APPROXIMATE SIMULATION OF ACUTE HYPOBARIC HYPOXIA WITH NORMOBARIC HYPOXIA

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INTRODUCTION. Some manufacturers of reduced oxygen (O₂) breathing devices claim a comparable hypobaric hypoxia (HH) training experience by providing FIO₂ < 0.209 at or near sea level pressure to match the ambient O₂ partial pressure (iso-pO₂) of the target altitude. METHODS. Literature from investigators and manufacturers indicate that these devices may not properly account for the 47 mmHg of water vapor partial pressure that reduces the inspired partial pressure of O₂ (PIO₂). Nor do they account for the complex reality of alveolar gas composition as defined by the Alveolar Gas Equation. In essence, by providing iso-pO₂ conditions for normobaric hypoxia (NH) as for HH exposures the devices ignore PAO₂ and PACO₂ as more direct agents to induce signs and symptoms of hypoxia during acute training exposures. RESULTS. There is not a sufficient integrated physiological understanding of the determinants of PAO₂ and PACO₂ under acute NH and HH given the same hypoxic pO₂ to claim a device that provides isohypoxia. Isohypoxia is defined as the same distribution of hypoxia signs and symptoms under any circumstances of equivalent hypoxic dose, and hypoxic pO₂ is an incomplete hypoxic dose. Some devices that claim an equivalent HH experience under NH conditions significantly overestimate the HH condition, especially when simulating altitudes above 10,000 feet (3,048 m). CONCLUSIONS. At best, the claim should be that the devices provide an approximate HH experience since they only duplicate the ambient pO₂ at sea level as at altitude (iso-pO₂ machines). An approach to reduce the overestimation is to at least provide machines that create the same PIO₂ (iso-PIO₂ machines) conditions at sea level as at the target altitude, a simple software upgrade.

Learning Objectives:

1. Applying basic principles of respiratory physiology to the design of reduced oxygen breathing devices.
2. Working toward a better understanding of hypoxia.
Reduced O2 breathing devices create a normobaric hypoxic (NH) exposure by providing an FIO2 < 0.209, breathed either through a mask or within a "hyperbaric tent". Some manufacturers claim an equivalent acute hypobaric hypoxic (HH) experience but under NH conditions. This eliminates the need for an expensive hyperbaric chamber and the risk of decompression sickness associated with hypobaric exposures, creating cost-effective hypobaric training techniques.

METHODS

The devices seem to duplicate the ambient partial pressure of O2 (PbO2) at sea level as exists at the target altitude, a feature that provides isohypoxia. This is defined as the same distribution of hypo and signs and symptoms under any circumstances of equivalent hypoxic dose, and hypoxic device, as an isomorphic hypoxic device. Some devices that claim an equivalent HH experience under NH conditions significantly overestimate the HH condition, especially when simulating altitudes above 10,000 feet (3,048 m).

CONCLUSIONS

At best, the claim should be that the devices provide an iso-pO2 (iso-PIO2) machine that creates the same PIO2 (iso-PIO2) conditions at sea level as at the target altitude, a simple software upgrade.

Reduced O2 breathing devices create a normobaric hypoxic (NH) exposure by providing an FIO2 < 0.209, breathed either through a mask or within a "hyperbaric tent". Some manufacturers claim an equivalent acute hypobaric hypoxic (HH) experience but under NH conditions. This eliminates the need for an expensive hyperbaric chamber and the risk of decompression sickness associated with hypobaric exposures, creating cost-effective hypobaric training techniques.

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