APPROXIMATE SIMULATION OF ACUTE HYPOBARIC HYPOXIA WITH NORMOBARIC HYPOXIA

J. Conkin¹, J.H. Wessel, III². Universities Space Research Association¹, 3600 Bay Area Boulevard, Houston, TX 77058-3696, Wyle Integrated Science and Engineering Group², 1290 Hercules Drive, Suite 120, Houston, TX 77058-2769.

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.
**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 to match the ambient 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 respiratory quotient (RQ) and depth of breathing in NH relative to HH. In the above example it follows from Loeppky and our example in Fig. 4 that physiological responses to acute NH or HH training are largely independent of the RQ of the inspired air.

**METHODS**

The device is calibrated to achieve iso-PIO₂ conditions at sea level as at the target altitude. A consequence of not correctly accounting for the PAO₂ and PACO₂ should be considered in a calculation over time.

**RESULTS**

An accurate application of the Alveolar Gas Equation requires that the inspired air contains N₂ as a result of modified PIO₂ and PACO₂ under a particular hypoxic condition.

**CONCLUSIONS**

The hypothesis that the inspired O₂ concentration was less than sea level NH is the same as hypoxic altitude. 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).

**References**