Intolerance to cold

Poor Aerobic Capacity

- **Maximal oxygen consumption during exercise is reduced**
  - pVO2-PPS: between 19-33 mL/kg/min, in literature.
  - PVO2-normal: 35-70 ml/kg/min
- **The aerobic capacity is also reduced when compared to healthy individuals**
  - 5.6 METS (similar to that of AMI)


Poor capacity in daily activities

- **Reduced movement economy**
  - eg: Walking;
    - is submaximal work in normal subjects
    - but in PPS; effort to be able to do this is relatively high!!!
      - during walking; patient has higher heart rates, higher blood pressures;
        but still they have low oxygen capacity, low metabolic rates
  - **PREDISPOSING TO PREMATURE FATIGUE, PAIN, WEAKNESS**

* Nollet; submaximal exercise capacity in polio,; Arch Phys Med Rehabil Vol 82, 2001
What should be the question?

“If you don’t use it; you lose it...”

- Can we increase this reduced aerobic capacity despite reduced neuromuscular status?
- How should be planned?
  - Modified according to clinical status
  - Overuse
  - Underuse
- Which type of aerobic exercise is suitable?
  - Submaximal intensity
  - Treadmill / ergometer / water
We can increase aerobic capacity in PPS

- It has been showed that 15%-19% increase in pVO2 in PPS subjects doing ergometer exercise after 8th-16th wk period
- Submaximal intensity
  - %70-75 HR-max
  - 3 sessions/wk
  - At least 6 wk duration


   - Modified aerobic walking program that was tested in three patients.

   - They concluded that patients with postpolio symptoms can increase their functional work capacity with a walking program
     - Avoiding some risks of traditional strengthening exercises
     - That the improvement reflects improved biomechanical efficiency as well as training effects.


   - 7 PPS subjects on treadmill walking during 6 wks
   - No improvement in pVO2
   - Mainly due to protocol was adjusted by only symptom-limited test
Aerobic exercise is beneficial in PPS

- The results of the meta-analysis conclude that:
  - aerobic exercise training could improve cardiopulmonary capacity;
  - lifestyle modification, exercise and modality intervention could alleviate pain & fatigue in polio survivors
  - Improves QoL parameters

Aerobic exercise is beneficial in PPS

• Strengthening exercises showed no significant improvement in muscle strength;
  • But, muscle endurance increases: “holding time”

• but aerobic exercise training showed significant improvement in maximal oxygen consumption (VO2max), peak workload (Wpeak), maximal heart rate (HRmax), and maximal minute ventilation (VEmax).

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Participant</th>
<th>Intervention</th>
<th>Duration</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCT</td>
<td>37</td>
<td>Cycle ergometer</td>
<td>16 wk 3seans/wk 15-20 min %70-75 HR</td>
<td>6 subjects withdrew (not adverse effects) Increase Watt and exercise during test Increase VEmax and VO2max</td>
</tr>
<tr>
<td>RCT</td>
<td>20</td>
<td>Arm ergometer</td>
<td>16 wk 3 seans/wk 15-30 min %70-75 HR</td>
<td>Improved in VEmax, VO2max, and power</td>
</tr>
<tr>
<td>Non-equivalent; pretest-posttest control group design</td>
<td>28</td>
<td>General fitness training in warm water</td>
<td>8 mo 2 seans/wk 40 min</td>
<td>No significant improved in peak work load, VO2max, and knee muscle strength</td>
</tr>
</tbody>
</table>

The modes of exercise can be varied depending on the functional capacity and other medical problems of subjects.

- Ergometer / treadmill / water

The intensity of exercise should be submaximal to avoid overuse.

- %70-75 of HR-max

2 or 3 exercise sessions per week provided an adequate training in polio. (recovery period)

The modification of exercise intensity may be necessary to improve the effects and exercise should be supervised.

Aerobic exercise has been shown to be effective on cardiopulmonary capacity of polio with no adverse effects, such as new pain and overuse muscle damage in terms of:

- Creatinin kinase
- EMG signs
- Lactate dehydroginase
- Myokinase

Limitations of the studies included;

- None of these studies except one measuring the effect of walking speed; evaluates the functional ability in ADL such as walking...

- The testing protocols were varied and may affect the determination of cardiopulmonary capacity
  - Standardized test protocols are needed...

- More randomized-controlled and long-term follow-up trials are needed

Cardiopulmonary endurance testing

- Cardiorespiratory endurance can be assessed subjectively by asking the patient how far they can walk without getting breathless or with the formal exercise testing can be performed where specialised equipment is available
  - Symptom-limited exercise testing according to Borg perceived exertion rating scale
  - By special equipment measuring gas exchange and HR-max

Cardiopulmonary testing in PPS

- Maximal or symptom-limited exercise testing is not recommended for polio survivors
  - Due to new weakness / unstable musculature
  - Max testing can be considered only asymptomatic polio survivors
- Workloads of 2-4 minutes recommended with 2-4 minutes interval
- Discontinous or ramped protocol is recommended for maximizing aerobic capacity and diminishing early musculoskeletal fatigue.

