

FUNDAMENTALS OF SPACE MEDICINE

"Human Standards"

by

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Human Standards

I. Introduction

- A. Definition of terms. Human Standards in space medicine obviously can be developed along various lines. In this lecture an introductory statement will be made in regard to the psychological and medical aspects of the problem. Emphasis will be placed, however, on those aspects of human standards relating to the tolerance of airmen and astronauts as well as their capability to carry out difficult and prolonged mission.
- B. Standards Relating to Psychological Performance. In the selection of astronauts, it will be necessary to have minimum standards in regard to the following variables:
 1. Mental Performance. The mental ability of potential candidates must be measured to insure the presence of the necessary skills. A college degree and additional graduate study will usually, but not always, assure minimum standards in this area.
 2. Psychomotor and Related Skills. By means of a previous test analysis, it will be necessary to determine what skills are required. Appropriate tests can then be devised to predict the required skills. Simulation can be of great assistance here.
 3. Personality and Emotional Adjustments. The objective measurements and tests in these fields are less reliable and it may be necessary to develop new ones in establishing minimum standards. An appraisal of the potential Astronaut's ability to work with others in isolation on prolonged missions must be considered.
 4. Research Related to New Concepts in Developing Minimum Standards. Many of the mere traditional approaches will have to be reconsidered in this new field of selection and minimum standards for Astronauts.
- C. Medical Aspects. The questions relating to medical fitness in the development of minimum standards is currently being studied in great detail and will be discussed by other speakers in this course. Only a few points will be emphasized here based on the wide experience of flight surgeons in the air transport and military services.
 1. Diagnostic Techniques in Relation to Future Physical Fitness. At the present time a great deal of thought is being given to the best techniques for predicting fitness and health during middle age, i.e. 40 years of age. Minimum standards will have to be developed in various fields of stress testing, such as a) exercise tolerance, b) simulated loss of cabin pressure, and c) selected tests of adrenal function and central nervous system integrity.

2. Computer Techniques for Medical Data. At the present time the experience of the FAA is very revealing in the development of human standards for private, commercial, and air transport pilots. More than 450,000 medical examination records have been placed on punch cards for the first time. It is now possible to study the data from individual tests in regard to the distribution and variability of the findings, and their relevance to operational procedures including accidents. Similar techniques might be applied to advantage in the study of Astronauts.
3. Studies of Physical Examination Records and Accidents. In the past no objective proof has been produced to show the possible relationship between physical defects or "standards" in regard to operational efficiency and accidents. A brief report will be presented of studies by Harper and Dougherty, as yet unpublished which suggest a new approach of considerable significance. Similar investigations should be made of the Astronaut population in regard to developing human standards in various psychophysical and medical areas.

II. Human Standards in Relation to Tolerance

It is necessary to attempt to measure the thresholds and tolerance limits under any given stress to be experienced by the Astronauts. Furthermore, each stress is critically dependent upon the exact environmental configurations at the time of the exposure. Thus, standards may vary and those devised under one specific set of conditions cannot be extrapolated to another.

- A. Injury Thresholds to Impact. Several examples will be presented from the experimental literature of the dangers involved in applying the findings from experiment to another under different conditions. Graphs will be presented from the experiments of Eiband, Hirsch, and Kornhauser to demonstrate this point.

III. Human Standard in Relation to Capability

It is equally important to develop standards in regard to capability for carrying out the varied tasks of space flight under different conditions of stress. In recent years the techniques of measurement have been greatly improved so that studies can now be made of an Astronaut's capabilities in regard to the above variables. These tests include not only the psychological aspects of performance but also impairment in physiological changes and work output, including the overt activity of the integrated organism during operational procedures.

IV. Techniques of Measurement

Techniques have now been developed in sensory and perceptual research which may be of use in developing human standards of Astronauts in space

flight. Primary features of such tests include a high degree of sensitivity, independence of the results from conscious effort, and stability of function when the stresses are applied.

- A. Measures of Speed and Accuracy Combined. With the development of information theory a way of combining measures of speed and accuracy into a single "rate-of-information-transmission" measure is available. In this way it is possible to determine the magnitude of task-induced stress required to produce an environmentally interacting effect.
- B. Tests that Detect and Scale Increased Effort. Two avenues of research offer tests of increased effort. One of these is concerned with spare capacity and of peripheral attention. The deterioration of performance on a primary task with increased load at a secondary task is a good example of this area of testing. The effects of fatigue can be measured in terms of the steepening gradient of these spare capacity measures. The other area of research relates to physiological measure of arousal, tenseness and so forth. A number of techniques for measuring not only muscular tenseness, but also central nervous system activity, and even specific components of neural reaction to signals have been developed.

V. Experimental Results Relating to Studies of Tolerance and Capability in Developing Human Standards for Space Flight.

The major part of this presentation will be devoted to reviewing the experimental literature in selected fields such as noise and vibration, temperature, hypoxia, carbon monoxide, and circadian rhythms in the development of human standards for space flight for Astronauts.

- A. Effects of Noise and Vibration on Human Performance. There is strong evidence of interaction between the environmental stresses of noise and vibration and task difficulty in determining performance decrement. Examples will be given to show how the proper selection and combination of tests will give rise to positive findings in areas that have previously resulted in negative findings.
- B. Effects of Temperature. In this field it has been possible to show how reaction times or errors in computation are not present until conditions become extreme. The newer approaches, however, where a selected grouping of tests have been used, have given positive results under more moderate environmental conditions. In one of our studies an apparatus has been developed with positive feedback so that the greater the success of responses, the greater becomes the rate of the stimulus programming. While performing this test, the subject is also required to monitor six signal lights, three on each side of his visual periphery. Thus, such a combination of tests can be used to study the effects on performance of temperature, hypoxia, sleep loss and other stresses.

- C. Hypoxia and Carbon Monoxide. In these areas it is necessary to study the effects of both acute and prolonged exposures. A series of experiments will be reviewed in which the author has demonstrated the effects of altitudes as low as 4,000 feet. Other studies of sensory and mental functions will show the effects on a wide range of tasks of altitudes up to 20,000 feet.

The studies of carbon monoxide have included a combination of sensory and physiological tests, such as the blood gases, in minor, acute and prolonged exposures. In these studies nomograms have been developed so that one can follow a series of variables in a simple chart.

- D. Circadian Rhythms. There is great interest in studies of tolerance and capability in regard to the effects of Circadian rhythm on human subjects. It is interesting to note that some of these newer techniques have been able to relate the subjective feelings to physiological measurements. A better understanding of this field will be of great importance in developing human standards for performance on long flights.

VI. Summary and Conclusions

In this lecture it has been pointed out that a completely new approach must be developed for appraising the performance and capability of Astronauts. The first step involves an adequate understanding of the physical stimuli which will be experienced during space missions. The next step is to try to simulate these tasks in the laboratory, and the final phase involves the integration of these findings into the development of human standards. Systems analysis, nomograms, and mathematical models are only as good as the data which are used to compile them. One can conclude that much remains to be done before satisfactory answers can be found to some of the questions raised above.