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Physiological Effects on Scientist Astronaut Candidates: Hypobaric Training Assessment

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Abstract : This paper is addressed to expanding our understanding of the effects of hypoxia training on our bodies to better model its dynamics and leverage some of its implications and effects on human health. Hypoxia training is a recommended practice for military and civilian pilots that allow them to recognize their early hypoxia signs and symptoms, and Scientist Astronaut Candidates (SACs) who underwent hypobaric hypoxia (HH) exposure as part of a training activity for prospective suborbital flight applications. This observational-analytical study describes physiologic responses and symptoms experienced by a SAC group before, during and after HH exposure and proposes a model for assessing predicted versus observed physiological responses. A group of individuals with diverse Science Technology Engineering Mathematics (STEM) backgrounds conducted a hypobaric training session to an altitude up to 22,000 ft (FL220) or 6,705 meters, where heart rate (HR), breathing rate (BR) and core temperature (Tc) were monitored with the use of a chest strap sensor pre and post HH exposure. A pulse oximeter registered levels of saturation of oxygen (SpO₂), number and duration of desaturations during the HH chamber flight. Hypoxia symptoms as described by the SACs during the HH training session were also registered. This data allowed to generate a preliminary predictive model of the oxygen desaturation and O₂ pressure curve for each subject, which consists of a sixth-order polynomial fit during exposure, and a fifth or fourth-order polynomial fit during recovery. Data analysis showed that HR and BR showed no significant differences between pre and post HH exposure in most of the SACs, while Tc measures showed slight but consistent decrement changes. All subjects registered SpO₂ greater than 94% for the majority of their individual HH exposures, but all of them presented at least one clinically significant desaturation (SpO₂ < 85% for more than 5 seconds) and half of the individuals showed SpO₂ below 87% for at least 30% of their HH exposure time. Finally, real time collection of HH symptoms presented temperature somatosensory perceptions (SP) for 65% of individuals, and task-focus issues for 52.5% of individuals as the most common HH indications. 95% of the subjects experienced HH onset symptoms below FL180; all participants achieved full recovery of HH symptoms within 1 minute of donning their O₂ mask. The current HH study performed on this group of individuals suggests a rapid and fully reversible physiologic response after HH exposure as expected and obtained in previous studies. Our data showed consistent results between predicted versus observed SpO₂ curves during HH suggesting a mathematical function that may be used to model HH performance deficiencies. During the HH study, real-time HH symptoms were registered providing evidenced SP and task focusing as the earliest and most common indicators. Finally, an assessment of HH signs of symptoms in a group of heterogeneous, non-pilot individuals showed similar results to previous studies in homogeneous populations of pilots.

Keywords : slow onset hypoxia, hypobaric chamber training, altitude sickness, symptoms and altitude, pressure cabin
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