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PALM COOLING FOR HEAT MITIGATION

Abstract

Thermoregulation in microgravity sees limited convective and evaporative heat transfer. In-flight body temperatures at rest and exercise are both higher than for those on Earth. In-flight exercise, vital to long-term missions, exacerbate heat accrual. Such changes are like those incurred by multiple sclerosis (MS) patients, who must exercise despite subsequent excessive heat accrual. With MS, body temperature increases of 0.5C can inhibit cutaneous vasodilation and evaporation. Similarities among conditions imply treatments to abate heat accrual in MS patients could also help astronauts. Human palms cover anastomoses, which are vascular structures that hasten conduction as the palm contacts cold objects. Palm cooling (PC) gloves were fabricated to facilitate conductive heat transfer. Astronauts and MS patients each experience conduction. Purpose: Compare thermal and physiological data from workouts with, and without, PC by a male MS patient. Methodology: An active 37-year-old with MS gave consent (IRB 23.0333). He did two identical cycle ergometer workouts eight days apart. Workloads were based on an Astrand-Rhyming test to estimate his VO2max. Workouts started with three-minute warm-ups against no resistance by pedaling at 50 rpm. After warm-ups, he pedaled for 15 minutes at 50 rpm against a 91-watt workload, followed by seven minutes against a 63-watt workload. Before, during, and after workouts, heart rates, auditory canal and palm temperatures, and the palm's thermal flux were measured. For the PC workout, gel packs (10.6oC) were inserted into the PC gloves halfway through the warm-up and removed when cycling concluded. New gel packs were inserted 15 minutes post-exercise, removed 30 minutes post-exercise, and reinserted 45 minutes post-exercise. Results: Inter-workout heart rate and auditory canal temperatures had minor differences, with increases during exercise followed by declines throughout recovery. Yet palm temperature and thermal flux values produced large inter-workout differences. PC workout palm temperatures were lower due to cold application but yielded greater thermal gradients and conduction. PC workout's thermal flux was up to 1569% higher than corresponding non-PC values. Conclusions: Absolute thermal flux values peaked at 658W/m2 from PC, far greater than those obtained from healthy persons during intense exercise. Areas of Discussion: With additional MS subject data, greater thermal flux may yield significantly lower heart rate and auditory

canal temperatures. Similarities among conditions suggest astronauts in microgravity could potentially derive comparable heat losses during and after in-flight exercise. Use of PC gloves by astronauts during in-flight exercise or operational tasks warrants inquiry.