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 F₁O₂ < 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.
INTRODUCTION

Some manufacturers of reduced oxygen (O2) breathing devices claim a comparable hypoxic hypoxia (HH) training experience by providing FIO2 < 0.209 at or near sea level pressure to match the ambient partial pressure of O2 at 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, which reduces the inspired partial pressure of O2 (PFI2). For no 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) for as HH, the devices ignore PFI2 and PCO2 as more direct agents to reduce signs and symptoms of hypoxia during acute training exposures. RESULTS: There is not a sufficient integrated physiological understanding of the determinants of PFI2 and PCO2 under acute NH and HH given the same hypoxic hypoxia (HH) exposure. Isohypoxia is defined as the same distribution of hypoxia signs and symptoms under any circumstances of equivalent hypoxic hypoxia, and hypoxic hypoxia (HH) as an isomorphic hypoxia experience. Some devices claim an equivalent hypoxia 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 PO2 (iso-PiO2) machines) conditions at sea level as at the target altitude, a simple software upgrade.

METHODS

Reduced O2 breathing devices create a normoxic NH (N2) exposure by providing an FIO2 < 0.209, breathed either through a mask or within a “hypo-tent”. Some manufacturers claim an equivalent acute hypoxic hypoxia (HH) experience but under NH conditions. This eliminates the need for an expensive hypobaric chamber and the risk of decompression sickness associated with hypobaric exposure, creating a cost-effective hypoxia training niche.

RESULTS

The form in the upper curve in Fig. 2 is that when you provide a FIO2 at sea level to match the PFI2 at the target altitude you create a PFI2 at sea level that is greater than the target PFI2, a consequence of ignoring pO2. It is best to provide a FIO2 at sea level defined by the lower curve in Fig. 3 that at least produces the equivalent PFI2 at sea level as at the target altitude. ACCURATE SIMULATION OF ACUTE HYPOBARIC HYPOXIA WITH NORMOBARIC HYPOXIA

REFERENCES