

Safety Ranges for Heart Rate Variability Parameters in Hyperbaric Environments

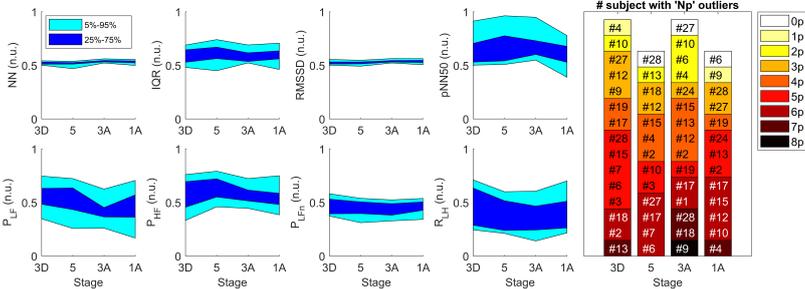
Carlos Sánchez*, Alberto Hernando, Juan Bolea, David Izquierdo, M^a Teresa Lozano, M^a Dolores Peláez-Coca

Centro Universitario de la Defensa, Zaragoza, Spain

The Autonomic Nervous System (ANS) tries to maintain homeostasis in hyperbaric environments, such as during diving activities, by controlling blood pressure and heart rate. This response is hard to assess in these environments and may present large variability between subjects. The aim of this study is to establish safety ranges for ANS-related indices derived from the electrocardiographic signal (ECG) during diving and use them to identify subjects with abnormal ANS response and avoid potential diving accidents.

A collected database, consisting of ECG recordings from 28 subjects introduced into a hyperbaric chamber, was analysed. During immersion, five steady stages were studied at 1, 3 and 5 atm during descent (D) and ascent (A): from 1D (basal state) to 3D, 5 (maximum depth), 3A and back to 1A. Eight ECG-derived indices, which reflect the sympathetic and parasympathetic ANS response, were calculated and normalized with respect to their values at the reference stage 1D. In particular, four time-related parameters extracted from the RR series and four frequency parameters based on the powers of the low and high frequency bands, 0.04-0.15 Hz and 0.15-0.4 Hz, respectively, were used.

Some parts of the ECG recordings were discarded when superposition of respiratory rate on low frequency band appeared or poor quality recordings were identified. High inter-subject variability in the ANS response is observed in the four stages (Figure, left). An outlier detection is performed for each immersion stage and, as a result, some subjects present highly abnormal responses, reflected in many parameters out of the interquartile range (Figure, right). The analysis performed in this study allows establishing safety ranges for ANS-related parameters that can be helpful for the identification of subjects with potential risk for their health in diving or other hyperbaric activities.



Left: Interquartile (25-75) and 5-95 percentile ranges of the eight parameters. Right: Specific subjects (#) with 'Np' parameters (color scale, from '0p' to '8p') considered outliers in each stage.