

NASA TASK FORCE ON COUNTERMEASURES

Introduction

In the Fall of 1995 a subgroup of the Life and Microgravity Sciences and Applications Advisory Committee (LMSAAC) was established for a one year period in which to a) assess the status of countermeasures routinely used by NASA to counteract the deleterious physiological changes in humans that occur in response to the microgravity environment involving space flight; and b) determine appropriate recommendations concerning essential research and development activities relevant to enhancing the effectiveness of the countermeasure program. Specifically, the Countermeasures Task Force (CTF) was charged with:

- Surveying the efficacy and appropriateness of existing countermeasures and the ongoing research program to develop countermeasures for long duration missions.
- Evaluate the adequacy of existing data bases.
- Evaluate NASA's plans in the area of countermeasures as currently constituted. For example, are there lessons to be learned from the Space Shuttle, Skylab and Russian Programs that should change the current program.
- Recommend both appropriate short term and long term changes for improving the countermeasure program and its implementation as well as recommend new and innovative research activities.
- Provide feedback concerning the quality and direction of the Medical Policies and Requirements Document formulated by the Medical Policy Board of NASA as a blue print for sponsored national and international missions involving humans in space.

Organization of the Task Force Committee:

On January 31, 1996 the CTF convened via teleconference and was formally charged by NASA Headquarters. At that meeting it was agreed that the committee would be formed into four subgroups to deal with countermeasure and operational issues pertaining to 1) the cardiovascular system; 2) the neuromuscular system including motor performance; 3) the bone and connective tissue system; and 4) clinical medicine including neurological issues. Subsequently, two additional subgroups were formed to deal specifically with neurological issues and the area of behavior and performance.

Following the initial teleconference, the committee formally met twice at the Center for Advanced Space Studies in Houston, Texas. The first meeting occurred on April 11-12, 1996 and was followed by a second meeting on June 27-28, 1996 in order to review the status of countermeasures currently used by NASA and to delineate the scope of the report as detailed in the sections presented below. The membership of the Task Force is provided in Appendix A.

Background:

For approximately 35 years, humans (and to a lesser degree other mammalian species) have been exposed to the microgravity environment of space flight for varying duration lasting from days to weeks to several months. During the course of human exposure to this unique environment a number of adaptations have been observed both inflight and post-flight. These include, but are not limited to, the following: inflight - vestibular and oculomotor dysfunction, a reduction in the intrinsic strength and power output of skeletal muscle, bone atrophy, and changes in connective tissue function; post-flight - reductions in work capacity and aerobic metabolic potential during the performance of high intensity exercise, cardiovascular deconditioning as manifest chiefly by the inability to regulate blood pressure in an upright posture, and balance and sensory motor disruption.

These deficits, both individually and in combination with one another, have had a significant negative impact on the functional and structural integrity of mammals, including humans, such that a major objective in both the NASA and Russian Space Programs has been to seek countermeasures to either fully ameliorate or minimize these deficits. The overall effectiveness of the countermeasures program has been difficult to assess for a number of reasons.

First, there has been a long history of policies and procedures designed to prevent any potential deleterious effects of space flight from impacting the functional integrity of humans upon return from the space environment. Consequently, all individuals exposed to space for a significant duration (several days) have undergone some type of countermeasure activity. This strategy has precluded the quantification of the maximal physiologic change that would occur during spaceflight. Second, often there have been numerous countermeasures simultaneously imposed, which has made it difficult to sort out which one(s) is more effective in reducing a specific deficit. Finally, there is a growing body of evidence to suggest that inappropriate strategies may have been utilized in attacking certain problems thereby reducing the success of correcting other deficits. Thus, as NASA prepares for the space station era in which humans routinely will be spending significantly longer periods (months) in space, it is essential that a complete analysis of the countermeasure program be undertaken at the present time.

Organization of the Report

In formulating the report, the various subcommittees of the CTF used two primary avenues of analyzing the current information pertaining to countermeasures: 1) a thorough review of the current literature (including NASA reports) describing the effects of space flight on physiological processes including the effectiveness of countermeasures; and 2) interaction with the program managers and scientists within NASA involved in both designing and implementing the current countermeasure strategies. Based on these deliberations the report is centered around a series of discipline reports that address the following generic issues: 1) the nature of the problem; 2) the status of current countermeasures to the problem; 3) concerns relevant to the problem; 4)

recommendations to improve countermeasures for a given discipline; and 5) milestones and overarching issues relevant to the integrated countermeasures program.

Presented below are the individual discipline reports. Following the presentation of these reports are a series of presentations in the appendix that are discipline specific and designed to further document the scope of the discipline recommendations.