

**HEALTH MONITORING OF JAPANESE PAYLOAD SPECIALIST - AUTONOMIC
NERVOUS AND CARDIOVASCULAR RESPONSES UNDER
REDUCED GRAVITY CONDITION
L-0**

**Chiharu Sekiguchi
National Space Development Agency of Japan
Japan**

Introduction

In addition to health monitoring of the Japanese Payload Specialist (PS) during the flight, this investigation also focuses on the changes of cardiovascular hemodynamics during flight which will be conducted under the science collaboration with the Lower Body Negative Pressure (LBNP) Experiment of NASA. For the Japanese, this is an opportunity to examine firsthand the effects of microgravity on human physiology. We are particularly interested in the adaptation process and how it relates to space motion sickness and cardiovascular deconditioning.

By comparing data from our own experiment to date collected by others, we hope to understand the processes involved and find ways to avoid these problems for future Japanese astronauts onboard Space Station Freedom and other Japanese space ventures.

Objectives

The primary objective of this experiment is to monitor the health condition of Japanese Payload Specialists to maintain a good health status during and after space flight. The second purpose is to investigate the autonomic nervous system's response to space motion sickness. To achieve this, the function of the autonomic nervous system will be monitored using non-invasive

techniques. Data obtained will be employed to evaluate the role of the autonomic nervous system in space motion sickness and to predict susceptibility to space motion sickness. The third objective is evaluation of the adaptation process of the cardiovascular system to microgravity. By observation of the hemodynamics using an echocardiogram we will gain insight on cardiovascular deconditioning. The last objective is to create a data base for use in the health care of Japanese astronauts by obtaining control data in experiment L-0 in the SL-J mission.

Experiment Description

The experiment consists of on-orbit data collection phase and ground data collection phase including KC-135 parabolic flight experiment and pre- and post-flight data collection. Parabolic flight data collection sessions are scheduled to familiarize PS crew members with donning and doffing of PMS equipment in microgravity. We will assure adequate mobility and performance of PS while wearing PMS. Baseline physiological data such as EKG, electrooculogram (EOG), finger plethysmogram, skin potential reflex (SPR), and respiratory wave (RW), with and without specific vestibular stimuli, will be collected.

Pre-flight and post-flight data collection will be obtained for blood and urine for electrolyte, hormone, and chemistries. In addition to the sample collection, hemodynamics will be measured under LBNP stress.

On-orbit experimental protocol consists of two parts: one is continuous physiological monitoring using PMS and the other is observation of hemodynamic changes using an echocardiograph, the LBNP, and related equipment. The continuous recording of basic physiological

data using a NASA/PMS is conducted while the PS is working at launch day, mission day (MD) 1, 2, 5, and 6 (re-entry day). Signals of ECG, RW, and SPR are transmitted to the ground via an infrared telemetry system three times a day when physiological data are monitored.

Echocardiographic parameters, central venous pressure, leg volume, blood pressure, and ECG are measured without LBNP stress at MD 2 and 5 and with LBNP stress at MD 4.

Hardware

Physiological Monitoring System Back Pack. The Physiological Monitoring System (PMS) Back Pack consists of PMS, respiratory wave signal conditioner, infrared telemetry system, and cassette data tape recorder. The PMS acquires blood pressure, ECG, SPR, and heart rate information. It consists of an arm cuff with a microphone to measure blood pressure, chest electrode leads to acquire the heart signals, and forearm electrodes to obtain the SPR signal. Infrared telemetry system downlinks some physiological parameters such as ECG, respiration, and SPR through the Data Interface Unit to the ground. The PMS displays blood pressure and heart rate on a numerical display unit.

Cassette Data Tape Recorder. The Cassette Data Tape Recorder (CDTR) is a battery-powered recorder that records the subject's ECG, respiration, and SPR. This is also installed in a PMS backpack.

Echocardiography. The Echocardiography (AFE) uses ultrasound (high frequency sound above hearing range), computer imaging, and data storage to produce multiple two-dimensional,

realtime pictures of the heart. This image provides information on heart dimensions and a basis for multiple measurements relating to the function of the heart.

Lower Body Negative Pressure Device. The components of the Lower Body Negative Pressure Device (LBNPD) are an inflatable cylinder assembly, a control console assembly, and a cover/stowage container. During launch and landing operation, the LBNPD is compressed into a compact unit, stowed in its nomex cloth container, and attached to a floor section of the Spacelab. The control console assembly contains a pressure/vacuum pump, switches, digital logic, pressure/vacuum and pressure relief valves, pressure/vacuum hoses, and a pressure gauge. The pressure/vacuum pump operates on 28 volts dc and pressurizes the walls of the cylinder to inflate it to its full height. After inflation, a negative pressure is created within the cylinder by operation of the pump in the vacuum mode. A manually-operated pressure regulator is used to obtain pressure in a range from 0 to -60 mmHg. A LED digital readout displays the level of vacuum in the cylinder. A latex rubber waist seal on the LBNPD forms an airtight seal around the subject. The LBNPD can be easily purged to ambient pressure by the operator.

Automatic Blood Pressure System. The Automatic Blood Pressure System (ABPS) is a flight-qualified model of the Puritan-Bennett Infrasonde series of blood pressure monitors. It is an electronic sphygmomanometer which, when used with cuff and transducer, comprises a system for measuring both systolic and diastolic arterial blood pressure using a patented infrasonic pulse-detection method. The ABPS incorporates a digital printer, a RS-232 communications interface, an ECG input connector, a heart rate monitor, and a series of buffer amplifiers to provide data outputs.

Central Venous Pressure Device and Data Recorder. The Central Venous Pressure Device (CVPD) consists of a non-invasive Doppler blood flow probe mounted in an aluminum enclosure along with an electronic pressure meter, hardware circuitry, and LCD display. A mouthpiece/pressure transducer plugs into the pressure meter. The probe is placed over the jugular vein in the neck. The subject expires into the restricted mouthpiece while listening through stereo headphones to the flow sounds and watching the pressure meter to generate various target pressures. Flow and pressure data are recorded onto the TEAC 7-channel cassette data recorder. The TEAC cassette data recorder is an off-the-shelf seven channel recorder, powered by a single 9-volt alkaline battery, used to record data from medical experiments.

Ultrasonic Limb Plethysmograph. The Ultrasonic Limb Plethysmograph (ULP) is a self-contained device which uses pulses of ultrasound to determine chord lengths through the calf at one or two levels. The instrument has ultrasound transducers which are attached to the skin over the calf muscle using double-sided adhesive tape rings. An ultrasonic pulse is produced by exciting the transmitter crystal with a fast-rising voltage pulse. The pulse propagates through the tissue to the receiver crystal. The receiver output is sensed by a high-gain amplifier and threshold detector.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



Figure 1. Photograph of PMS system performance test onboard the KC-135 aircraft. Payload Specialist Dr. Mohri, who was wearing the PMS device (left), and the author were checking the performance of the system.