Proceedings of 3rd International Conference on Environmental Ergonomics
8—12 August 1988 Helsinki, Finland
eds. R. Ilmarinen and A. Påsche, p. 58

FLUID REPLACEMENT DURING COLD WATER IMMERSION: HYDRATION AND THERMAL STATUS

T.J. Doubt, P.A. Deuster, K. Haberman, C. Ryan, J. Bilanin, and L. Montgomery

Diving Medicine Department

Address for reprints:

Naval Medical Research Institute
Bethesda, Maryland 20814-5055 USA

Two significant events occur as a result of immersion in cold water; diuresis and hypothermia. Thus, the question arises whether fluid and caloric replacement during immersion might offset these two events. The present study examined 10 males for 3 hours at rest during head-out immersion in either 25 or 35 °C water. Each hour subjects ingested 250 ml of either water (W) or glucose polymer (GP) solution (fluid temp = 10 °C, total intake = 750 ml). Five of the subjects also completed an immersion at each temperature where no fluid (NF) was ingested. Thermal measurements and oxygen consumption ($\dot{V}O_2$) were measured every 4 min. Blood and urine samples were collected every 30 min. Table below lists several relevant findings (mean ± SE).

	Urine output (ml)	Change plasma volume (%)	Change rectal temp (°C)	Avg. heat flux (W/m2)
35 °C, NF	995 ± 207	5.3 ± 2.5	-0.10 ± 0.05	35.8 ± 0 9
35 °C, W	1565 ± 107	0.7 ± 2.7	0.00 ± 0.12	29.7 ± 0.6
35 °C, GP	1787 ± 151	4.1 ± 1.9	-0.13 ± 0.10	31.5 ± 0.7
25 °C, NF	1055 ± 60	-5.9 ± 4.8	-0.98 ± 0.17	102.2 ± 1.6
25 °C, W	1930 ± 156	-11.3 ± 4.9	-1.03 ± 0.09	104.5 ± 1.5
25 °C, GP	1651 ± 177	-11.8 ± 5.6	-0.88 ± 0.11	105.5 ± 1.6

Venous lactate rose progressively at all 25 °C conditions. Plasma glucose remained stable at both 25 and 35 °C with either NF or W ingestion, but was elevated transiently 30 min after GP ingestion. Free fatty acid increased progressively when either NF or W was provided, whereas no rise was observed with GP at either water temperature. $\dot{V}O_2$ was unaffected by fluid ingestion at 35 °C. Average $\dot{V}O_2$ was higher at 25 °C and ingestion of either fluid caused further elevations of about 2 ml/min/kg lasting for 30-40 min, indicating a rise in metabolic rate. Heat flux during these transient periods at 25 °C was also slightly higher, but less than heat production. These results indicate that fluid ingestion during prolonged immersion will not offset declines in plasma volume due to diuresis, nor affect net changes in core temperature. However, ingestion of cold fluid will transiently increase heat production in cold water. This latter effect occurs only if peripheral thermal receptors are exposed to cold. Although net thermal balance was little affected by fluid intake, the induced transient rises in heat production may represent a favorable effect that might promote survival at sea. (Supported by U.S. Naval Medical Research and Development Grant M0099.01A.1003)