

PRAXAIR HEALTHCARE SERVICES INFORMATION SHEET

HELIOX

Heliox is a prepackaged blend of helium USP and medical oxygen USP. Conventionally, heliox has been supplied with helium at 70% or 80%, balanced with oxygen. Substituting helium for nitrogen in a gas mixture changes the physical properties of the inhaled gas decreasing density and increasing the propensity for laminar air flow in patients' airways. The medical use of heliox as a breathable gas for respiratory disease was first introduced in 1934 by Barach¹. Since then, heliox has been studied in a variety of upper and lower airway conditions.

Reference

1. Barach, AL., Use of helium as a new therapeutic gas. Proc Soc Exp Biol Med 1934; 32: 462-464

Information on heliox is available from events sponsored by the American Association of Respiratory Care (AARC).

- 2004 professor's round by Michael Gentile, RRT "Helium and Nitric Oxide – Getting the most of Alternative Gas Therapies".
- Webcast on January 26, 2005 by Dean Hess PhD RRT "Heliox Therapy". This webcast is available on the AARC's online continuing education system—until Dec 31, 2005.
- **AARC's 51st Annual Congress** Saturday, December 3, 2005 (1:00 pm to 4:50 pm) San Antonio Convention Center (Ballroom C), TX. A symposium on Heliox Therapy: Practice, Evidence, Risk and Opportunities. Please check AARC program for details.

For further information, please visit our web site:
<http://www.praxair.com/heliox>

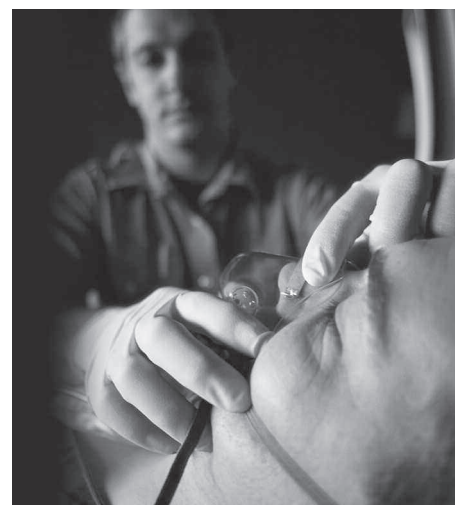
ABSTRACTS FROM HELDX PUBLICATIONS

Information on heliox is available in scientific and medical literature, such as the following articles:

Helium/Oxygen-Driven Albuterol Nebulization in the Treatment of Children With Moderate to Severe Asthma Exacerbations: A Randomized, Controlled Trial

In K. Kim, MD; Erin Phrampus, MD, MPH; Shekhar Venkataraman, MD; Raymond Pitetti, MD, MPH; Al Saville, RRT; Timothy Corcoran, PhD; Ed Gracely, PhD; Nicole Funt, MPAS, PA-C; and Ann Thompson, MD
(*Pediatrics* 2005;116:1127-1133)

Background: Helium and oxygen mixtures (heliox) increase both pulmonary aerosol delivery and gas delivery relative to oxygen. We aimed to compare the effectiveness of a 70%:30% helium/oxygen (heliox) driven continuous aerosol delivery versus



100% oxygen driven delivery in the treatment of asthmatic children with moderate to severe exacerbations.

Methods: We enrolled 30 children aged 2 to 19 years who presented to an urban, pediatric emergency department (ED) with moderate to severe asthma as defined by a pulmonary index (PI) score of greater or equal to 8. PI scores can range from 0 to 15. In this randomized, controlled, single-blind trial conducted in a convenience

sample of children, all patients in the trial received an initial nebulized albuterol (5 mg) treatment driven by 100% oxygen and a dose of oral prednisone or prednisolone. Subsequently, patients were randomly assigned to receive continuously nebulized albuterol (15 mg/hour) delivered by either heliox or oxygen using a nonbreathing face mask. The primary outcome measure was degree of improvement as assessed in blinded video-recorded PI scores over 240 minutes (at 30-minute intervals for the first 3 hours) or until ED discharge (if <240 minutes).

Results: The mean change in PI score from baseline to 240 minutes or ED discharge was 6.67 for the heliox group compared with 3.33 for the oxygen group. Eleven (73%) patients in the heliox group were discharged from the hospital in <12 hours, compared with 5 (33%) patients in the conventional group.

Conclusion: Continuously nebulized albuterol delivered by heliox was associated with a greater degree of clinical improvement compared with that delivered by oxygen among children with moderate to severe asthma exacerbations.

Heliox Administration in the Pediatric Intensive Care Unit: An Evidence-Based Review

Vineet K. Gupta, MD; Ira M. Cheifetz, MD, FCCM (Pediatr Crit Care Med 2005; 6:204-211)

Objective: To provide a comprehensive, evidence-based review of helium-oxygen gas mixtures (heliox) in the management of pediatric respiratory diseases.

Data Source: A thorough, computerized bibliographic search of the preclinical and clinical literature regarding the properties of helium and its application in pediatric respiratory disease states.

