Constant Work Rate Testing

M.S. Riley
\[ \dot{\text{VO}_2} \] lactate (mM)

above AT

5.3

0.9

0.9

0.5

0.6

Components of response

\[ \dot{V}O_2 = b + A(1 - e^{-(t-td)/\tau}) \]
Low intensity exercise

![Graph showing VO_2 (ml.min^-1) over time with markers for Pulmonary VO_2 and Muscle VO_2]

Krustrup et al. 2009
Mechanism of slow component?
$\textit{Q}_{10}$

Koga et al. 1997
\( \dot{V}O_2 \) (l/min)

Time (min)

Begin Epinephrine Infusion

Gaesser et al 1994
A scatter plot showing the relationship between $\Delta V_O^2 (6-3)$ [L/min] and $\Delta$Lactate [mmol/L].

- **Young Adults** represented by circles.
- **CHF** represented by triangles.
- **Old Middle Age** represented by squares.
- **Young Middle Age** represented by dots.

The equation of the trend line is:

$$y = 0.051x + 0.013$$

- Correlation coefficient, $r = 0.85$
- Number of data points, $n = 147$
- Level of significance, $p < 0.001$
\( \dot{V}O_2 \) in McArdle’s Disease

Ong et al. AJRCCM 2004
Barstow et al. 1996

![Graph showing oxygen cost over time for different percentages of Type I muscle fibers.](image)
What happens in disease?
End-exercise heart rate
2.7 km h$^{-1}$ 5% slope

Riley et al.
End-exercise R
2.7 km h\(^{-1}\) 5% slope

\[ \text{Riley et al} \]
L did exercise at the set rate...with practically no discomfort, and soon recovered afterwards.

R, on the other hand, was always greatly distressed, and usually had to be driven to complete it.
40W Constant work rate

\[ \dot{V}O_2 \text{ (l min}^{-1}) \]

- Short time constant
- Long time constant

Control
iPAH

Riley et al. JACC 1992
Constant workrate exercise

\[ \dot{V}O_2 \text{ (ml kg}^{-1}\text{ min}^{-1}) \]

- Normals
- CCF NYHA II: \( \tau = 29\text{s} \)
- CCF NYHA III: \( \tau = 49\text{s} \)
- CCF NYHA III: \( \tau = 71\text{s} \)

Riley et al. Br Heart J 1994
Ramp model

\[ \int A(1 - e^{-t/\tau}) \, dt = At + A\tau e^{-t/\tau} + c \]
Applications
Constant work rate exercise

• Reflects daily activity better than ramp exercise
• May be less demanding than ramp exercise
• Yields additional physiological information to ramp exercise

Riley et al
Power - Duration

Before intervention

After intervention

Whipp & Ward 2009
Koike et al. 2000
Indirect Calorimetry

Fat

\[ C_{16}H_{32}O_2 + 23O_2 \rightarrow 16CO_2 + 16H_2O \]

\[ RQ \sim 0.7 \]

Carbohydrate

\[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \]

\[ RQ = 1.0 \]
## Gas stores

<table>
<thead>
<tr>
<th></th>
<th>Blood &amp; tissues (ml)</th>
<th>Alveolar gas (ml)</th>
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<tbody>
<tr>
<td>$\text{CO}_2$</td>
<td>6100</td>
<td>120</td>
</tr>
<tr>
<td>$\text{O}_2$</td>
<td>1080</td>
<td>300</td>
</tr>
<tr>
<td>$\text{N}_2$</td>
<td>996</td>
<td>1560</td>
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</tbody>
</table>
RER = RQ
RQ during exercise

Substrate utilization

* p<0.0005

Constant work rate exercise

- Normal patterns of gas exchange
- Mechanisms of slow component
- Disease patterns
- Applications