

CHANGES IN THE CARDIOVASCULAR SYSTEM DURING ACCLIMATIZATION IN THE INTRACONTINENTAL REGION OF ANTARCTICA

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The climate of the intracontinental region of Antarctica is the harshest to be found on earth. Here man is exposed to the action of an unfavorable combination of external conditions (low external environmental temperatures, low atmospheric pressure, the prolonged polar night, etc.). For the first time, an attempt has been made to determine the effect of these conditions on man.

There is virtually no information on this problem in the literature. In similar conditions K. V. Lapkin observed a fall of 15% in the blood pressure. Isolated observations have been made on animals subjected to cooling at a low atmospheric pressure [16]. Workers who have made separate studies of the effect of mountain and polar climates on the organism have in some cases recorded a fall of arterial pressure in mountain conditions [6,12,13]. Others consider, on the other hand, that no significant change occurs in the arterial pressure [5,7,18]. Most workers have noted quickening of the pulse in mountain regions, especially at the beginning of the stay [1,9,15,17,19]. An increased reaction of the cardiovascular system to physical exertion was observed by O. N. Pavlova, M. S. Reizin, and L. A. Fel'dman [9,14]. In polar conditions, especially during the polar night, nearly all investigators have found some degree of depression of the arterial pressure [2,3,11,10] and some have reported a considerable slowing of the pulse [8].

EXPERIMENTAL METHOD

The investigations were carried out at the "Vostok" station in the winter of 1959. This station is situated in the vicinity of the South Geomagnetic Pole (Latitude 78°27' S, Longitude 106°52' E). The distance from the nearest point on the coast is 1300 km and the altitude above sea level 3420 m (bearing in mind that the mean annual atmospheric pressure was about 468 mm Hg, in accordance with the degree of hypoxia the altitude of the station is equivalent to 4000 m absolute atmosphere). The mean annual temperature in the region of the station is -55.4°, the mean temperature of the warmest month (December) -31.1°, and the winter temperature sometimes falls below -88° (the station is the pole of cold for the Earth). The continuous winds still further aggravate the severity of the weather. The polar day and polar night each have a duration of 4 months. In the summer period a very intensive solar radiation is observed as a result of the exceptional purity of the atmosphere and the high albedo (up to 96%). The absolute humidity of the air is negligible.

Observations were made on 10 winterers—middle aged, clinically healthy males. The cardiovascular system was investigated monthly. Preliminary observations on the winterers were made in normal conditions.

Besides the ordinary clinical examination, the investigations of these subjects also included an interrogation. The pulse rate and arterial pressure were measured after a preliminary rest for 15 min in recumbency. A physical exercise was then given (squatting 15 times in the course of 30 sec), after which the pulse and arterial pressure were again determined until returning to their initial level.

EXPERIMENTAL RESULTS

During the first days of their stay at the station, some of the winterers complained of palpitations, unpleasant sensations, and actual pain in the region of the heart; in the course of time the number of such complaints increased to a maximum at the end of the polar night; with the arrival of the polar day the complaints almost completely

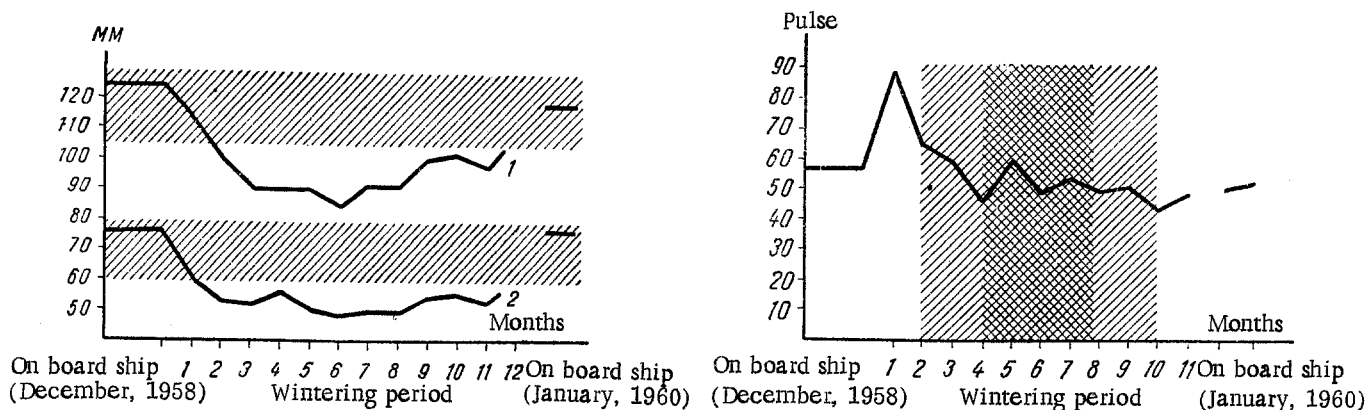


Fig. 1. Mean arterial pressure month by month during the period of wintering. 1) Systolic; 2) diastolic pressure.

Fig. 2. Changes in pulse rate. The period of the polar night is shaded.

disappeared. One or two weeks after their arrival at the station some winterers were aware of a murmur in the region of the apex of the heart, and in the third month of their winter season more or less distinct bruits were found in nearly all the subjects, and the heart was enlarged. Most commonly the enlargement of the heart was uniform on both sides; less commonly the enlargement was more marked towards the left. The heart murmurs and enlargement of the organ persisted until the end of the winter season. Not until the winterers had returned to normal conditions did these changes gradually regress. Cyanosis of the lips and nailbeds was observed more or less constantly throughout the winter period.

