

Innovation in Pulmonary Rehabilitation: Experimenting With a Hybrid

Why does a study about the use of noninvasive ventilation (NIV) and helium-oxygen mixtures in pulmonary rehabilitation call to mind a movie about World War II? Released in 1949, *Twelve O'Clock High* was based on a fictionalized version of the experiences of a writer who had served under Brigadier General Frank Savage, the officer responsible for implementing the use of precision daylight bombing of German industry. In addition to being hailed as a realistic portrayal of the stresses faced by American pilots and crews, this movie has been used to teach business people how to survive management crises.

Toward the end of the movie, when the bombardier crews needed supplemental oxygen, the men donned leather masks that dropped from above. Those masks looked like early incarnations of nonbreathing masks, but actually may have been pressure demand oxygen masks with a valve to regulate the flow of oxygen.¹ These devices and others that V Ray Bennett and Forrest Bird designed for the military evolved into the intermittent positive-pressure breathing units that respiratory therapists used to treat patients with asthma, chronic obstructive pulmonary disease (COPD), congestive heart failure, pneumonia, and other pulmonary disorders.²⁻⁴

In the 1930s researchers conducted the first experiments in the use of positive end-expiratory pressure (PEEP) to treat patients with pulmonary edema.⁵ Approximately 30 years later, early clinical applications of PEEP involved submerging the distal limb of the expiratory circuit under water. Soon, ventilator manufacturers designed valves to provide end-expiratory pressure with volume ventilators. In 1971, Petty and Ashbaugh reported on the use of PEEP to treat patients with the acute respiratory distress syndrome.⁶ And since then the use of PEEP has become widespread among patients being ventilated through artificial airways.

But the original generation of intermittent positive-pressure breathing devices could not be used in conjunction with PEEP. The creation of bi-level ventilators enabled clinicians to use NIV with end-expiratory pressure for patients with neuromuscular diseases, obstructive sleep apnea, and chronic respiratory diseases.^{7,8} By the late 1980s, clinicians were using NIV to treat acute respiratory failure, and it is now a standard of care in many emergency departments and critical care units for patients with cardio-

genic congestive heart failure and COPD exacerbation. Recently the American College of Chest Physicians and the American Association of Cardiovascular and Pulmonary Rehabilitation recommended the use of NIV during pulmonary rehabilitation.⁹

Starting in the 1970s, studies on the use of helium-oxygen mixtures were conducted on 2 different groups: animals in the laboratory, and deep-sea divers. By 1979 the effect of helium and oxygen on reducing P_{CO_2} levels in patients with COPD had been documented.¹⁰ In 1986 one study showed a diminution in P_{CO_2} levels in healthy subjects using a helium-oxygen mixture while exercising and at rest.¹¹ During the 1980s studies showed the positive effects of the use of helium-oxygen mixtures on pre-term infants with bronchopulmonary dysplasia,¹² a patient with upper-airway obstruction,¹³ pediatric patients with post-extubation stridor,¹⁴⁻¹⁶ and patients in status asthmaticus.¹⁷ Thus, despite the technical challenges and cost issues associated with the use of helium-oxygen mixtures, its effectiveness has been documented in treating patients with asthma, bronchiolitis, bronchopulmonary dysplasia, COPD patients receiving mechanical ventilation, asthmatics, and COPD patients during exercise.¹⁸ Earlier this year, investigators reported the successful use of a normoxic helium-oxygen mixture in delivering oxygen to exercising patients with COPD.¹⁹

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In the paper by Allan and coauthors, the authors describe the results of an innovative exercise regimen for COPD patients being treated in a military hospital.²⁰ In a novel approach designed to enhance exercise capacity, the participants in this study performed constant-work cardiopulmonary exercise tests using 4 combinations of gas mixtures and NIV/placebo: compressed air with sham NIV (placebo); compressed air with NIV; 60% helium/40% oxygen with sham NIV; and 60% helium/40% oxygen with NIV. It should be noted that the NIV device used in this study provided pressure support, but not PEEP. The authors found that the hybrid created by combining helium-oxygen therapy with NIV was safe, tolerable, and feasible. However, the efficacy of this regimen was inconsistent,

and the authors justifiably conclude that larger studies need to be conducted.

This paper leaves researchers and clinicians working in pulmonary rehabilitation with some choices. Researchers may want to study what subgroups of COPD patients could benefit most from the use of NIV or helium-oxygen mixtures alone and in combination; for example, studies in which patients are stratified by the degree of obstruction might help determine the individual and collective benefits derived from these therapies. Perhaps PEEP will be available on future devices that combine NIV with the use of helium-oxygen mixtures; if this innovation becomes reality, researchers will be able to study the combined effects of pressure support, end-expiratory pressure, and helium-oxygen mixtures in pulmonary rehabilitation. This study did not include COPD patients who were oxygen-dependent at rest or with exertion; future studies could address this patient population.

Clinicians working in pulmonary rehabilitation programs may consider following the American College of Chest Physicians/American Association of Cardiovascular and Pulmonary Rehabilitation recommendation to see whether their patients' exercise tolerance improves by adding NIV.

Whether the use of NIV with helium-oxygen mixtures becomes widespread in pulmonary rehabilitation or to treat a specific patient population remains to be seen. But when researchers combine 2 effective treatments into a single regimen, they contribute to a process that will develop another generation of hybrids.

And studies like this are a signal for clinicians to try out treatments that once were innovative and have been proved safe and effective.

Philip E Alkana MA RRT

Pulmonary, Critical Care, and Allergy Division
 Boston Medical Center
 Boston, Massachusetts

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Correspondence: Philip E Alkana MA RRT, Pulmonary, Critical Care, and Allergy Division, Boston Medical Center, 88 East Newton Street, Boston MA 02118-2393. E-mail: phalkana@bmc.org.