FISA ROWING TRAINING CAMP
Seminar for Coaches of Development Countries
Thursday 11 April 2019

Monitoring training adaptation in elite endurance rowers and tapering to the main competition: opening the door to effective monitoring

Dario Cerasola, PhD
Sciences of Human Movement and Sport Performance
Italian Rowing Federation Coach
Biomechanical, Performance and functional evaluation of the Olympic Team
– Rowing Introduction

– Physiological Aspects
  • Evaluation
    – Aerobic >> VO2max
    – Anaerobic >> Alactacid - Lactacid

– Biomechanic Aspects
  • Evaluation
    – Rowing technique >> power and angle

– State of fatigue
  • Evaluation
    – Heart rate variability >> overtraining
STEP 1°

Introduction
Rowing Physiology

Aerobic 75-80%
Anaerobic 15-20%
2000 mt
1xf 7:40 min / 8+m 5:30 min


Rowing Performance Aspects

Environment condition

Physiological

Training
Rowing Performance Aspects

Technique

Race Strategy

Psychological
The main purpose of the coaches is:

- Influenze of water
- Influence of air
- Technique

Rowers Faster

- Physiological aspect
- Training
- Technique

Resistent

Propulsion
STEP 2°

Physiological factors
Anatomy of a

Anatomy of a Rower.mp4
Season Program

“The annual plan is often viewed as the most important tool for the coach to guide athletes’ training over a year.”
T. Bomba

Figure 1: The Periodisation of Dominant Abilities in Rowing

<table>
<thead>
<tr>
<th></th>
<th>Preparatory</th>
<th>Competitive</th>
<th>Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength</td>
<td>General Preparation</td>
<td>Pre-Competition</td>
<td>Transit</td>
</tr>
<tr>
<td></td>
<td>Specific Preparation</td>
<td>Main Competition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max strength</td>
<td>Maintenance</td>
<td>Chps</td>
</tr>
</tbody>
</table>
| Endurance| Aerobic Endurance            | Development of Foundation of  | Specific Endurance | Aerobic
|          |                              | Specfic Endurance             |              |

October >> February

March >> Agust
VO_{2\text{max}} \rightarrow 70\% \text{ central conditions}
30\% \text{ peripheral conditions}

- Central conditions \rightarrow \text{Systolic cardiac output}

- Peripheral conditions \rightarrow \text{Muscular capillarization}
### Figure 1: The Periodisation of Dominant Abilities in Rowing

<table>
<thead>
<tr>
<th>Endurance</th>
<th>Preparatory</th>
<th>Competitive</th>
<th>Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aerobic Endurance</td>
<td>Development of Foundation of Specific Endurance</td>
<td>Specific Endurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aerobic Endurance</td>
</tr>
</tbody>
</table>

- **Low aerobic intensity training**: Muscular capillarization
- **High aerobic intensity training**: Systolic cardiac output

---

**Muscular capillarization**

**Systolic cardiac output**
**Anaerobic**

Table 1: Stroke rate, peak force, peak power, work and power per stroke and average power for stroke and recovery during a typical rowing race in the single scull. Results are compiled from biomechanical measurements and evaluations in the former department of biomechanics of the Humboldt-Universität at East Berlin and the center of rowing research of the former East Germany (courtesy of P. Schwanitz and W. Roth).

<table>
<thead>
<tr>
<th>Time</th>
<th>Stroke rate (l/min)</th>
<th>Peak force (N)</th>
<th>Peak velocity (m/s)</th>
<th>Peak power (W)</th>
<th>Work per stroke (Nm)</th>
<th>Power per stroke (W)</th>
<th>Average power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start spurt</td>
<td>0-10 s</td>
<td>36-42</td>
<td>1000-1500</td>
<td>3.0-4.0</td>
<td>2500-3000</td>
<td>900-1100</td>
<td>800-1200</td>
</tr>
<tr>
<td>Final spurt</td>
<td>5-6 min</td>
<td>34-38</td>
<td>600-700</td>
<td>2.2-2.8</td>
<td>1300-1800</td>
<td>700-800</td>
<td>750-1000</td>
</tr>
</tbody>
</table>

**Figure 1: The Periodisation of Dominant Abilities in Rowing**

<table>
<thead>
<tr>
<th></th>
<th>Preparatory</th>
<th>Competitive</th>
<th>Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Preparation</td>
<td>Specific Preparation</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>Anatomical Adaptation</td>
<td>Max strength</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conversion to Musc. End.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance</td>
<td>Chps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rehab.</td>
</tr>
</tbody>
</table>

Anaerobic alactacid  Anaerobic lactacid

Types of evaluation tests

• Direct tests: they measure the required parameter

• Indirect tests: they measure the parameter across an secondary factor
Indirect tests VO2max

- Math formulas
- Test / graphic
- Device (garmin-suunto)

Relation between oxygen uptake and power output in oarsmen (▲, n=44) and oarswomen (□, n=27) exercising on the 2000 mt Concept II rowing ergometer.