The arterial pressure, both systolic and diastolic, showed a tendency to be lowered in all the inhabitants of the polar station from the very beginning of their period of wintering (Fig. 1). Initially, during the first three months, its rate of fall was most marked and during the 4th-8th months (April-August, the period of the polar night) the changes were very slight. The lowest values of the arterial pressure were observed in June. During this month the systolic pressure reached 100 mm in only two winterers, in 2 it was 90-95 mm, in 4 it was 80-85 mm, and in 2 it was below 80 mm. The lowest pressure recorded was 60/30 mm. With the arrival of the polar day a slight increase in the arterial pressure (about 10 mm) was noted in all the winterers, but it still remained far below the initial level. The diastolic pressure in the majority varied within the range 40-50 mm during the polar night, and it rose slightly with the arrival of the polar day. After a return to normal conditions the arterial pressure regained its initial value fairly quickly (in roughly one month). Because the fall in the systolic pressure was greater than that in the diastolic, the pulse pressure also fell to a certain extent. Notwithstanding this marked hypotension, the winterers by and large remained fit to work. Only in one case, when the pressure fell to 60/30 mm, was it necessary to give tonics.

Immediately after their arrival at the station, all the winterers showed a considerable rise in their pulse rate (Fig. 2), but a fall soon set in. After its initial rise, by the third month the pulse rate had fallen to its initial value, but thereafter it continued to fall.

After the physical exertion test (squatting 15 times in 30 sec) the systolic pressure rose significantly. The highest increase in systolic pressure after physical exertion was observed during the first months of wintering (January, February): in 8 persons it rose by 40-55 mm. In the course of acclimatization the value of this increase fell gradually, and in November in 9 persons it did not exceed 10-15 mm (Fig. 3). In the first months of the stay at the station, the systolic pressure returned to its initial level after exertion in the course of 6-7 min, compared with 3 min during the second half of the wintering period.

Similar changes were observed in the pulse rate after exertion. In the first month, January, the pulse rate rose by more than 20 beats per minute in all the winterers, while at the end of the wintering period in 9 persons the increase in the pulse rate did not exceed 20 beats per minute. In the first months the pulse rate did not return to its initial level before the fifth minute, but after the 3rd-4th month of wintering at the station it was back to normal at the 3rd minute. Often after exertion a phase of an inverse reaction was observed, in which the pulse rate and arterial pressure fell below their initial values for a short time, as is sometimes seen also in normal conditions. The diastolic pressure was not significantly changed during physical exertion.

Examination of a large group of winterers at the Mirnyi observatory, where the living and climatic conditions are more favorable, revealed a normal arterial pressure throughout the year.

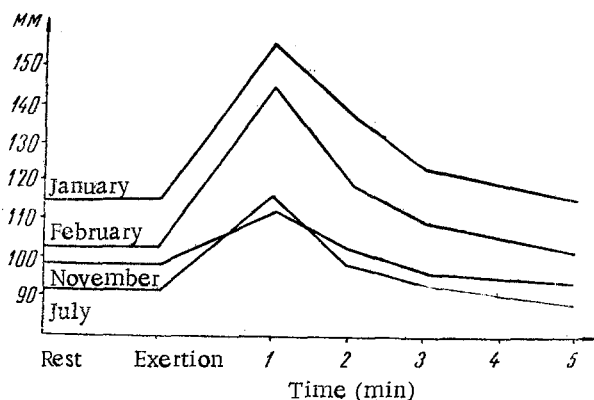


Fig. 3. Changes in systolic pressure after physical exertion during wintering.

system during the period of the polar night. As the polar day draws nearer, the activity of the nervous system begins to return to normal; this is manifested above all by improvement in the mood, appetite, and sleep, and by improved working capacity; some time later the arterial pressure also rises. Against this background of depression of the central nervous system the vagotonia is more clearly apparent (as is also the case in normal conditions in persons at night), for this is most likely the cause of the hypotension and bradycardia which was observed.

These observations show that after the 6th-7th month and until the end of the year's stay at the station the activity of the cardiovascular system of the winterers is established at a new, and more or less stable functional level, satisfying the demands of the organism in a state of rest. During physical exertion, however, until the end of the wintering period a cardiovascular insufficiency is observed (dyspnea, palpitations, sometimes increased acrocyanosis), from which it may be concluded that complete acclimatization to these extremely rigorous conditions has not taken place.

SUMMARY

Observations were carried out at the Soviet Antarctic Station located in the region of the South Geomagnetic Pole. The leading factors affecting the body state were low air temperatures, low atmospheric pressure, prolonged polar night and isolated localization of the winter settlement. During the first six months there were many complaints, including palpitations and pain in the cardiac area. With the appearance of the polar day the number of complaints exhibited a considerable drop. Almost in all the persons observed there were enlargement of the area of cardiac dullness and murmurs. Systolic, diastolic and pulse pressure decreased for the whole period of stay in the Antarctic, especially during the polar night.

The pulse considerably quickened during the first days of the stay, then rapidly dropped to the initial level. Reaction to physical load (pulse acceleration, the rise in arterial pressure, restitution time) was especially marked at first, later less so. A one-year stay is inadequate for complete acclimatization in the Antarctic Continent.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