Cardiopulmonary testing in PPS

- Standard leg/arm ergometry may give reliable data to determine aerobic capacity
  - 6 continuous minutes is enough for test duration

- Walking tests for those able, up to 6 minutes could be used to estimate aerobic capacity
  - 2 or 3 ramped stages

- But the objective is to develop exercise prescription; only submaximal test protocol is advised
  - Sufficient lower extremity function

- The termination of the test could be based on RPE/Heart rate

The American College of Sports Medicine’s recommendations for the exercise testing of patients with prior polio and post polio syndrome

- Optimally utilise available muscle mass.
- Avoid use of a painful and/or recently weakened limb during an exercise test.
- Use equipment that does not require complex motor co-ordination.
- Use submaximal exercise tests (elicit at least a “somewhat hard” rating of perceived exertion and terminate testing when the “hard” rating of perceived exertion is reported)
This was the first study comparing the effects of home and hospital-based (supervised) exercises on aerobic capacity.

We also investigate the effect of aerobic exercise on fatigue and on QoL.

We used modified walking programme that was planned individually according to results of testing protocol.
Participants

- subjects fulfilling the criteria of MoD-2001
- With the age < 65 years-old

- They were required to walk 30 meters in less than 60 secs with hands-on support, using aid if necessary, and to walk on a treadmill

- Subjects with cardiopulmonary problems and extreme joint pain that prevented walking were excluded

- They were screened for any concomitant disorder

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS

Total number of patients enrolled n=32

Hospital-based group n=16

Losses (n=1) Due to transport problem

Group I: 15 participants

Group II: 13 participants

Home-based group n=16

Losses (n=3) Due to loss of interest

Total number of pts who were given information n=48

Total number of pts who were given information n=48

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS

Before and after 8-wk exercise programme; 3th author who was blinded to clinical course, interviewed the subject for fatigue and QoL:
- FSS (Fatigue severity scale)
- FIS (Fatigue Impact Scale)
- NHP (Notthingham Health Profile)
- Performed the cardiopulmonary exercise test
Supervised exercise programme

- 3 sessions/wk
- 8 wks totally
- Each session: 1.5 hrs
- Supervised by a physiotherapist at hospital

Home exercise programme

- 3 sessions/wk
- 8 wks totally
- Each session: 1.5 hrs
- Speed, intensity of walking was instructed by physiotherapist step by step with written instructions

Intensity: %50-70 of pVO2; at the level of 13-15 on borg scale

Aerobic exercises;

- Walking duration was increased as tolerated, up to a maximum of three rest periods
- Once maximum walking duration was attained, intensity was increased by increasing walking speed
- Flexibility exercises were given before aerobic exercises

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS
Test protocol

- **Naughton protocol**
  - Submaximal intensity: 3,5 MET
  - Symptom-limited, incremental cardiopulmonary testing
  - Breath-by-breath measurements of VO2max and VCO2max were obtained using Masterscreen CPX metabolic device
  - According to VO2max; treadmill speed / slope is determined

- Treadmill model 770 CE
  - Heart rate, rhythm, blood pressure and ST-T changes with ECG were monitored

*Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS*  
Oncu J, Durmaz B, Karapolat H. *Clinical Rehabilitation* 2009;23:155-163
### Test protocols

<table>
<thead>
<tr>
<th></th>
<th>MAXIMAL</th>
<th>SUBMAXIMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bruce</td>
<td>Balke</td>
</tr>
<tr>
<td>Type of the disease</td>
<td>CVS</td>
<td>CVS</td>
</tr>
<tr>
<td>Treadmill speed and</td>
<td>1,7 mph % 10 (5 MET)</td>
<td>3,0 mph % 0 (3,5 MET)</td>
</tr>
<tr>
<td>slope at the beginning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increment / every 2 min</td>
<td>3 MET</td>
<td>0,5 MET</td>
</tr>
<tr>
<td>Duration</td>
<td>21 min</td>
<td>22 min</td>
</tr>
</tbody>
</table>

The test was terminated;

- Severe angina
- Limiting symptoms: leg pain, cramps, fatigue
- Ventricular tachycardia
- ST depression > 3mm
- Excessive increase (> 230 mmHg) and drop in BP (<30 mmHg)

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS
### Results;