Biology of Sport, Vol. 20 N3, 2003
# Direct tests VO2max

<table>
<thead>
<tr>
<th>Time</th>
<th>Work Min</th>
<th>Watt</th>
<th>HR</th>
<th>BF</th>
<th>RQ</th>
<th>RQ CO2</th>
<th>VE l/min</th>
<th>V02 l/min</th>
<th>V02/ml</th>
<th>MET</th>
<th>VO2/kg</th>
<th>VO2/HR</th>
<th>PCO2</th>
<th>RQ CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:30</td>
<td>450</td>
<td>158</td>
<td>37</td>
<td>1.13</td>
<td>41</td>
<td>82.2</td>
<td>1.75</td>
<td>19.5</td>
<td>5.6</td>
<td>0.12</td>
<td>1.99</td>
<td>3.07</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>420</td>
<td>171</td>
<td>59</td>
<td>0.85</td>
<td>40</td>
<td>161.3</td>
<td>4.79</td>
<td>53.3</td>
<td>15.2</td>
<td>0.31</td>
<td>4.07</td>
<td>1.60</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>1:30</td>
<td>420</td>
<td>178</td>
<td>63</td>
<td>0.92</td>
<td>30</td>
<td>214.6</td>
<td>6.10</td>
<td>67.8</td>
<td>19.4</td>
<td>0.38</td>
<td>5.61</td>
<td>3.32</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td>390</td>
<td>174</td>
<td>67</td>
<td>1.00</td>
<td>38</td>
<td>227.3</td>
<td>6.00</td>
<td>66.7</td>
<td>19.1</td>
<td>0.38</td>
<td>6.03</td>
<td>3.37</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>2:30</td>
<td>400</td>
<td>175</td>
<td>64</td>
<td>1.03</td>
<td>37</td>
<td>227.2</td>
<td>5.95</td>
<td>66.1</td>
<td>18.9</td>
<td>0.38</td>
<td>6.11</td>
<td>3.41</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>3:00</td>
<td>380</td>
<td>178</td>
<td>65</td>
<td>1.03</td>
<td>37</td>
<td>236.4</td>
<td>6.11</td>
<td>67.9</td>
<td>19.4</td>
<td>0.38</td>
<td>6.31</td>
<td>3.39</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>3:30</td>
<td>390</td>
<td>180</td>
<td>67</td>
<td>1.03</td>
<td>37</td>
<td>234.7</td>
<td>6.09</td>
<td>67.7</td>
<td>19.3</td>
<td>0.38</td>
<td>6.30</td>
<td>3.41</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>4:00</td>
<td>370</td>
<td>181</td>
<td>62</td>
<td>1.02</td>
<td>37</td>
<td>229.2</td>
<td>6.03</td>
<td>67.1</td>
<td>19.2</td>
<td>0.37</td>
<td>6.16</td>
<td>3.42</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>4:30</td>
<td>390</td>
<td>179</td>
<td>65</td>
<td>1.01</td>
<td>38</td>
<td>233.8</td>
<td>6.13</td>
<td>68.1</td>
<td>19.5</td>
<td>0.38</td>
<td>6.18</td>
<td>3.36</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>5:00</td>
<td>380</td>
<td>178</td>
<td>64</td>
<td>1.01</td>
<td>37</td>
<td>232.6</td>
<td>6.16</td>
<td>68.4</td>
<td>19.6</td>
<td>0.38</td>
<td>6.21</td>
<td>3.39</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>5:30</td>
<td>380</td>
<td>181</td>
<td>68</td>
<td>1.00</td>
<td>38</td>
<td>235.5</td>
<td>6.18</td>
<td>68.6</td>
<td>19.6</td>
<td>0.38</td>
<td>6.19</td>
<td>3.34</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>6:00</td>
<td>434</td>
<td>180</td>
<td>67</td>
<td>1.01</td>
<td>38</td>
<td>229.6</td>
<td>5.98</td>
<td>66.4</td>
<td>19.0</td>
<td>0.37</td>
<td>6.02</td>
<td>3.33</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>6:30</td>
<td>7:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>450</td>
<td>181</td>
<td>81</td>
<td>1.13</td>
<td>41</td>
<td>236.1</td>
<td>6.10</td>
<td>68.6</td>
<td>19.6</td>
<td>0.38</td>
<td>6.31</td>
<td>3.42</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Fred</td>
<td>193</td>
<td>199.5</td>
<td>3.37</td>
<td>48.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>%Pre</td>
<td>92%</td>
<td>118</td>
<td>103</td>
<td>150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A typical VO2 curve during simulated 2000 m race is shown below. To calculate average VO2 during the test the values of the first minute VO2 have to be excluded from the analysis due to the "slow take-off" of the aerobic energy system. The ability to sustain high VO2 during the race is trivial for rower and this ability can be increased even if there is the plateau of the VO2max in elite rowers.

