

APPROACHES TO MONITORING THERMAL STATUS IN HUMANS UNDER NONUNIFORM HEATING/COOLING ON THE BODY SURFACE

V.S. Koscheyev, M.J. Dancisak and G.R. Leon, Division of Kinesiology, University of Minnesota, Minneapolis, Minnesota, USA.

Nonuniform temperatures on different parts of the body surface are often encountered during various conditions in space as well as in medical and occupational circumstances on Earth. In such cases, the primary challenge is how to best manage body comfort and safety with the information obtained by monitoring core and skin temperature. Findings from our research program have shown that traditional methods of monitoring body thermal status are not adequate in such conditions; usual measurement sites are not informative, and the relationship between the coefficients of core and skin temperature for averaging body temperature are not correct. Compared to uniform thermal conditions, the powerful influence of simultaneous cold and warm applications on different parts of the body surface significantly changes the response latency of the core, for example, rectal temperature. Moreover, nonuniform temperatures applied to the right and left sides of the head, respectively, result in a rapid and differential response in left and right ear canal temperatures. Therefore, this traditionally used site for making decisions about adding or removing body heat to achieve and maintain safety and comfort of personnel in Space and in other environments will provide incorrect information if only one side of the body is monitored. A plastic tubing liquid cooling/warming garment (LCWG) was designed in our laboratory with the capacity to differentially cool/warm different body zones. Through this experimental paradigm, our overall goal has been to achieve a better understanding of how to manage nonuniform thermal conditions while astronauts are engaged in extravehicular activities or in various on-board situations, with applications for Earth purposes. A further objective is to evaluate the efficiency of heat transfer from different body areas to identify the most effective zones to minimize the surface coverage by the LCWG, thus reduce energy consumption of the system, and precisely control body thermal status under such nonuniform thermal influences. Compared with temperature data from other body zones, findings demonstrated that the most informative method of assessing total body thermal status was by monitoring the thermal profile of the phalanges. This area vividly reflected the dynamic processes of heat dissipation or storage developing within the body. The marked changes in finger temperature amplitude and in blood perfusion intensity under nonuniform thermal conditions indicate the usefulness of the fingers to precisely measure alterations of heat balance in the body, predict changes in thermal status, and provide an alert for countermeasures to deal with a growing heat deficit or heat accumulation. The implications of this research for the development of an automatic feedback system to control thermal status and comfort of astronauts in space and occupational personnel on Earth are discussed.

kosch002@tc.umn.edu