BREATHING A HELIUM-OXYGEN MIXTURE WHEN PULMONARY GASEOUS EXCHANGE IS IMPAIRED

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A great deal of work has been done to determine the usefulness of breathing a mixture of helium and oxygen in bronchial asthma, pulmonary emphysema, bronchitis, tracheitis, and pulmonary tuberculosis [2-8].

It has been shown that a favorable effect is obtained.

The result is explained as being due to the fact that the density of the mixture is very much less than that of atmospheric air or pure oxygen, so that less effort is required to overcome the resistance of the current of air at inspiration and expiration.

In our laboratory [1] it was shown long ago in human subjects performing muscular work that when additional respiratory resistance had been artificially introduced, respiratory efficiency was markedly reduced, with the result that there was a reduction in the oxygen saturation of arterial blood.

This led us to use a mixture of helium and oxygen under these conditions.

METHOD

The experiments were carried out on 8 women and 3 men aged from 25 to 30 years.

The subjects breathed a gaseous mixture consisting of 20 % oxygen and 80 % helium, and extra resistance was introduced both while they were at rest or performing muscular work.

The additional resistance was introduced by using water valves, and a water column height of 100 mm. The resistance was effective both at inspiration and expiration. Records were made of pulmonary ventilation, arterial blood oxygen saturation, and intrapulmonary pressure at both inhalation and exhalation (using a water manometer).

At rest, breathing through the added resistance was continued for 12-16 min, and when working, for 16 min.

Both at rest and when working, every four minutes, the helium-oxygen mixture was replaced by atmospheric air.

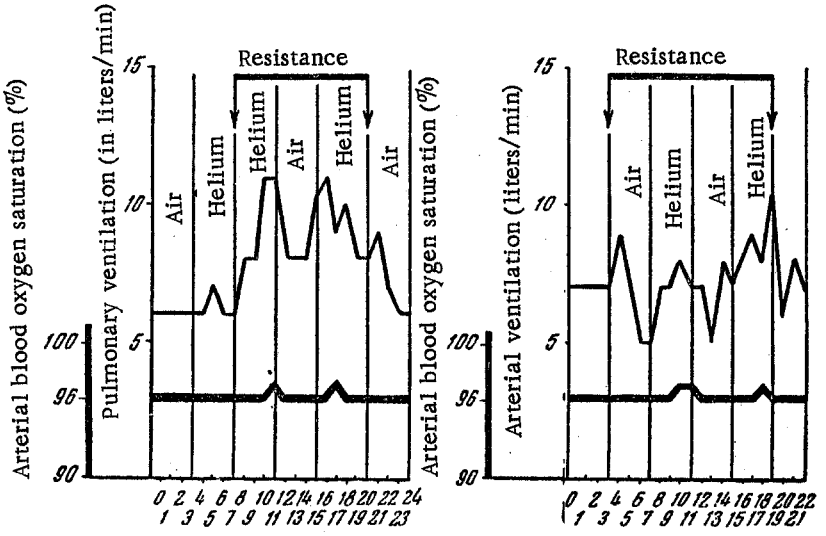

Fig. 1. Change in pulmonary ventilation and arterial blood oxygen saturation when breathing a helium-oxygen mixture through an increased resistance at rest.

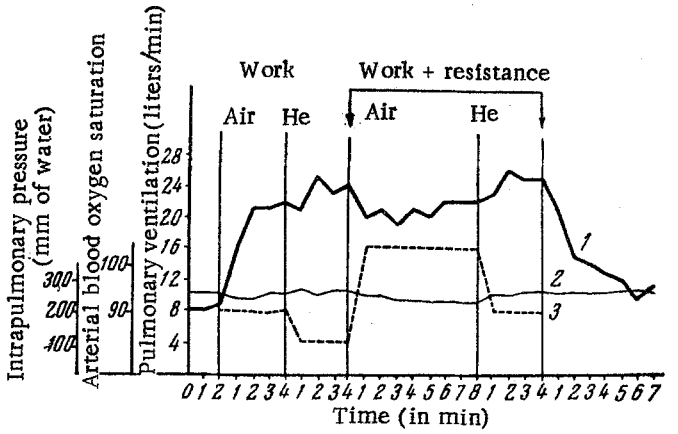

Fig. 2. Change in pulmonary ventilation (1) and arterial blood oxygen saturation (2) on breathing a helium-oxygen mixture during muscular work with and without an added respiratory resistance.