NOTE: As VO2max is the prerequisite of becoming a high level rower, the ability to sustain high VO2 for longer period is the mark of how effectively a rower uses his potential.

Maximal oxygen consumption values during the simulated 2000 m rowing ergometer test.
Seminar for Coaches of Development Countries  
Thursday 11 April 2019


Seasonal changes in VO2 max

Seasonal changes in physiological parameters in young club level rowers. Sport Science Foe He  
vol. 9, p. 30, ISSN: 1824-7490
STEP 3

Biomechanical factors
TECNIQUE
biomechanically correct application of the forces
Stroke length and power
Seminar for Coaches of Development Countries
Thursday 11 April 2019

Power line
8+ Boat

Catch

Drive

Finish

Recovery

Average

<table>
<thead>
<tr>
<th></th>
<th>min</th>
<th>max</th>
<th>length</th>
<th>effect</th>
<th>catch/finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>287</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>213</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>235</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>212</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>230</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>220</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>216</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>216</td>
<td>W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boat Average: 234, Average Speed: 3.91, Rating: 15.0

Average Power: 400 W, Average Speed: 4.00 m/s, SPM: 20.0
STEP 4°

State of fatigue
The evaluation of the state of fatigue to prevent the overtraining

- Heart Rate Variability (HRV)
- The HRV describes the variations in the intervals between successive heartbeats
- Parasympathetic and Sympatetic Systems
  - Parasympathetic Systems >> (HF) decrease heart rate
  - Sympathetic Systems >> (LF) increase heart rate
- Relationship Parasympathetic and Sympatetic >> state of fatigue/overtraining
- Ratio 0-2 Good >2 Probably overtraining
Seminar for Coaches of Development Countries
Thursday 11 April 2019

Polar V800

kubios

For Better
Heart Rate Variability Analysis
Seminar for Coaches of Development Countries
Thursday 11 April 2019

Sympatetic

Parasympathetic
Surpercompensation Principle

An unbalanced supercompensation is the first cause of overtraining.

Legend:
A = Alarm Phase
B = Resistance Phase
C = Supercompensation Phase
D = Exhaustion or Detraining Phase

Training 100% load

Training 50% load

Recovery
Surpercompensation Principle

Adequate training and recovery ratio

Not adequate training and recovery ratio

Good performance

Bad performance
Problem!!!
Seminar for Coaches of Development Countries
Thursday 11 April 2019
Kurt Jensen Model

Watt percentage refer to 2000m = 100%

Test

10sec  60sec  2000m  6km  60min

Anaerobic Power (Alactacid)

Aerobic power

Anaerobic capacity (Lactacid)

Aerobic capacity

Endurance
Video Analysis

Simple Rowing Stroke Analysis with Kinovea.mp4

Kinovea.Ink
Seminar for Coaches of Development Countries
Thursday 11 April 2019
The importance of monitoring the athlete

- Provide an initial assessment of the subject's strengths and weaknesses
- Evaluate the effectiveness of the training program
- Assess the health status of athletes
Seminar for Coaches of Development Countries
Thursday 11 April 2019

Dario Cerasola, PhD
cerada@icloud.com    Mobile+39 3391485145