HEMODYNAMIC CHANGES IN MAN DURING FLIGHT

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Quickening of the pulse in navigators during flight is attributed to emotional factors and not to energy requirements. Adjustment of the intensity of the circulation to correspond to energy requirements evidently takes place through a decrease in systolic volume.

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Assessment of the circulation in flying personnel is mainly based on changes in the heart rate. Investigations by Soviet and Western workers have shown that during flight the pulse quickens and may reach 160-180 beats/min. Piloting a modern aircraft does not require any significant physical effort. The energy

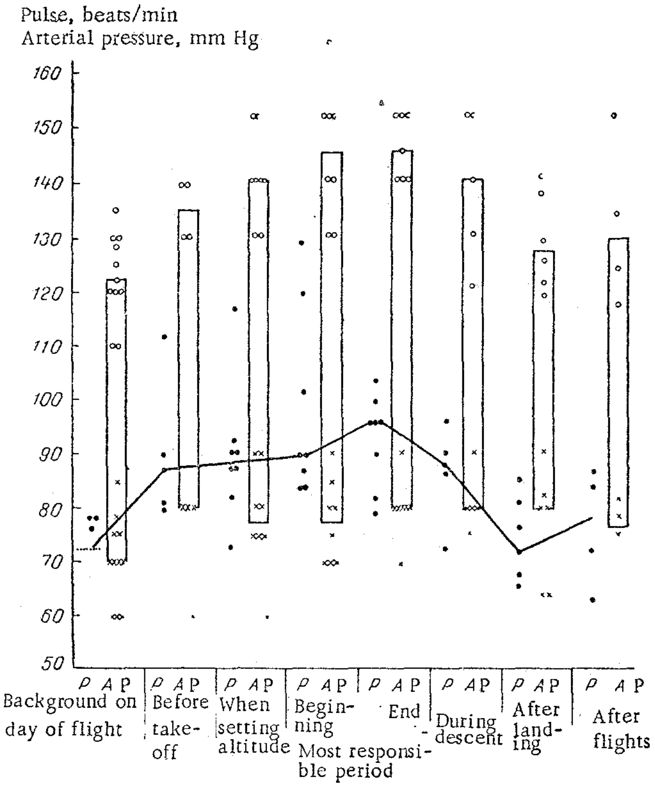

Fig. 1. Changes in pulse rate and arterial pressure of navigators. Points denote pulse rate, circles systolic pressure, and crosses diastolic pressure, in individual measurements. Lines and columns denote mean values of pulse rate and arterial pressure. Here and in Figs. 2 and 3 the median is taken as the mean value.

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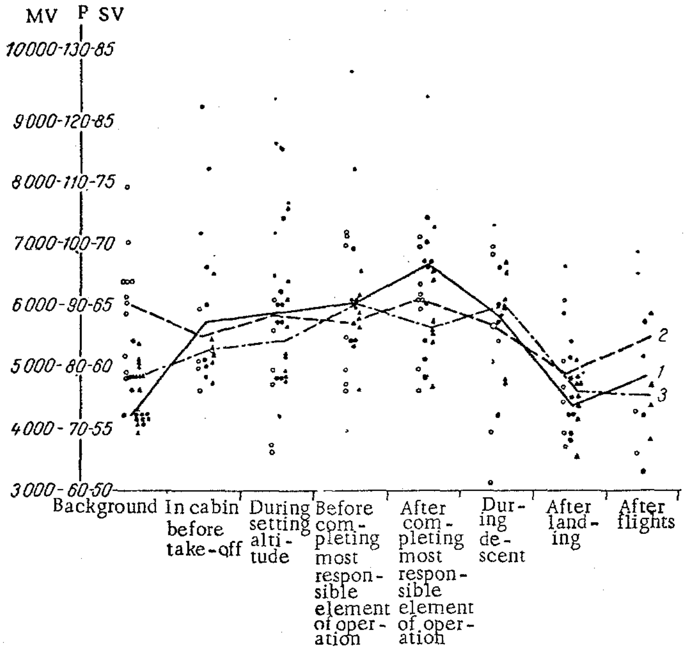

Fig. 2. Changes in pulse rate and systolic and minute volumes in navigators. Ordinate, pulse rate (beats/min), systolic and minute volumes (in ml); abscissa, moments of investigation: 1 and points denote pulse rate, 2 and circles systolic volume, 3 and triangles minute volume.