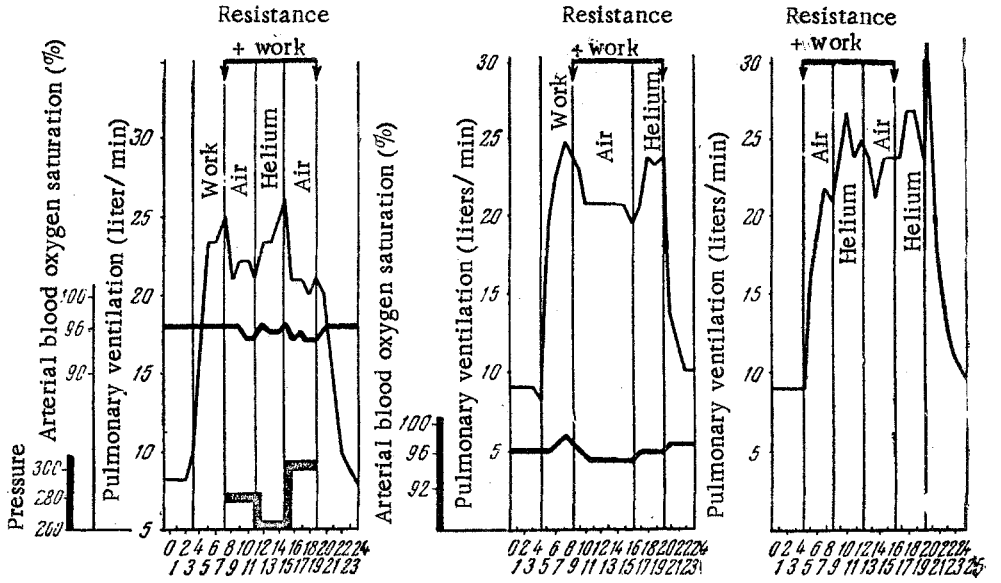

Fig. 3. Change in pulmonary ventilation and arterial blood oxygen saturation when breathing a helium-oxygen mixture during work with added respiratory resistance.

It was found that at rest, and when breathing normally, the mixture caused no noticeable respiratory changes.

When breathing against a resistance, both when inhaling and exhaling, the effectiveness of the breathing was found to depend to a great extent on whether the subject was breathing atmospheric air or the helium - oxygen mixture. When breathing the mixture, ventilation increased by 1-4 liters/min, it caused some increase in the oxygen saturation of the blood, and intrapulmonary pressure was reduced to a value below that obtaining when atmospheric air was breathed (Fig. 1).

Similar changes in respiratory movements were observed when the subject breathed the helium-oxygen mixture while performing work on a bicycle ergometer. The pulmonary ventilation was then 3-5 liters/min greater than when the same work was performed while atmospheric air was breathed, while, on the other hand, the pulmonary pressure was reduced by 20-30 mm of water.

Breathing the helium and oxygen mixture proved particularly effective when performing work and breathing through an added resistance. Usually, pulmonary ventilation was reduced when air was breathed, but under these conditions it began to increase as soon as the helium-oxygen mixture was given. The ventilation increased by 3-6 liters/min. At the same time there was an increased arterial blood oxygen saturation and a reduced intrapulmonary pressure (Fig. 2 and 3).

The results showed, therefore, that when breathing was made more difficult by adding the extra resistance,

the helium-oxygen mixture facilitated respiration by virtue of its physical properties.

This result apparently explains the useful effect obtained by giving a helium-oxygen mixture in diseases of the respiratory system, when breathing is impaired as a result of the pathological changes.

SUMMARY

Inhalation of a mixture containing 80 % helium and 20 % oxygen when respiratory resistance was artificially increased caused the following changes: pulmonary ventilation increased, there was a greater arterial blood oxygen saturation, and intrapulmonary pressure was reduced. The respiratory changes were more pronounced during exercise than at rest.

LITERATURE CITED

1. A. M. Kulik, The Physiology and Pathology of Respiration, Hypoxia, and Oxygen Therapy [in Russian] (Kiev, 1958) p. 211.
2. A. L. Barach, Proc. Soc. Exper. Biol. and Med. 32, 462 (1934).
3. A. L. Barach, J. A. M. A. 107, 1273 (1936).
4. D. Bates and R. Christie, Clin. Sci. 9, 17 (1950).
5. W. A. Briscoe, Clin. Sci. 10, 37 (1951).
6. W. A. Briscoe, Clin. Sci. 11, 45 (1952).
7. U. H. Eversole, J. A. M. A. 110, 878 (1938).
8. E. Ricen, U.S. Nav. Med. Bull. 40, 853 (1942).