DEVELOPMENT OF A NOVEL THERMAL CONTROL SUIT FOR HUMAN THERMOREGULATION AND ENVIRONMENTAL ERGONOMIC STUDIES

S.S. Cheung, C.G. Brideau, M.X. Richardson and L.J. Thornley, School of Health & Human Performance, Dalhousie University, Halifax, Canada.

Cooling suits are becoming increasingly common in occupational and athletic settings in order to keep humans cool while working or exercising in hot environments. These cooling garments typically consist of vests containing packets of ice, or else liquid-cooling garments (LCGs) where conductive heat transfer is achieved by the movement of externally cooled water through narrow tubing stitched into the clothing. In research settings, LCGs can be used to heat or cool subjects by controlling the temperature of the water entering the LCG. We are in the development stage for a Thermal Control Suit (TCS) for use in thermophysiology and environmental ergonomic studies. The TCS is designed to extend the flexibility and limit of thermal control possible with present LCGs based on running water and an external heating/cooling source. The primary specifications for the TCS are the ability to, during either rest or light exercise: 1) maintain core temperature (T_c) at a stable (± 0.10°C) level (T_c range 35.0-40.0°C) for 60 min, 2) control the rate of T_c increase or decrease at a level of 0.05°C/min, 3) have multiple thermoregulatory controls for different body regions that can be independently controlled or combined in flexible configurations, and 4) accomodate individuals from 1.65-1.95 m. The TCS employs multiple (~30) thermo-electric modules (TEMs) distributed throughout the body, with each module capable of up to 20 W heat exchange. By changing the direction and magnitude of the current flowing into the TEM, fine control of heating or cooling of each individual module can be achieved. To achieve conductive heat exchange with the body, each TEM heats or cools a small sac (~50 mL) of water held against the skin. The custom software developed for the TCS can, for each TEM, either maintain a constant TEM temperature or, alternately, vary TEM temperature to maintain a constant skin or core temperature. The TEMs are held in place using a webbing system that permits multiple configurations and maximal flexibility in the placement of the TEMs. Overall, the TCS will permit fine and flexible control of overall and regional body temperature not possible with previous systems. Initial unmanned validation work has successfully proven the concept of heating/cooling control using TEMs by manipulating the temperature of insulated bodies of water. Present work revolves around the validation of the TCS on human subjects.

scheung@is.dal.ca