Polysomnography in Extreme Environments: the MagIC Wearable System for Monitoring Climbers Ascending on Mount Everest Slopes

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We recently developed a textile-based wearable system (called MagIC) for monitoring ECG, thoracic respiratory movements, body accelerations and posture in unrestrained subjects. This study presents results on the applicability of MagIC for polysomnographic recordings at very-high altitude in climbers on Mt. Everest slopes. Five professional mountaineers were provided with MagIC modified for the HIGHCARE expedition by integrating a finger pulse oximeter (Nonin Xpod) and by substituting cotton with polypropylene, a yarn for thermal underwear which facilitates transpiration. Signals were recorded continuously for more than 10 hours at night, first at sea level (SL), and then during the ascent on Mount Everest slopes, at 6000m (Camp1) and 6800m (Camp2). Each climber found MagIC comfortable to wear and completed the monitoring set-up without need of help, even in the most challenging environment of Camp2. After having visually scored the signal quality, the average artefacts rate (ratio between cumulative duration of artefacts and length of the recording) resulted to be lower than 5%. This allowed the identification of central sleep apneas and the calculation of tachogram-derived parameters. The mean R-R interval (RRI) and its standard deviation (SDNN) were obtained on the last 4 hours of sleep, easily identified from the accelerometric signals. During night RRI tended to decrease from SL (956.2$\pm$50.1ms, mean$\pm$SEM) to Camp1 (938.3$\pm$39.1 ms) and Camp2 (894.3$\pm$41.2ms). SDNN increased significantly from SL (110.7$\pm$15 ms) to Camp1 (159.6$\pm$14.0 ms) and from Camp1 to Camp2 (186.5$\pm$18.8 ms). Central apneas, absent at SL, occurred frequently at high altitude and the oxygen saturation was lower at Camp2 (69%$\pm$5%) than at Camp1 (75%$\pm$3%). MagIC demonstrated to be suitable for cardiorespiratory monitoring in such extreme environments, being comfortably used by climbers and offering high quality recordings. Our results provide the first description of cardiorespiratory changes during sleep in climbers exposed to hypobaric hypoxia at very high altitude.