Letter to the Editor re: Hypoxia Occurrence in a Military Aviator Below 3048 m

Dear Editor:

The case report of "Hypoxia Occurrence in a Military Aviator Below 3048 m" by Tristan[8] was a remarkable and interesting one about the insidious threat of hypoxia during flight. As the author mentioned, despite technological advances, hypoxia continues to remain a concern because of the known and unknown potential catastrophic consequences in aviation. There are two important aspects in this case report. The first one is the subjective type symptoms of hypoxia that were recently described as the individual "hypoxia signature" of the aviator. It is important to recognize these in order for the aviator to take prompt actions to correct the hypoxia before it progresses.[7] The second is the effect of physical activity or exercise on the aircrew member who is in a hypoxic situation.

There are studies showing that physical activity exacerbates the hypoxic condition at altitude.[2] The increased physical activity is related to increased cardiac output and leads to decreased time for oxygen to diffuse across the pulmonary capillary bed.[5] Thus the pulmonary responses of physical activity and decreased Po_2 at high altitude seems to increase the risk of hypoxia for aircrew. We believe that there is still debate about what exactly the "hypoxia tolerance" is and what measure is important to deal with hypoxic conditions during flight. Concerning hypoxia tolerance, measuring the parameters like TUC (Time of Useful Consciousness), arterial oxygen saturation, blood partial pressure changes of oxygen and carbon dioxide, and oxygen consumption ($\dot{V}O_2$) have been proposed as indicators of hypoxia tolerance.[6] Also, the subjective symptoms of hypoxia and their appearances were considered as an indicator of hypoxia tolerance.[10] Further, the effects of hypoxia are exhibited differently in each individual and these differences are not only limited to symptoms, but also include the altitude at which an aviator becomes symptomatically hypoxic.[8] Cognitive and psychomotor impairment responses to hypoxia have become important issues in recent years.[4,5] Could measuring the impairment of these functions be an indicator of hypoxia tolerance?

In the discussion of this topic, the aviator was considered to become symptomatically hypoxic at an altitude less than 10,000 ft because of a combination of altitude and physiological changes from exercise by moving about the cabin. However, there are recent data indicating that improvement in cognitive function is attributable to exercise and hypoxia has no effects on cognitive function and moderate hypoxia and resultant biological processes did not provide sufficient stress to impair working memory and executive function during prolonged exercise.[1,3] It has been suggested that exercise facilitates implicit information by enhanced noradrenergic and dopaminergic systems and these physiological changes somehow modulate neural activity and lead to the improved cognitive functioning that occurs during exercise. However, it remains largely unknown as to how acute exercise improves cognitive function under hypoxia and whether physiological response to a lower partial pressure of oxygen appear to be different between normobaric and hypobaric hypoxia. Increased carbon dioxide production balanced by a hypoxia induced hyperventilation during exercise could be a factor.

Above 8000 ft there is an acute hypoxic ventilatory response (HRV) causing hypocapnia and a respiratory alkalosis. This affects cerebral oxygen delivery in terms of both blood oxygen content and cerebral blood flow. Hyperventilation-induced hypocapnia at ground level has been shown to impair motor performance, which in turn affects the ability to perform cognitive tasks despite preservation of intellectual performance. Symptoms of hypocapnia are similar to those of hypoxia.[5] The addition of CO_2 to inspired air was reported to improve performance during hypoxia by preventing PH-associated hypocapnia-induced vasoconstriction of brain blood vessels.[9] Physical activity during hypoxia per se may be a positive factor against cerebral vasoconstriction that induced by hyperventilation and carbon dioxide reduction.

We would ask that you further discuss the detrimental role of physical activity on hypoxia tolerance and the increased risk of hypoxia. Do you think that physical activity as reported is truly dangerous in hypoxic conditions for aircrew?

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[Ed Note: The author of "Hypoxia occurrence in a military aviator below 3048 m"[8] was contacted but declined to respond.]