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=15)</th>
<th>Group II (n=13)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age year (mean+SD)</td>
<td>40.43±7.48</td>
<td>44.21±10.26</td>
<td>0.45</td>
</tr>
<tr>
<td>Sex (male/female; n)</td>
<td>8/7</td>
<td>4/9</td>
<td>0.25</td>
</tr>
<tr>
<td>Stable time after polio (year) (mean+SD)</td>
<td>37.07±6.93</td>
<td>38.35±15.65</td>
<td>0.52</td>
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<tr>
<td>Walking aid (yes)</td>
<td>4</td>
<td>3</td>
<td>0.40</td>
</tr>
</tbody>
</table>

*Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS.*

<table>
<thead>
<tr>
<th></th>
<th>GROUP I (n=15)</th>
<th></th>
<th>GROUP II (n=13)</th>
<th></th>
<th>Between groups p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PreE</td>
<td>PostE</td>
<td>P value</td>
<td>PreE</td>
<td>PostE</td>
</tr>
<tr>
<td>pVO2</td>
<td>17.20+3,32</td>
<td>21,19+4,02</td>
<td>0,001</td>
<td>20,97+5,94</td>
<td>19,52+5,54</td>
</tr>
<tr>
<td>FSS (total)</td>
<td>4,46+1,27</td>
<td>2,77+0,70</td>
<td>0,001</td>
<td>4,76+1,03</td>
<td>4,03+0,71</td>
</tr>
<tr>
<td>FIS-cognitive</td>
<td>29,14+14,61</td>
<td>10,64+9,00</td>
<td>0,001</td>
<td>35,43+15,98</td>
<td>12,57+8,02</td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIS-physical</td>
<td>17,36+6,05</td>
<td>9,14+5,33</td>
<td>0,001</td>
<td>15,71+6,80</td>
<td>16,07+6,56</td>
</tr>
<tr>
<td></td>
<td><strong>7,25% decrease</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIS-psychosocial</td>
<td>22,26+9,59</td>
<td>15,50+7,96</td>
<td>0,001</td>
<td>23,50+11,20</td>
<td>24,92+11,63</td>
</tr>
<tr>
<td>FIS-Total</td>
<td>68,64+28,84</td>
<td><strong>34,92+20,42</strong></td>
<td>0,001</td>
<td>75,07+31,48</td>
<td><strong>54,85+23,49</strong></td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
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<td><strong>7,25% decrease</strong></td>
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<tr>
<td>NHP-Energy</td>
<td>61,14+21,08</td>
<td><strong>17,14+11,25</strong></td>
<td>0,002</td>
<td>58,97+30,24</td>
<td><strong>44,68+24,58</strong></td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,25% decrease</strong></td>
</tr>
<tr>
<td>NHP-Pain</td>
<td>34,98+23,17</td>
<td>28,33+1,97</td>
<td>0,041</td>
<td>46,88+33,47</td>
<td>22,00+27,87</td>
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<tr>
<td>NHP-Sleep</td>
<td>8,04+26,67</td>
<td>4,34+16,24</td>
<td>0,180</td>
<td>14,73+30,08</td>
<td>10,08+26,53</td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
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<td></td>
<td></td>
<td><strong>7,25% decrease</strong></td>
</tr>
<tr>
<td>NHP-Emotional reaction</td>
<td>42,53+22,37</td>
<td>18,42+16,96</td>
<td>0,011</td>
<td>35,34+20,64</td>
<td>21,93+20,79</td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,25% decrease</strong></td>
</tr>
<tr>
<td>NHP-Social isolation</td>
<td>43,03+21,05</td>
<td><strong>18,14+25,98</strong></td>
<td>0,003</td>
<td>40,70+34,01</td>
<td>29,06+36,52</td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,25% decrease</strong></td>
</tr>
<tr>
<td>NHP-Physical mobility</td>
<td>39,18+10,34</td>
<td><strong>21,90+9,39</strong></td>
<td>0,001</td>
<td>45,22+16,14</td>
<td><strong>23,24+14,21</strong></td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>7,25% decrease</strong></td>
</tr>
<tr>
<td>NHP-Total</td>
<td>208,90+75,05</td>
<td><strong>88,29+65,28</strong></td>
<td>0,001</td>
<td>241,86+85,10</td>
<td><strong>151,06+89,10</strong></td>
</tr>
<tr>
<td></td>
<td><strong>19,9% increase</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
CONCLUSION;

- After an 8-wk programme; improvement was seen on fatigue and QoL parameters in both groups.

- Increase in aerobic capacity was seen in only hospital group; even decrease was observed in home-exercise group.

- A decrease in fatigue in both groups but more prominent in hospital group was observed.

Short-term effects of aerobic exercise on functional capacity, fatigue, and quality of life in patients with PPS
Clinical messages;

- Physical exercise undertaken in hospital under supervision leads to more functional improvement in people late after polio than a similar programme taught and then undertaken at home, supervised...

- Treadmill walking exercise under supervision can be advised in patients with PPS to increase aerobic capacity
  - Feasible, Well-tolerated. Secure

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Warm wishes from İstanbul...