

Combination Effects of Circadian Variations and Fatigue-Assessment by Flight Simulator and Multi-plate Posturography

Y. Shub, R. Kohen-Raz, A. Kohen-Raz, I.E. Ashkenazi

Department of Human Genetics, Sackler School of Medicine, Tel Aviv University, Tel Aviv

School of Education, The Hebrew University, Jerusalem

Many of aviation accidents are attributed to human error induced by fatigue, which in turn is modulated by circadian variability. We searched for adequate tools to assess these effects. As the human postural system involvement in stress and fatigue has been documented by neuroanatomical and aviation research, it appeared worthwhile to evaluate the effects of fatigue and circadian variations on the postural system by posturographic tests and on performance by use of a flight simulator. Seven healthy males, aged 27-42, were exposed to a period of 30 consecutive working hours. Subjects woke up at 6:00 a.m. and commenced their working day at 8:00 which continued until 12:00 a.m. of the next day. Tests were performed every two hours and included posturographic examinations during which the subjects were required to assume different positions involving various degrees of postural stress, i.e. standing on elastic pads with eyes open, or closed, head tilted, etc. The standard experimental time per position was 30 or 45 seconds. The following measures were analysed: "Harmony of sway distribution," "Heel/toe coordination movement," and "power of frequency weight." At these times the subjects performed 7 flight scenarios, in a flight simulator called PES (Pilot Evaluation System) simulator. The PES is a high fidelity, cognitive and senso-motoric testing tool, routinely and extensively used in Air Forces and airlines, The test offered in the PES is composed of 7 flight profiles, each lasting approximately 3 minutes. Each scenario introduced a flight manouevre or task, eventually leading to more complex workloads.

The goal of the present study was to validate and compare the efficiency and sensitivity of the two instruments, in measuring effects of fatigue and detecting related circadian variations. These analyses offer a more rigorous and stringent design of data intake by comparing the postural responses to the performance on the flight.

The output of the measured parameters exhibited patterns compatible with sinusoidal functions, which exhibit periodicities of 24 hours, 8 hours and a combination of these two components. Work and fatigue significantly affected in a time dependent manner the levels and phases of these patterns. The analysis also yielded a component involved in shaping the pattern and which is related to accumulated fatigue. This component was best expressed by a parabolic quadratic equation. Implications of these results in the field of aviation medicine are discussed.

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