

Karsten Koehler<sup>1</sup>, Hans Braun<sup>1</sup>, Mario Thevis<sup>2</sup>, Wilhelm Schänzer<sup>2</sup>

## **Glycerol as prohibited substance: meta-analysis on the effects of glycerol administration on haemoglobin, haematocrit and plasma volume**

Institute of Biochemistry, German Research Center for Elite Sports, German Sport University, Cologne, Germany<sup>1</sup>; Institute of Biochemistry, Center for Preventive Doping Research, German Sport University, Cologne, Germany<sup>2</sup>

### **Abstract**

Due to its osmotic properties, glycerol can be used to prevent dehydration. When glycerol is administered exogenously with excess fluid, a proportion of the fluid is retained and hyperhydration occurs. Several studies have shown that glycerol hyperhydration may improve endurance performance (van Rosendal et al., 2010) and increase blood and plasma volume. Consequently, the oral and intravenous administration of glycerol has been prohibited by WADA since 2010. However, literature data on the effects of glycerol hyperhydration on doping-relevant blood marker has been inconclusive so far. Hence, the purpose of this meta-analysis was to review the scientific literature and to quantify the effects of oral glycerol administration on plasma volume, haemoglobin and haematocrit.

A MEDLINE search was conducted for all studies published between 1960 and 2011 with the search queries “glycerol AND plasma volume”, “glycerol AND haemoglobin” and “glycerol AND haematocrit”. The initial search identified 995 publications but the vast majority (975) was rejected because the inclusion criteria (placebo-controlled administration study, healthy subjects) were not met. Twelve additional studies were rejected due to the lack of an adequate control group, insufficient pre-administration sampling or because data was displayed only graphically. A total of eight studies were included into the final meta-analysis, which was performed with the ‘metaphor package’ for R statistics. If not available directly, pretest-posttest effect sizes were calculated according to Morris (2008).

The meta-analysis revealed that there was a highly significant increase in plasma volume of 3.3% (95%-confidence intervals (CI): 1.1-5.5%) after administration of glycerol compared to placebo fluid. Haemoglobin values were significantly reduced by glycerol by 0.2 g/dL (95%-CI: -0.3-0.0) and the mean difference in haematocrit was 0.0% (95%-CI: -0.7-0.8%).

The present meta-analysis shows that glycerol administration leads to small but significant increases in plasma volume. However, the effects on haemoglobin and haematocrit levels, which are commonly used for the detection of blood doping, are small and negligible when compared with the administration of fluid only. These results partially contradict the rationale for banning glycerol as a masking agent by WADA.

The meta-analysis will be published in more detail elsewhere.

### **References**

- Van Rosendal SP, Osborne MA, Fasset RG, Coombes JS. (2010). Guidelines for glycerol use in hyperhydration and rehydration associated with exercise. *Sports Medicine* **40**, 113-129.
- Morris SB. (2008). Estimating effect sizes from pretest-posttest-control group designs. *Organizational Research Methods* **11**, 364-86