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Wallace N. Jensen, M.D.

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introduction for the "Black Book" section of hematology. Please let him know if these words are satisfactory.

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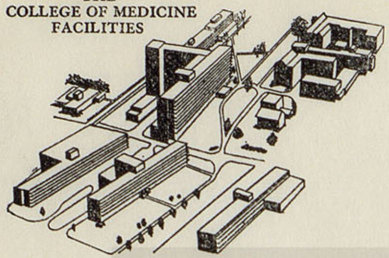

Department of Medicine

THE OHIO STATE UNIVERSITY

410 West 10th Avenue
Columbus, Ohio 43210

May 31, 1968

Sherman P. Vinograd, M.D.
Space Medicine, Manned Space Flight
National Aeronautics and Space Administration
Washington, D.C.

Dear Sherm:

Enclosed is the introduction for the "Black Book" section of hematology. I have not included references though we have these. The reason for this is that until a final copy is ready, a bibliography will probably just have to be changed.

Please let me know if these words are satisfactory.

Sincerely,

WNJ/pds

Wallace N. Jensen, M.D.
Professor and Vice-Chairman
Department of Medicine

WNJ:pds

Enclosures

HEMATOLOGY

INTRODUCTION

MAN: The criteria for selection of astronauts includes an exhaustive and detailed examination in which the candidates are filtered from a population because they have advantages which allow a greater probability of ~~more~~ successful completion of a mission in space. Just as the normal population varies in many obvious and easily measured attributes, the same population varies in biochemical and biophysical composition. Whether or not some of these normal individuals are by reason of differences more suited for existence and function in space environment can best be determined by inclusion of detailed and specific description of biochemical characteristics on all astronauts.

A number of these biochemical variables are detectable by examination of hemopoietic cells and plasma proteins. The techniques available for the characterization of the genetically determined differences in cells and plasma proteins presently have achieved a remarkable degree of sophistication. The availability of these cells and proteins allow the opportunity for study of the interaction of these different but normal parameters and the environment of space. A clear and possible overt example of the selection of a normal but disadvantageous individual for space travel would be that of a person with hereditary hemoglobinopathy which might not be detected by routine examinations and would not be expressed in the form of symptomatic disease in the usual earth environment, but when exposed to the environment of a space capsule would develop methemoglobinemia and consequent hypoxia. Thus, it is proposed that the measurement of these heritable, biophysically variable proteins and their interaction with the space environment might eventually provide additional bases for a determination of fitness for space flight.

SPACE ENVIRONMENT: The factors in the space environment which require consideration are: the gaseous environment, temperature, vibration, acceleration, restricted activity, and weightlessness. The hematologic components which should be specifically considered are red cell mass, plasma volume, defense mechanisms toward infectious agents, and hemostatic mechanisms.

THE RED CELL MASS: Quite unexpectedly, there was evidence that our astronauts had a decreased red cell mass which occurred during space flight. The loss may have occurred as a result of decreased rates of red cell production or because of increased rate of red cell destruction, or from both processes. The data available do not show a correlation between time of space flight (4 days Gemini IV, 14 days Gemini VIII) and the degree of red cell loss. The deficit of red cell mass was apparently restored within a short period of time after return to earth.

Further studies are needed to determine more precisely the degree and mechanism of loss of red cells. There are several experimental observations which are pertinent to this problem and include those of Fischer and Beery, Zalusky, and Fischer and Mengel. The experimental data which has been obtained in one aspect of space flight, that is, hyperoxia and red cell formation and destruction, was summarized by Bean in 1945. Little of this information is pertinent to current space flight problems. Recently, there has been work which provides a more systematic approach to the effects of graded hyperoxia on rates of red cell formation and destruction.

The effects of prolonged weightlessness on hemopoiesis are not known. Weightlessness has not been simulated at ground level for very long periods of time and attempts at approximation of this phenomenon have been made by the immobilization of individuals in a horizontal position at bed rest. The effects of this maneuver on red cell production and destruction have not been precisely quantified. Studies of vibration and its effect on red cell production and destruction are only partially available. It is conceivable that certain vibrations could indice physical destruction of circulating erythrocytes. Similarly, studies of the effect of different temperatures on red cell production and destruction under _in vivo_ and _in vitro_ conditions are not extensive and must be expanded. The possibility that radiation which is unique to space may have an inordinate effect on hemopoeitic tissues should be considered but such studies could be accomplished at ground level.

HEMOSTASIS: There is little reason to expect alterations of platelet function or plasma coagulation proteins during space travel. Except for trauma of skin and mucous membrane imposed by the restricted cabin space, unusual garments, gas environment, temperature changes, and the forces of acceleration and deceleration, it is anticipated that hemostasis will not be a problem. It is, however, of great importance _to know_ that hemostasis is not a problem in space travel. Studies of hemostasis before and after space flight should be done as well as in persons subjected to ground level simulated flight conditions.

DEFENSE MECHANISMS AGAINST INFECTIOUS AGENTS: The complex system important to resistance to infection includes the skin and mucous membranes acting as physical barriers, surface immunoglobulins and other secretions, the integrity of vascular system and granulocytes, reticuloendothelial cell, and the lymphocyte. Simple tests of this complex multicellular system are not available and more complicated measurements would require laboratory facilities during space flight. Perhaps the best compromise between simplicity of operation and the obvious functional complexity would be description of the inflammatory response which would be done by the skin window technique described by Rebuck. Ground level space flight simulation would be of great importance to evaluate many of the aspects of resistance to infection on the part of inhabitants of a space capsule.

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