HELIUM-OXYGEN INHALATION

A RECENT ADVANCE IN THE TREATMENT OF LARYNGITIS AND TRACHEITIS

BY

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In 1934, Dr. Alvan Barach, of the Department of Medicine, Columbia University, New York, published the first paper on the therapeutic use of helium and oxygen mixtures. His work has created great interest because, as stated by DuBois, it marks the introduction of a new principle in therapeutics.

Helium is a non-combustible, odourless, monatomic inert gas with a molecular weight of 4 and therefore a specific gravity only one-seventh that of nitrogen and one-eighth that of oxygen. Its value in medicine depends entirely on its physical properties of low specific gravity and rapid rate of diffusion. A mixture of 79 per cent. helium and 21 per cent. oxygen is about one-third as heavy as air, and as 100 per cent. oxygen which is slightly heavier than air. Barach reasoned that the force required to move a column of gas to and from the lungs is proportional to the molecular weight of the gas, other things being constant. A vast amount of experimental work has been done on dogs and on human subjects. His results show that when helium-oxygen is used there is a decrease of 25 to 54 per cent. in inspiratory and expiratory pressure, a decrease in total pulmonary ventilation, and a comparable reduction in respiratory effort.

The biologic inertness of helium is proved by the fact that mice have lived three months in helium-oxygen atmospheres without apparent injury. Extensive studies of the effects of helium upon the human body have been carried out by the United States Navy with regard to its use in 'divers' disease.' No ill effects have been observed in patients.

The pathology of unrelieved respiratory obstruction in the large or small air passages is development of congestion and oedema in the lungs. Moore and Binger (1927) found that these changes take place in dogs subjected to inspiratory obstruction alone, but do not occur when the animals expire against obstruction. Barach and Kernan (1937) also find that pathological changes in the lungs are minimal during expiration against resistance, whereas severe pulmonary congestion and oedema at the hilar and basal regions of the lungs, with emphysema at the periphery, occur during inspiration against obstruction. They find that the great negative pressure induced in the chest during forced inspiration is the causative factor. The influence of the pathologically elevated intrapleural pressure, which Barach finds may be up to seven times the normal in dogs and in asthmatics, is primarily to exert suction on the pulmonary capillaries with exudation of serum, and later to cause congestion, oedema,

dilatation of the right heart and circulatory failure. When helium-oxygen is administered, particularly under slightly positive pressure, the negative intrapulmonary pressure is reduced one-quarter to one-half and exudation is stopped.

In clinical studies Barach finds that the use of helium-oxygen mixtures in obstructive conditions of the larynx, trachea and bronchi can compensate for a 50 per cent. obstruction in the lumen, and in some cases can obviate the need of tracheotomy. It also relieves dyspnoea in cases of obstruction below the level where tracheotomy would be helpful.

In one series, twenty-one cases have been studied at the Babies Hospital, New York. Specific diagnoses are not given, but all cases showed intercostal and substernal or suprasternal retraction. Of the twenty-one cases, five were excluded because they were moribund or helium had to be withdrawn prematurely. Sixteen cases remained for clinical judgment; of these three had a degree of obstruction too great for helium to relieve. In eight cases helium-oxygen was temporarily helpful for periods up to eight days, after which tracheotomy was done, either because the expected duration of obstruction made helium-oxygen therapy too expensive or because the obstruction progressed to an unrelievable degree. Of these eight cases, four lived and four died. In none of the cases was there any reason to believe that earlier tracheotomy would have helped, while the reverse is conceivably true. In every instance the patient was in better condition to withstand operative procedure. Five cases were relieved and recovered without tracheotomy.

Another series of twenty-one cases was published a year later by Barach and Kernan (1937). Case summaries are given.

Fifteen of these patients were in the paediatric age group and ten were under two years of age. Of the ten patients under two, six lived and four died. Of the six who recovered, three eventually required tracheotomy, for one of the reasons given above, but recovered uneventfully. A fourth patient was a year-old infant who had laryngotracheitis with cultures showing pneumococci, haemolytic staphylococci and haemolytic streptococci. This patient was discharged cured in five days. A fifth had a laryngitis with oedema which was treated for two days with helium-oxygen and was discharged cured on the sixth hospital day. The otolaryngologist felt that in this instance tracheotomy would have been inevitable without the aid of helium. Of the four deaths, two were due to broncho-pneumonia, six and three days after tracheotomy respectively. The third was a two-and-a-half months old premature infant who died of broncho-pneumonia, and the fourth infant died of haemolytic streptococcal sepsis and pneumonia. It is to be noted that both of these series were reported before the use of sulphanilamide, or sulphapyridine, became common. The authors feel that mortality might have been reduced further by the use of helium under slightly positive pressure.

In every instance, regardless of the final outcome, dyspnoea was markedly relieved and the general condition of the patient improved. The most favourable field is for inflammatory swelling of the air passages due to infection or mechanical irritation and instrumentation. The patient can frequently be tidied over with helium and oxygen until the infection subsides without surgical intervention. The only quick relief for obstructive dyspnoea that compares in

efficiency with helium-oxygen is the passage of the bronchoscope as a preliminary to tracheotomy, and even this may result in sudden death.

To date, helium-oxygen inhalation has been used most extensively in the treatment of intractable asthma with results which are not obtainable by any other existing method of therapy. Patients apparently moribund in status asthmaticus, who were refractory to epinephrine, regained epinephrine-sensitivity in periods of helium-oxygen inhalation varying from one hour to five days. It is of proven value, experimentally and clinically, in emphysema, bronchiectasis and pulmonary fibrosis. Other conditions in which benefit has been reported are cardiac dyspnoea, post-operative atelectasis, unresolved pneumonia, laryngeal oedema following surgical procedures on the larynx and thyroid, and oedema following x-ray therapy. Its use in cases with marked respiratory depression and oncoming paralysis from high spinal anaesthesia suggests a possible use in poliomyelitis.

Details of the method of administration are given in Barach's original publication. The gas must be given in an absolutely air-tight system. Any small leak allows nitrogen to enter and nullify the effect. The ordinary oxygen tent is not helium-proof. The best apparatus for patients of all ages appears to be the Benedict helmet type of hood. For older children, oronasal masks may be used. Tanks with helium and oxygen pre-mixed are used, and extra oxygen may be added when needed from a separate tank. The danger of using tanks of pure helium is that the oxygen may be forgotten and asphyxiation occur suddenly. Because of the expense, the helium is usually rebreathed.

The inhalation may be given in periods of fifteen minutes to one hour or longer, repeated three to six times a day. Adults have inhaled helium-oxygen mixtures almost continuously for many hours without ill effect.

In conclusion, it has not been suggested that helium-oxygen inhalation replaces chemotherapy and surgical procedures in the treatment of laryngitis and tracheitis, but only that it be used as a valuable adjunct to the therapy of what has thus far proved a discouraging disease.

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