Evaluation of physiological response of the pilots’ body to hypobaric hypoxia. Assessment of potential risks and impact on the professional performances of military pilots

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The human body's physiological response to an intense request such as that generated by the flight activity, where many stimuli demonstrate their action simultaneously on the pilot, has begun to be studied and researched since 1918. In time, studies have proven crucial in enhancing flight safety in limiting accidents caused by exceeding the adaptability capacity, in a timely intervention of the body to offset the effects caused by the variations of the atmospheric pressure, temperature, body’s degree of oxygenation and the effects produced by the accelerations, vestibular and visual illusions.

Understanding the body's response to these stimuli also led both to the development of a more protective avionic technology to the limited human capacity to certain external forces and to achieve an individual training targeted on those apparatus or systems biologically deficitary and increasing adaptation level to certain conditions, factors.

Achieving this research subject involved the collaboration with the Institute of Aviation and Space Medicine of Bucharest, where military and civilian pilots perform annual medical check-out, compulsory to extend the medical approval for flight.

Within this study we used a batch of 84 persons, flying personnel to whom we have studied the variations induced by exposing the human body to hypoxia and hypobaric conditions on the values of pulse-oximetry, heart rate, intraocular pressure, changes in blood and urinary biological parameters and also of altered mental status. Simulating altitude of 5500 meters and thus creating the conditions of hypoxia and hypobarism was achieved by an experimental study decompression chamber.

During the study period there were selected five times for recording and comparing data, from different times of exposure to hypoxia. The results obtained were analyzed in terms of accuracy main statistical indicators, namely: standard correction, standard deviation, coefficient of variation and standard error.

Knowing that the concentration of oxygen breathed at sea level is 21%, this study succeeds to provide an overview image of the human body's physiological response subject to a hypoxia where the oxygen concentration in the breathing the air is 10%, corresponding to the altitude of 5500 m and a barometric pressure of 380 mm Hg.

Thus, the data obtained in the analysis of oxygen saturation in the specific conditions of an altitude higher than 5000 meters, indicate a marked decrease in arterial oxygen saturation level, far below the safe conduct of human activities (77.9%) without benefiting of an outside supply of oxygen.

Regarding the changes in heart rate to stimuli such as hypoxia and hypobarism, the study shows an average increase of 28 beats per minute to the examined subjects, between baseline of
the study and a maximum time of exposure to hypoxia. The presence of arrhythmias could be highlighted in a number of 36 out of 84 subjects participated in the study, as follows:

- Sinus tachycardia occurs in 32 subjects and respectively 38%;
- Sinus bradycardia in 2 subjects, i.e. 2.38%;
- The presence of atrial extra systoles (<6/min) in 2 subjects, namely 2.38%.

Regarding the influence exercised by hypoxia and hypobarism on the intraocular pressure values, the results showed minimal influence, reflected by a mean intraocular pressure before the decompression chamber of 17.99 to 17.57, after the decompression chamber sample. These results prove the improbability of developing an eye disease through exposure to conditions of hypoxia and hypobarism of the flying personnel, corresponding to the altitude of 5500 meters.

Concerning the changes produced on urinary biological markers after exposure to hypobaric-hypoxia conditions, we could observe the following: a decreased urinary density and a corresponding increase of the urine pH, changes taking place but without exceeding the reference interval of the two parameters; a decreased excretion of creatinine, phosphorus, urinary amylase; an increased excretion of calcium and sodium; the hypobaric-hypoxic stress determined the presence in spontaneous urine of the bilirubin and urobilinogen; regarding the urea, uric acid, magnesium, potassium and chlorine, their excretion was not significantly influenced by exposure to hypobaric-hypoxia.

Concerning the changes produced on sanguine biological markers, after exposure to hypobaric-hypoxia conditions, we found out the following:

- a decrease, statistically confirmed, post-exposure, of the following markers: blood glucose, total protein and the leukocyte number.
- it was also noted that exposure to hypobaric hypoxia conditions favor, at an increased number of survey participants, an increased of the serum iron values, lipase, LDH's, triglycerides, total bilirubin, urea and TGP's. Post-exposure, decreasing hemoglobin, hematocrit, erythrocyte count, SGOT, cholesterol, testosterone, cortisol and thyroxine (T4). All these changes are not relevant but statistically speaking. Creatinine, uric acid, albumin and gamma-GT suffered a slight decrease from sustained high percentage of the values remaining constant before and after decompression chamber. Changes in serum calcium levels were recorded as constant.
To assess the mental status of the body exposed to hypobaric hypoxia, by the tests applied to subjects, we could notice the following:

- Under the conditions of hypoxia, the average errors per test (logical test) was doubled when compared to prior exposure to hypoxia.
- In case of the test "sample of writing", making a comparison between writing calligraphy in the four moments of writing, we have noticed slight changes in writing at the time T1 and T3, which correspond to the first phase of exposure to hypoxia corresponding to 5500 m altitude (T1) and time (T3) after the physical effort, within the decompression chamber and 700 seconds after beginning the test.

*In conclusion, using external systems of oxygen administration in unpressurized aircraft (airplanes, helicopters) or during mountaineering expeditions at altitudes above 5,000 m, represents the only method of protection against altitude illness.*