Plasma Volume, Altitude & the ABP

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Overview

- Components of blood
- Biological variance and the ABP
- Plasma volume and exercise
- Altitude
- What magnitude of change can be expected
- How do we respond?
What makes up whole blood?

Blood Volume

Plasma Volume
~55%

Red Cell Volume

Centrifuge

Same Blood Volume

Higher Red Cell Volume

Higher Plasma Volume
Variance components of [Hb]

Within-subject Variation

- Plasma Volume
- Analytical
- Hb mass

Between-subject Variation

- Genetic (ethnicity) and Environmental (nutrition and unexplained)
- Age
- Sex
- Analytical Bias

Adapted from Sottas et al., Transl Res, 2011 and Lobigs et al., Eur J Sports Sci, 2018
Plasma volume & exercise

Plasma volume & acute exercise

Post exercise:

[**Hb**] +20 g/L (+13%)

OFF-score +20 units

Plasma volume - 576mL (-20%)

Retic # no change

Adapted from Lobigs, et al., Am J Haematol, 2017
Plasma volume & chronic exercise

Plasma volume reduction and hematological fluctuations in high-level athletes after an increased training load

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250% increase in training volume for 1 week:
Plasma volume 10% increase
[Hb] ~6% decrease
OFF-hr ~16% decrease
Return to baseline: 2 days (PV) and 4 days ([Hb])
Observed atypical passport profiles
### Plasma volume & multi-day racing

**Table 1. Review of the hematological changes observed during endurance cycling events.**

<table>
<thead>
<tr>
<th>Tour</th>
<th>N</th>
<th>Collection</th>
<th>Hb (g/L)</th>
<th>HCT (%)</th>
<th>RET%</th>
<th>Plasma volume (%)</th>
<th>Blood volume (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giro d’Italia 1987 (22 stages)</td>
<td>15</td>
<td>10</td>
<td>-4</td>
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<td></td>
<td></td>
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<td>(Campanini et al., 1988)</td>
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<td>16</td>
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<td>-2.6</td>
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<td>(Chicharro et al., 2001)</td>
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<td>-12</td>
<td>-2.8</td>
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<td>22</td>
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<td>-3.2</td>
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<td>Giro d’Italia 2011 (21 stages)</td>
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<td>-13</td>
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<td>0.18 *</td>
<td>1.6 #</td>
<td>(Corsetti et al., 2012)</td>
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<td>-2.1</td>
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<td>(Garvican et al., 2010)</td>
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<td>-4</td>
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<td>17</td>
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<td>Simulated cycling tour ** (14 stages)</td>
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<td>6</td>
<td>-12</td>
<td>-3.4</td>
<td>-0.09</td>
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<td>14.5</td>
<td>(Garvican-Lewis et al., 2014)</td>
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<td>Tour of Niedersachsen 1989 (10 stages)</td>
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<td>(Schmidt et al., 2000)</td>
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</tbody>
</table>

Adapted from Lobigs, et al., Eu J Sports Sci, 2018
Why train at altitude?

St Moritz, Switzerland

1,822 m
Altitude & the ABP

Altitude: 3484 m
28 days

During altitude

Figures do not include the first 2 days at altitude.

Lobigs L., et al., Am J Haematol, 2018
Extreme changes during altitude

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Min, Max</th>
</tr>
</thead>
</table>
| [Hb]⁺  
(n = 258 M, 87 F) | ≤ −1.2 (4) | −1.5, 3.0      |
|                | ≥ 2.6 (3)⁺ |                |
| sqrt(retic%)  
(n = 222 M, 73 F) | ≤ −0.315 (3)⁺ | −0.343, 0.508  |
|                | ≥ 0.472 (3)|                |
| OFF-score      
(n = 204 M, 73 F) | ≤ −26.8 (3)⁺ | −31.4, 35.4    |
|                | ≥ 27.1 (3) |                |

Adapted from Lobigs L., et al., Am J Haematol, 2018
Post altitude – the return to baseline

Lobigs L., et al., Am J Haematol, 2018
How do we respond?

- Plasma volume marker
- Research into multi-day events
- How long does it take to return to baseline after altitude?
Questions?