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

Author: Prof. Jens Tank
Hannover Medical School, Germany, tank.jens@mh-hannover.de

Dr. Roman Baevsky
Institute for Biomedical Problems, Russian Federation, baevsky@pike.net.ru
Dr. Irina I. Funtova
Institute for Biomedical Problems, Russian Federation, funtova@imbp.ru
Prof. André Diedrich
Vanderbilt University, United States, andre.diedrich@vanderbilt.edu
Dr. Juergen Drescher
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), United States, jd@dlr.de

AUTONOMIC FUNCTION TESTING ONBOARD ISS FOR CREW HEALTH MONITORING WITH "PULS" AND "PNEUMOCARD" – RESULTS, LIMITATIONS AND NEXT STEPS.

Abstract

Investigations during short and long term space flights have shown characteristic individual autonomic function control pattern which may be responsible for in-flight and post-flight cardiovascular deconditioning. We presented results from in-flight measurements in eight cosmonauts based on data collected with the software diagnostic complex "Pulse" for routine inflight ECG, photoplethysmography and breathing measurements during ISS missions from 2004 to 2007 (Baevsky RM et al. J Appl Physiol 2007). The device "Pneumocard" was developed to obtain additional information on cardiovascular regulation in terms of hemodynamic measurements based on non invasive impedance- and seismo-cardiography and replaced "Pulse" in March 2007 onboard the ISS. Since that time "Pneumocard" was successfully used during in-flight experiments on ISS for autonomic function testing in nine male cosmonauts. Recordings and analysis were made prior to the flight, monthly in-flight as well as post-flight during spontaneous respiration and during maximum voluntary inspiratory and expiratory breath holds. In summary the "Pneumocard" experiments supported the findings with "Pulse" regarding heart rate (HR), respiratory rate (RR), and pulse wave transit time (PWTT). Analysis of the thoracic impedance signal suggests that stroke volume is not reduced during long term space flight. The increase of dZ/dt during flight at rest may indicate maintained cardiac function during and after 6 month in space. Furthermore, our results show inter-individual differences which may have influence on post-flight autonomic dysfunction. However, the highest HR, RR, blood pressure values and the lowest PWTT were measured after landing. Autonomic cardiovascular control analyzed by means of heart rate variability shows significant differences between individual astronauts. The major limitation of our measurements is the use of indirect methods which can not be calibrated. Moreover, the physiological interpretation of the signals is still controversial. Different equations for stroke volume calculations are described and all are under debate (Bernstein DP J Electr Bioimp 2010). More sophisticated methods of signal analysis may help to further support our results as well as results from studies using direct measurements of cardiac output in space. Combining non invasive hemodynamic measurements with monitoring of cardiovascular control by means of heart rate and stroke volume variability may help to define individual regulatory types and to elucidate the possible influence on in-flight and post-flight deconditioning. Further improvement of data analysis can help to better understand the individual adaptational process, to predict possible problems and to assess human performance required for long-duration missions to the Moon and Mars.