CE5b

M-092

3.5 Experiment M092. Lower Body Negative Pressure

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Preliminary Scientific Report as of R+8 Day

Experiment M092 assesses orthostatic tolerance by measuring cardiovascular responses to lower body negative pressure (LBNP). This is a preliminary medical analysis of losses of tolerance to LBNP stress indicating the major physiological in-flight and post flight changes from the preflight baseline data of the three crewmen of SL 1/2.

A review of the trend charts in section 1.2 shows that losses in tolerance to LBNP stress during flight varied among the three crewmen both in rate and magnitude of change. Initially a rapid decline in resting calf size occurred and thereafter, a steady but slower decline continued until about two-thirds of the way through the mission. A smaller decline was seen during the last few days. The increase in leg volume during LBNP was much larger in-flight than in either preflight or post flight tests. This excessive increase appeared to diminish in the latter part of the mission but still remained high. In all post flight tests the leg volume change again resembled those seen preflight.

charts?

Heart rate at rest tended to vary from test-to-test and was generally comparable to preflight rates. However, in the case of the CDR, whose resting and early in-flight resting heart rates were very low, a trend toward increasing resting rates was apparent as flight duration increased. Periodically, the stressed heart rate in all became higher in a somewhat cyclic pattern during flight without definite evidence of a leveling-off trend. Blood pressure changes at rest and during stress varied among crewmen and from test-to-test, but usually were within preflight ranges. In each crewman, however, during LBNP stress either diastolic pressure or pulse pressure tended to become lower, again periodically, but particularly in the latter half of the flight. Changes in the heart rate and blood pressure responses to LBNP were largely confined to the high stress levels.

Symptoms in association with high heart rate and low pulse pressure occurred on the thirteenth day in the SPT during exposure to minus 50 mmHg negative pressure. Thereafter, negative pressure during the last five-minute period of exposure was kept at minus 40 mmHg. He again experienced symptoms at this level on his last test, performed on the 25th flight day. In both instances the test was terminated early. On the 18th day of flight the PLT's test was terminated during the last five minutes while negative pressure was minus 50 mmHg. Although he did not experience symptoms, heart rate had increased and pulse pressure had decreased to levels indicating that symptoms would soon have occurred. In subsequent tests the third five-minute period of negative pressure was also held at minus 40 mmHg for the PLT.

The magnitude of change in cardiovascular responses seen in each crewman on recovery day generally parallel those observed during flight. The CDR and the SPT exhibited greater changes on at least one of the first three post flight tests than had occurred during any of their in-flight tests. The post flight responses to LBNP of the CDR were unlike any observed after previous flights in that they were nearly like preflight on recovery day but became progressively greater in the next two tests.

The SPT pressurized his antihypotensive garment about 30 minutes after splashdown when he began to experience symptoms of motion sickness. In his case, the decrease in orthostatic tolerance at the post flight stand test and the initial LBNP test appeared to be greater than has been seen after previous flights. The validity of this observation is clouded, however, by the concurrent symptoms of motion sickness. All crewmen exhibited postural tachycardia and/or hypotension during the early post flight period. All have also shown a slower return of orthostatic tolerance to preflight levels than has been required after previous flights.

The pressurized antihypotensive garment provided significant protection against post flight orthostatic intolerance. Standing heart rates with the garment inflated stabilized between 100 and 110 and, with the garment deflated, increased from these levels to 120 to 130 beats per minute.

Analysis

Adaptative cardiovascular changes due to weightlessness differed both in rate of development and degree among the three crewmen suggesting that different control mechanisms, systems, and subsystems affecting cardio-vascular responses may have been affected to different degrees. The initial large loss of leg girth must have been due principally to fluid loss from these tissues while the subsequent slower loss must have represented tissue loss as well. The slow post flight return of leg volume supports the concept of tissue loss. The relatively great percentage increase of leg volume during negative pressure in weightlessness probably resulted chiefly from the virtual absence of blood in leg veins at the beginning of the tests.

Changes in heart rate and blood pressure in-flight and post flight are more difficult to explain, but undoubtedly result from both cardiac and peripheral vascular changes. Loss of circulating blood volume can only be contributory. Whether cardiac and vascular changes were merely functional changes associated with alterations in neural and hormonal control factors or an inability of these organs to respond adequately cannot be determined. Theoretically, however, the capacitance vessels and the right heart, which should be subjected to much less stress in zero-g than normally encountered on earth, might be expected to experience, over prolonged periods of weightlessness, some changes of disuse atrophy. These may, as appears to be the case of lower extremity antigravity muscles, include the loss of muscular tissue.

Whatever the basic changes responsible for in-flight and post flight loss of orthostatic tolerance, SL 1/2 in-flight trend data and post flight observations, even though still in a preliminary stage of analysis, have important implications to the 56-day mission. The in-flight data give no assurance that further changes in cardiovascular function will not occur after 28 days. In-flight tests appear to be useful in predicting the post flight condition. In general, one might expect that a crewman who became consistently unable to tolerate the minus 40 mmHg level of the LBNP test would require additional support in a non-nominal recovery. Further declines in cardiovascular integrity, for example, the inability to tolerate even lower levels of negative pressure, would warrant serious consideration of terminating the mission. It seems evident also that cardiovascular changes of this nature progress to greater degrees in some crewmen than others.

On the positive side, from the in-flight trend data, some of the changes, for example, loss of leg girth, did appear to be occurring at a slower rate during the last part of the mission. Use of the antihypotensive garment counteracted the post flight postural hypotension and tachycardia to a significant degree. In addition, even without the garment, blood pressure and heart rates remained relatively normal and the crewmen were comfortable as long as they remained recumbent. This position seemed of particular benefit during the early post flight hours and may well be an important measure for ameliorating the cardiovascular manifestations of the transition from prolonged weightlessness back to earth's gravity.

M-092

M092 EARLY EXPERIMENT TERMINATIONS

MISSION	CREWMEN	PLANNED TIME OF DAY	EVENT DAYS	EXP. START TIME* (LOCAL)	ALTERED SCHEDULE	END TIME OF LAST MEAL (LOCAL)	Δ[1] BETWEEN END OF LAST MEAL & RUN START
SL-2	Conrad[2]	AM					(Worst Case)
	Kerwin	PM	MD13 MD25	1429 1028	No Yes - early	1343 0905	56 min. 83 min.
	Weitz	PM	MD18[1]	1610	No - late afternoon	1310	180 min.
SL-3[4]	Bean	PM	MD6 MD20 MD46	1421 1511 1943	No No No - early evening	1210 1237 1845	131 min. 154 min. 58 min.
	Garriott	PM	MD5	1701	No - late afternoon	1250	Consider 4 hrs. no snacks
SL-4	Carr	AM	MD16	1607	Yes - late	1320	151 min.
	Gibson	PM	MD14 MD34	1603	No	1413	110 min.
	Pogue[3]	PM	MD10	1747	No - late afternoon	Missed lunch	(Busy day -reported fatigue)

1 - Not considered a presync. episode
2 - Conrad had a preflight run, Jan. 25, in afternoon, hr 20 beats higher @ -20mmHg than normal
3 - Pogue had one presync episode in preflight
4 - SL-3 crew altered saddle settings to prevent deep penetration into can - possibly caused less stress
General - Per Dr. Hoffler, tolerance to orthostatic stress in afternoon generally less than in morning

*Beginning with rest

CE5b