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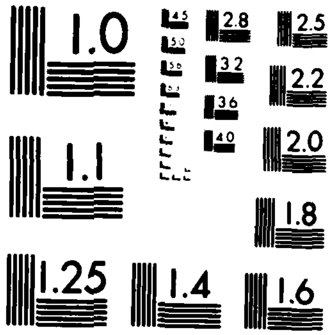

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FACTORS DETERMINING TOLERANCE TO HIGH ALTITUDES

Final Report

John B. West, M.D., Ph.D.

January 10, 1983

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Highlights of the research included the first direct measurement of barometric pressure and temperature on the summit of Mt. Everest to measure effects of hypoxia at extreme altitudes. Also, measurements of maximal work capacity at 6300 meters were done. Measurements of pulmonary gas exchange and maximal exercise, extensive studies carried out in other areas including sleep, hematology, metabolism and endocrinology, intestinal absorption, psychometric tests, the control of ventilation, and effects of hemodilution.

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Final Progress Report

This contract supported research carried out during the American Medical Research Expedition to Everest during the fall of 1981. The research program was outstandingly successful. Extensive series of measurements were carried out at the Base Camp laboratory located at 5400 meters (17,700 feet) and the Camp 2 laboratory located at 6300 meters (20,700) feet. Some measurements were made at the Camp 5 laboratory located at 8050 meters (26,400 feet) and actually on the summit itself, at an altitude of 8848 meters (29,028 feet).

Highlights of the research included the first direct measurements of barometric pressure and temperature on the summit. The pressure was measured at 253 torr which is slightly higher than we had predicted and 17 torr higher than the U.S. Standard Atmosphere for that period. This is important because the standard atmosphere has been used to predict the effects of hypoxia at extreme altitudes. The cause of the higher pressure is the large mass of cold air in the stratosphere above the equator.

Thirty-four alveolar gas samples were collected at altitudes over 8000 meters. These showed that alveolar P_{CO_2} decreased approximately linearly as barometric pressure fell, reaching the astonishingly low value of about 7.5 torr on the summit. For a respiratory exchange ratio of 0.85, this gives an alveolar P_{O_2} of about 35 torr. However, calculations of the change in P_{O_2} along the pulmonary capillary, based on blood values measured during the expedition, indicate the arterial P_{O_2} of a climber at rest on the summit is about 28 torr.

Venous blood samples were taken from two climbers on the morning after their successful summit climb. These gave a mean base excess of -7.2 mEq/L. If we assume that they have the same base excess on the summit during the previous day, the calculated arterial pH on the summit is 7.78.

Measurements of maximal work capacity in the main laboratory at an altitude of 6300 meters (barometric pressure 351 torr) showed that V_{O_2} max was reduced to about half of its sea level value. When two well-acclimatized subjects were given 14% O_2 to breathe, their V_{O_2} max was 1.07 L/min. During those measurements, the inspired P_{O_2} was 43 torr, which is the same as on the Everest summit.

In addition to these measurements of pulmonary gas exchange and maximal exercise, extensive studies were also carried out in other areas including sleep studies, hematology, metabolism and endocrinology, intestinal absorption, psychometric tests, the control of ventilation, and effects of hemodilution. The attached list indicates papers and abstracts which have been submitted or accepted for publication.

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