PLASMA VOLUME MEASUREMENT: COMPARISONS DURING SHORT-TERM THERMONEUTRAL AND COLD-WATER IMMERSION

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While exposure to short-term (<2hr) water immersion elicits increases in plasma volume (PV) during thermoneutral immersion (34.5°C), and a PV decrease during cold-water immersion (18°C), the magnitude of these shifts is inconsistent. Previous data have shown that the most prevalent, indirect PV measurement technique, which utilises changes in haematocrit (Hct) and haemoglobin concentration ([Hb]), underestimates actual PV changes during thermoneutral immersion when compared to a direct, tracer-dilution technique (Evans blue (EB) dye). Such methodological comparisons have not been made during cold-water immersion, leaving our understanding of PV changes during such exposures unclear. Therefore, we compared both indirect and direct PV measures (EB dye tracer-dilution) during both thermoneutral and cold-water immersion. We also evaluated the utility of an EB dye computer programme. Seven healthy males (age 27.6 yr SD ±9.2, height 183.1 cm SD ±4.6, mass 82.1 kg SD ±9.1, skinfold thickness 83.5 mm SD ±28.0) were tested three times (60 min; balanced design): seated upright in air (control: 21.2°C SD ±1.1); thermoneutral immersion (34.5°C SD ±0.2) and cold immersion (18.6°C SD ±0.2). Posture was identical across tests, with immersion to the third intercostal space, and tests being separated by two weeks. Plasma volume was determined at immersion baseline and during the control test, using three methods (EB dye column elution; EB dye computer programme; Hct/[Hb] calculation), and during immersions using the EB dye column elution and Hct/[Hb] calculation methods. Plasma volume during the control trial remained stable, and equivalent across and between the three methods (P>0.05). During thermoneutral immersion, PV increased by 16.2% (±1.4) and 8.5% (±0.8) when determined by the EB dye column elution method and the Hct/[Hb] calculation, respectively (both P<0.05). The Hct/[Hb] calculation underestimated relative PV change by 43% (±9.1; P<0.05), when compared with the EB dye column elution method. During cold immersion, PV decreased significantly (17.9% ±3.0 (EB dye) and 8.0% ±1.2 (Hct/[Hb]); both P<0.05), with the latter representing a 52% (±6.8; P<0.05) underestimation of PV change. When the control and pre-immersion baseline data were combined, the absolute PV, derived using the EB dye computer programme, correlated well with the EB dye column elution PV (r=0.83; P<0.05). The current study is the first to show that the Hct/[Hb] method clearly underestimates PV changes during both thermoneutral and cold immersion. The mechanism underlying this PV discrepancy has yet to be elucidated. Furthermore, the EB dye computer programme method provides an acceptable alternative to the EB dye column elution technique for baseline PV determination.

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