Data Synthesis: After an overview of the potential benefits and technical aspects of helium-oxygen gas mixtures, the role of heliox is addressed for asthma, aerosolized medication delivery, upper airway obstruction, postextubation stridor, croup, bronchiolitis, and high-frequency ventilation. The available data are objectively classified based on the value of the therapy or intervention as determined by the study design from which the data are obtained.

Conclusions: Heliox administration is most effective during conditions involving density-dependent increases in airway resistance, especially when used

early in an acute disease process. Any beneficial effect of heliox shall become evident in a relatively short period of time. The medical literature supports the use of heliox to relieve respiratory distress, decrease the work of breathing, and improve gas exchange. No adverse effects of heliox have been reported. However, heliox must be administered with vigilance and continuous monitoring to avoid technical complications.

Helium-oxygen Reduces Work of Breathing in Mechanically Ventilated Patients with Chronic Obstructive Pulmonary Disease

Marc Gannier, Jean-Michael Arnal, Patrick Gerbeaux, Stephane Donati, Laurent Papazian, Jean-Marie Sainty (Intensive Care Med 2003 29:1666-1670)

Objective: To evaluate whether helium-oxygen mixture reduces inspiratory work of breathing (WOB) in sedated, paralyzed, and mechanically ventilated patients with acute exacerbation of chronic obstructive pulmonary disease (COPD).

Design and setting: Open prospective, randomized, crossover study in the medical intensive care unit in a university hospital.

Patients and participants: 23 patients admitted for acute exacerbation of COPD and mechanically ventilated.

Measurements: Total WOB (WOB_t), elastic WOB (WOB_{el}), resistive WOB (WOB_{res}), and WOB due to PEEP_i (WOB_{Peepi}) were measured. Static intrinsic positive and expiratory pressure (PEEP_i) static compliance (C_{rs}), inspiratory resistance (R_{ins}), inspiratory (*t*_{insp}), and expiratory time constant (*t*_{exp}) were also measured. These variables were compared between air-oxygen and helium-oxygen mixtures.

Results: WOB_t significantly decreased with helium-oxygen (2.34±1.04 to 1.85±1.01 J/L, p<0.001). This reduction was significant for WOB_{el} (1.02±0.61 J/L to 0.87±0.47, p<0.01) WOB_{Peepi} (0.77±0.38 J/L to 0.54±0.38, p<0.001), and WOB_{res} (0.55±0.19 J/L to 0.44±0.24, p<0.05). PEEP_i, R_{ins}, *t*_{insp} and *t*_{exp} significantly decreased. C_{rs} was unchanged.

Conclusions: Helium-oxygen mixture decreases WOB in mechanically ventilated COPD patients.

Helium-oxygen mixture could be useful to reduce the burden of ventilation.

The Utility of Albuterol Nebulized with Heliox During Acute Asthma Exacerbations

John P. Kress, Imre Noth, Brian K. Gehlbach, Nitin Barman, Anne S. Pohlman, Annette Miller, Sherwin Morgan, and Jesse B. Hall

(Am J Respir Crit Care Med Vol. 165 pp 1317-1321, 2002)

Heliox improves lung deposition of inhaled particles when compared with air or oxygen inhalation. We studied the spirometric effects of albuterol nebulized with heliox during emergency room visits for asthma exacerbations. Forty-five patients were randomized to receive albuterol nebulized with oxygen (control) versus heliox (n = 22 control and 23 heliox subjects). At baseline, demographics, outpatient asthma medications, vital signs, oxygen saturation, and forced expiratory volume in one second were not different between the two groups. Three consecutive albuterol treatments were given to each group. The heliox group had a significantly higher heart rate after albuterol nebulization compared with the control group. Following albuterol Treatment 1, the median change in forced expiratory volume in one second was 14.6% in the control group and 32.4% in the heliox group (p = 0.007). After Treatment 2, the results were 22.7% versus 51.5%, respectively (p = 0.007). After Treatment 3, the results were 26.6% versus 65.1%, respectively) p = 0.016). We conclude that during acute asthma exacerbations, albuterol nebulized

with heliox leads to a more significant improvement in spirometry when compared with albuterol nebulized with oxygen. This is likely due to the low-density gas improving albuterol deposition in the distal airways.

Heliox Therapy in Infants with Acute Bronchiolitis

Federico Martín-Torres, MD, PhD; Antonio Rodríguez-Núñez, MD, PhD; and Jose María Martín-Sánchez, MD, PhD
Pediatrics 2002;109:68-73

Objective: To assess the therapeutic effects of breathing a low-density gas mixture (heliox: 70% helium and 30% oxygen) in infants with bronchiolitis.

Design: Prospective, interventional, comparative study.

Setting: A pediatric intensive care unit (PICU) in a tertiary care, teaching hospital.

Patients: Thirty-eight infants, 1 month to 2 years old, consecutively admitted to the PICU for treatment of moderate-to-severe acute respiratory syncytial virus bronchiolitis.

Interventions: The first 19 patients were enrolled as the control group, and received supportive care and nebulized epinephrine. In the next 19 patients, heliox therapy was added through a nonrebreather reservoir face mask.

