IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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CORE BODY TEMPERATURE CHANGES UNDER DIFFERENT PHYSICAL AND ENVIRONMENTAL CONDITIONS ON EARTH AND IN SPACE

Abstract

Heat exchange between an organism and its environment occurs via conduction, convection, radiation, and evaporation. Under terrestrial conditions, heat exchange for an adult occurs mainly by radiation and convection, and the body core temperature fluctuates by only +/- 0.5 Celsius degree (C) throughout the day, i.e. the "circadian rhythm". In space, the heat loss pathways are challenged due to the lack of natural convection which results in the diminished occurrence and/or efficiency of evaporation. We have recently developed a non-invasive heat flux device (Double Sensor, Tcore®) that can be used to monitor core body temperature changes in humans. Three investigations will be presented. They dealt with core body temperature changes under terrestrial and micro-g conditions: i) during rest and exercise in a climate chamber at 10C, 25C, 40C ambient temperature, ii) during long-term bed-rest, and finally iii) during rest and exercise in space. In the first study (study 1), the heat flux sensor methodology was tested in comparison to nasopharyngeal and rectal temperatures in 20 male subjects; in the second study (study 2) 7 males were monitored during long-term bed rest, and in the last study core body temperature changes were determined in 11 astronauts during a regular VO2 ergometer testing before flight, several times in space on the ISS, and after spaceflight (study 3). Study 1 showed that the recordings of the Double Sensor differed by -0.16 to 0.1C from the mean rectal temperature, study 2 proved that the device correlated well ($r>0.704$) with the rectal temperature recordings, and study 3 revealed that the astronauts had marked and prolonged increases during exercise in core body temperature, sometimes >40C, in space on the ISS ($p<0.01$). Changes in body core temperature can be markedly attenuated in space. Further studies on this topic are urgently needed because i) the frequency, length, and intensity of extravehicular activities will increase in future and ii) any alteration of the circadian rhythms might aggravate the physical, psychological, and cognitive performance of humans in space.