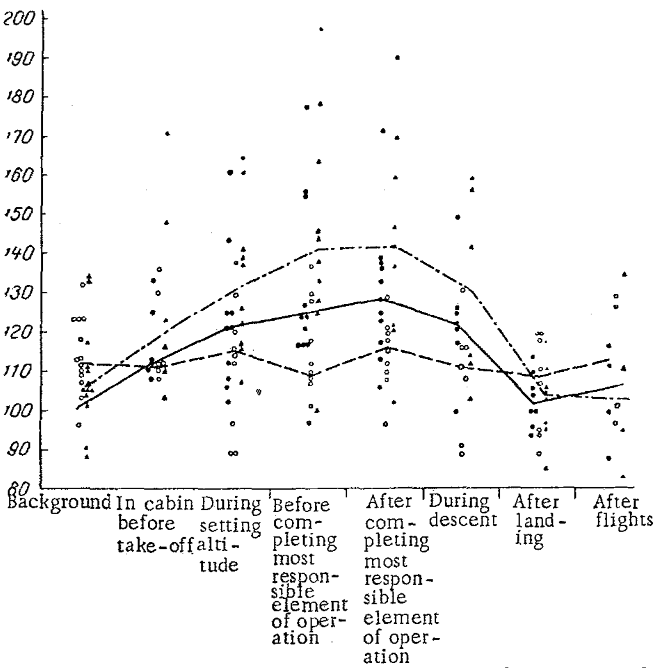

Fig. 3. Relationship between changes in pulse rate and systolic and minute volumes expressed as percentages of their initial values. Legend as in Fig. 2.

expenditure of members of the crew, according to results obtained by Yu. F. Udalov and A. G. Shibuneev [3], corresponds approximately to light physical work. Quickening of the heart during flight may therefore be considered to be an autonomic component of the emotional stress response rather than the result of an increase in energy demands placed on working organs and tissues. In man the chronotropic influences on the heart are known to be the most highly corticalized [1, 2, 4]. It is difficult, therefore, to state a priori whether the hemodynamic indices in crew members rise in proportion to the increase in the pulse rate or whether some different relationship exists between them.

In this paper we describe results with a bearing on this problem obtained by analysis of measurements of the arterial pressure and pulse rate in navigators using the PRAD apparatus designed by L. A. Kazar'yan*.

EXPERIMENTAL METHOD

Six persons aged 29-40 years were investigated. The pulse rate and arterial pressure 1.5-2 h before the beginning of the flights were taken as initial values. Subsequent measurements were made in the cabin 5-10 min before take-off, during altitude setting, before and after performing the most responsible element of the operation, during descending, immediately after landing, and after the end of the flights. Altogether 69 investigations were made. By means of Starr's [6] formula the systolic and minute volumes were calculated from the results obtained. The flights were made in a pressurized cabin (pressure not less than 0.65 atm., partial pressure of oxygen in inspired air not less than 150 mm).

EXPERIMENTAL RESULTS

The results given in Fig. 1 show that the pulse rate began to increase before performance of the most complex element of the navigational operation. Subsequently it fell, but did not reach its initial level. The changes in arterial pressure were similar. Initially the increase in systolic pressure was slightly greater than in the diastolic, resulting in an increase in pulse pressure. During the second half of the flight the maximal pressure gradually fell while the minimal remained practically unchanged and the pulse pressure diminished.

The calculated values of the systolic and minute volumes, together with the pulse rate, are shown in Fig. 2. The curves demonstrate a parallel trend between the changes in the indices they represent. Some discrepancies between the dynamics of the systolic volume and pulse rates can also be seen. This difference becomes more obvious if the values studied are expressed as percentages of their initial levels (Fig. 3). The pulse rate and minute volume exceeded the initial level before completion of the most responsible part of the navigational operation by a statistically significant margin. The minute volume began to fall during descent, and the heart rate after landing.

The systolic volume remained practically unchanged during flight. The divergent character of the relationships between the systolic and minute volumes and the pulse rate during flight can be seen in Fig. 3. Judging from the data given, an appreciable increase in pulse rate in the navigators during flight was accompanied by a very moderate increase in circulation, so that the systolic volume was maintained at its initial level or slightly below it.

In this way the concurrence between the energy demands of the body and the level of the circulation was maintained during flight, when reflex quickening of the heart took place without any corresponding physical exertion.

LITERATURE CITED

1. L. Ya. Balonov, Proceedings of a Conference on Problems in Cortico-Visceral Physiology and Pathology [in Russian], Leningrad (1953), p. 16
2. V. V. Petelina, In the book: The Orienting Reflex and Investigative Activity [in Russian], Moscow (1958), p. 158.
3. Yu. F. Udalov and A. G. Shibuneev, Byull. Éksp. Biol., No. 11, 61 (1963).
4. N. L. Barr and R. B. Voas, Am. J. Cardiol., 6, 59 (1960).
5. J. Starr, Circulation, 9, 664 (1954).

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