Measurements and Outcomes: Respiratory distress score, respiratory rate, heart rate, end-tidal CO₂ (etCO₂), and pulse oximetry oxygen saturation (satO₂) values were recorded at baseline and at regular intervals. Data obtained during the first 4 hours were analyzed for comparison purposes.

Demographic data, age, time elapsed from the start of the symptoms to the admission to PICU, length of stay in PICU (PICU-LOS), and duration of heliox therapy were also collected for each patient. Reductions in clinical scores and PICU-LOS were considered primary outcomes.

Main Results: At baseline, the heliox and control groups had similar age (5.5 ± 3.1 vs 5.9 ± 3 months), previous length of course (47.3 ± 19.3 vs 45.4 ± 18.6 hours), clinical score (6.7 ± 1.1 vs 6.6 ± 1) heart rate (160 ± 24 vs 165 ± 20 beats per minute), respiratory rate (64 ± 7 vs 61 ± 7 respirations per minute), satO₂ (91 ± 2.3 vs 91 ± 2.5%), and etCO₂ (34 ± 7 vs 33 ± 6 mm Hg). Clinical score, heart rate, respiratory rate, and satO₂ improved during the study in both groups. After 1 hour, the improvement in clinical score was significantly higher in the heliox group than in the control group (3.6 ± 1.16 vs 5.5 ± 0.89), and these differences continued to be significant at the end of the observation period (2.39 ± 0.69 and 4.07 ± 0.96, respectively), with a total average decrease in the score of 4.2 points in the heliox group versus 2.5 points in the control group. Heart and respiratory rates were also significantly lower in the heliox group compared with the control group after 1 hour and stayed lower throughout the rest of the study period. No changes were noted either in satO₂ between groups or in etCO₂ within or between groups throughout the study. Mean duration of heliox administration was 53 ± 24 hours (range: 24-112 hours) and no adverse effects were detected.

PICU-LOS was significantly shorter in the heliox group (3.5 ± 1.1 days) than in the control group (5.4 ± 1.6 days).

Conclusions: In infants with moderate-to-severe respiratory syncytial virus bronchiolitis, heliox therapy enhanced their clinical respiratory status, according to the marked improvement in their clinical scores and the reduction of the accompanying tachycardia and tachypnea. This beneficial response occurred within the first hour of its administration and was maintained as long as heliox therapy continued. In addition, PICU-LOS was reduced in heliox-treated patients. Long-term prospective studies are required to corroborate these findings and to establish the proper place of heliox in the therapeutic schedule of bronchiolitis.

Inhaled Helium-Oxygen Revisited: Effect of Inhaled Helium-Oxygen During the Treatment of Status Asthmaticus in Children

Theresa M. Kudukis, MD, Constantine A. Manthous, MD, Gregory A. Schmidt, MD, Jesse B. Hall, MD and Mark E. Wylam, MD
(J Pediatr 1997; 130:217-224)

Objectives: To assess the effects of breathing a low-density gas mixture on dyspnea and the pulsus paradoxus in children with status asthmaticus.

Design: In an urban academic tertiary referral center, 18 patients, aged 16 months to 16 years, who were being treated for status asthmaticus with continuously inhaled beta-agonist and intravenously administered methylprednisolone and had a pulsus paradoxus of greater than 15 mm Hg received either an 80%:20% helium-oxygen gas mixture (heliox patients) or room air (control patients) at 10 L/min by nonbreathing face mask in a double-blind,

randomized, controlled trial. In all patients, baseline data, including pulsus paradoxus (determined by sphygmomanometer or arterial catheter blood pressure readings), respiratory rate, heart rate, investigator-scored dyspnea index, and oxygen saturation, were compared with values obtained 15 minutes during and after intervention. In a subset of patients, peak flows before and after breathing heliox or room air were measured. When clinically indicated, arterial blood gases were obtained.

Results: The pulsus paradoxus (in millimeters of mercury) fell significantly from an initial mean value of 23.3 ± 6.8 to 10.6 ± 2.8 with heliox breathing ($p < 0.001$) and increased again to 18.5 ± 7.3 after cessation of heliox. Peak flow increased $69.4\% \pm 12.8\%$ during heliox breathing ($p < 0.05$). The dyspnea Index decreased from an initial mean value of 5.7 ± 1.3 to 1.9 ± 1.7 with heliox breathing ($p < 0.0002$) and increased again to 4.0 ± 0.5 after cessation of heliox breathing. In control patients, there was no significant difference in pulsus paradoxus or dyspnea index at any time during the study period. Mechanical ventilation was averted in three patients in whom dyspnea lessened dramatically during breathing of heliox.

Conclusion: During acute status asthmaticus, inhaled heliox significantly lowered the pulsus paradoxus, increased peak flow, and lessened the dyspnea index. Moreover, heliox spared three patients a planned intubation and caused no apparent side effects. Thus heliox reduces the work of breathing and may forestall respiratory failure in children with status asthmaticus, thus preventing the need for mechanical ventilation.