Is an Intermittent Normobaric-Hypoxia Exposure Conditioning Program Useful for Improving Health and Performance at High Altitudes?

Background

Altitude acclimatization allows personnel to achieve maximum physical and cognitive performance and decrease their susceptibility to altitude illness during operations at high altitude. Prior studies support the efficacy of staging (1; 7) and intermittent altitude exposures (2; 3; 5) above 5,000 ft to induce effective altitude acclimatization for subsequent rapid ascent to altitudes up to ~14000 ft. However, many personnel residing below ~5,000 ft do not have access to high altitude regions where they can reside for several days or more to acquire altitude acclimatization. Alternatively, several hours exposure per day in unpressurized aircraft above 5,000 ft may induce beneficial acclimatization, but may not be feasible. A commercially-available simulation of altitude is provided by normobaric hypoxic devices. These devices use technology to separate the oxygen and nitrogen molecules in the air allowing the user to “dial down” the percentage of inhaled oxygen from the normal 21% to below 16%, simulating the hypoxia of high altitudes. Users can be exposed to the low oxygen gas breathing through a mask or inside a confined space, such as a small tent or sealed room during sleep or while exercising.

Myths and/or Claims

Manufacturers of normobaric hypoxic devices promote the use of intermittent normobaric hypoxic exposure (INHE) conditioning programs. They claim that individuals using their products will stimulate physiological adaptations that will increase physical performance capacity greater than achievable using a physical conditioning program alone while residing at low altitude. The manufacturers also claim that individuals can “pre-acclimatize” to high altitude prior to leaving a low altitude location. Promoters of these devices and INHE conditioning programs frequently cite the established benefits of the “live high, train low” conditioning programs developed and tested using actual high altitude exposure. Manufacturers also frequently cite “testimonials” from athletes, mountaineers, etc., that claim use of these devices improved their performance.

Facts

Manufacturer claims of the benefits derived from INHE conditioning programs are largely unfounded. Published peer-reviewed evaluations of the efficacy of INHE conditioning programs to decrease susceptibility to acute mountain sickness (AMS) and improve work performance during actual high altitude exposures report only small reductions in AMS, no improvement in work performance (4; 6; 12), and no improvement in sleep quality at high altitude (9). Recent results of two INHE studies by our Institute indicate only small reductions (~25%) in AMS during a subsequent rapid ascent to ~14,000 ft, and no improvement in physical work performance. One study evaluated a conditioning program consisting of daily INHE (2 hours at 14,800 ft resting, and 1 hour at 10,000 ft exercising) for 6-7 days (11). The other INHE program used an overnight sleep period exposure with simulated altitude increasing nightly from 7,000 to 10,000 ft over 7 nights. The sleep INHE treatment did improve sleep breathing during subsequent ascent to 14,000 ft, but did not reduce AMS during the first 24 hours at high

altitude (8). Published peer-reviewed reports indicate that daily 3-12 hour long INHE treatment sessions do induce some of the physiological adaptations characteristic of altitude acclimatization (10), but appear only to be expressed when measured under INHE conditions. However, the results of INHE studies when compared to those carried out under true altitude conditions suggest that decreasing the barometric pressure is an important, if not critical, component to inducing effective altitude acclimatization. No commercially available normobaric hypoxic system is capable of simulating the actual high altitude environment, i.e., low pressure and low oxygen.

Cautions

There are no reports of adverse effects of an INHE conditioning program in healthy, fit individuals. However, sudden exposure to severe hypoxia (less than 14.4%, or simulating an altitude above 10,000 ft) can cause dizziness, and/or syncope that could result in an injury. Exposure to severe hypoxia for more than 4-6 hours can cause development of acute mountain sickness in some individuals just starting an INHE conditioning program.

Summary

Compared to traditional approaches (staging and graded ascents) to induce altitude acclimatization (1; 7), INHE conditioning programs are not an effective approach to inducing functionally useful altitude acclimatization in personnel based at low altitudes. Actual exposure and residence at high altitudes (above 5,000 ft) is the most effective approach to inducing effective altitude acclimatization.

Recommendation

Personnel based at low altitude (below 5,000 ft) may obtain a modest reduction in their risk of developing acute mountain sickness by participating in an INHE conditioning program prior to ascending to high altitudes. Personnel should not expect an INHE conditioning program to produce any improvement in physical work performance at high altitude. Actual ascent and residence at high altitude (above 5,000 ft) is by far the most effective method for decreasing risk of altitude sickness and improving work performance at high altitudes. Likewise, daily ascents of a few hours duration to very high altitudes (~14,000 ft) are also effective at inducing altitude acclimatization.

Resources

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11. **Muza SR, Fulco CS, Beidleman BA, Jones JE and Cymerman A**. Evaluation of an intermittent normobaric hypoxic exposure program to reduce AMS at 4300 m. *High Alt Med Biol* in review: 2010.

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