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# THE RATIO OF CAPILLARY AND VENOUS PERIPHERAL BLOOD, ASSESSMENT OF THEIR CHANGES AFTER SHORT-TERM COOLING

A comparative analysis of capillary and venous blood parameters in practically healthy people before and after general cooling was carried out. It has been established that in capillary blood a higher level of leukocytes is provided mainly by mature forms of monocytes, neutrophils, eosinophils and basophils. There were no significant differences in the level of lymphocytes. The response to cooling, depending on the hematological test, is an increase in the circulating pool of leukocytes in capillary blood due to increased cell migration and activation of lymphocyte recycling, and in venous blood - an increase in the output of neutrophils from the depot. Red blood cells in capillary blood have a large degree of variation in size. After cooling, erythrocyte indices of capillary and venous blood have the same tendency to increase, with a higher rate of increase in the capillary sample, which may reflect their importance in the regulation of the homeostasis of small vessels during cooling. In capillary blood the level of platelets is lower, but their population is more heterogeneous and the content of large cells is higher. With general cooling, platelet parameters, regardless of the hematological test, did not change significantly. Thus, changes in the composition of venous blood reflect the classic response to stress with an increase in the level of segmented neutrophils. Changes in capillary blood parameters are aimed at maintaining the homeostasis of small vessels, increasing the pool of functionally active and recirculating cells that provide an effective response to antigenic influence.

**Keywords:** capillary blood, venous blood, leukogram, hemogram, general cooling, adaptation.

**Introduction.** A complete blood count is the most commonly performed test needed to evaluate a patient's condition. Capillary blood is usually used as an alternative to venous blood when conducting general clinical analysis on hematology analyzers. However, there are a number of differences in the determined indicators of these types of blood. Capillary blood has a higher average hemolysis index, which must be taken into account if the analysis is not performed within 24 hours after blood collection (8,26). In addition, it has been shown that the thin aperture of the hematology analyzer (75 micron capillary) can become clogged with epithelial destruction products and other tissue fragments when taking capillary blood, which are automatically counted as blood cells, distorting the actual picture (2). Venous and capillary blood serum cannot be interchangeable when assessing the concentration of lipids and lipoproteins, the levels of which are significantly lower in capillary blood (12). Comparative studies of the content of potassium, chloride, sodium, calcium, phosphorus, creatinine, total protein, urea, bilirubin, AST, ALAT, LD, insulin, thyroxine, thyroid-stimulating hormone (TSH), glucose in the serum of venous and capillary blood ( 8, 13, 18, 21, 29). In addition, these indicators change significantly under the influence of physical activity, stress, etc. [27, 28]. Assessment of the levels of erythrocyte, platelet and leukocyte indicators of venous and capillary blood is also very controversial, although it is generally accepted that differences in indicators are not clinically significant (6, 11, 14, 15). According to most sources, the number of platelets in venous blood exceeds their content in capillary blood (1, 2, 3, 5, 24). This may be due to the activation of tissue platelet aggregation factors released when finger tissue is pierced. In addition, in the tissue fluid there is a high titer of antibodies mediating binding to the surface glycoproteins of the platelet in the presence of an anticoagulant such as EDTA (1, 2, 11). A feature of capillary endothelial cells is the high expression of HLA-DRII molecules and adhesion molecules, which allows them to actively capture, adhere and infiltrate immune cells [25]. The number of red blood cells in capillary blood is higher according to data (1, 5, 24). Other studies have shown that the content of red blood cells, hemoglobin, lymphocytes, neutrophils and hematocrit of venous blood is slightly lower than or equal to their number in capillary blood (2, 10). The level of hemoglobin and hematocrit of capillary blood is higher than that of venous blood according to data (1, 2, 5, 24). Assessment of hemoglobin in capillary blood is not recommended when diagnosing anemia, because indicators are often underestimated compared to venous blood, which leads to a false diagnosis [23]. There is evidence that blood parameters related to red blood cells are more stable than those related to leukocytes or platelets (10). According to some data, the level of leukocytes in capillary blood is higher (1, 2, 5, 24). Detected differences in the content of leukocyte and erythrocyte parameters in capillary and venous blood may be the result of immediate local accumulation of leukocytes upon stimulation of skin puncture, as well as due to the absence of an additional amount of tissue fluid in capillary blood samples, which affects the ratio of liquid and cellular components of hematological samples (2). The level of leukocytes in the blood changes dynamically under the influence of various factors, such as physical activity, stress, changes in diet, influence of climatic conditions, etc. We have previously shown that after general short-term cooling, 3 response options are formed on the part of lymphocytes, which is manifested in maintaining their level, reducing, or increasing their number in circulation in the venous blood (4). Small peripheral vessels are primarily ex-

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posed to low temperatures, their spasm occurs, cell aggregation, their migration and functional activity changes, which determines dynamic changes in blood parameters aimed at maintaining the homeostasis of the body. Assessment of the background level and changes in leukocyte, erythrocyte and platelet parameters in different hematological samples during short-term general cooling will allow us to determine the features and correlation of the formation of adaptive reactions, which is necessary when studying the influence of stress factors and interpreting the results when using different hematological samples. Knowledge of the ratio of reactions in capillary and venous blood under normal conditions, with pathology or the influence of some external factors is necessary, because Capillary sampling has recently been increasingly considered as an alternative to venous sampling due to greater accessibility, less discomfort for the patient, and the possibility of more frequent and faster sample collection and analysis.

**Aim.** To conduct a comparative analysis of adaptive changes in leukocyte, erythrocyte and platelet parameters of capillary and venous blood after general short-term cooling in practically healthy people.

**Abbreviations:** WBC - leukocytes, RBC - erythrocytes, HGB - hemoglobin, HCT - hematocrit, MCV - average erythrocyte volume, MCH - average hemoglobin content in an erythrocyte, MCHC - erythrocyte hemoglobin saturation, RDW-SD - erythrocyte distribution index, RDV-CV - degree of deviation of red blood cell size from normal, PLT - platelets, PDW - platelet distribution width, MPV - mean platelet volume, P-LCR - percentage of large platelets, PCT - thrombocrit.

**Materials methods.** A study of hematological and immunological parameters was carried out in 212 practically healthy people of working age before and immediately after general cooling for 5 minutes in a cold chamber (USHZ-25N, Russia) at -25°C. The volunteers wore cotton clothes under constant video surveillance, did not have any acute or exacerbation of chronic diseases during the study period, and had not previously or currently engaged in hardening. Blood was collected by qualified medical personnel before and immediately after being in the cold chamber from the cubital vein into Vaccuette vacuum tubes with EDTA to obtain plasma and conduct hematological studies; with a blood clotting activator to produce serum. Serum and plasma were separated by centrifugation. The samples were frozen once at a temperature of minus 20°C. The leukogram and hemogram were determined using a hematology analyzer XS-1000i (Sysmex, Japan). In blood smears stained according to Romanovsky-Giemsa on a Nikon HemaVision microscope at immersion magnification ×40, a lymphocytogram was studied according to the method of Kassirsky I.A., with determination of the content of large (more than 12 μm), medium (from 8 to 12 μm) and small (up to 8 μm) lymphocytes; monocytogram according to O.P. Grigorova's method, with differentiation of mononuclear cells into promonocytes, monocytes and polymorphonuclear cells; a neutrogram with a count of up to 100 neutrophilic leukocytes, among which cells with 1, 2, 3, 4, 5 or more nuclear segments were isolated. The research results were processed using the Statistica 6.0 application package (StatSoft, USA). To check the data for normality of distribution, the Shapiro–Wilk normality test was used. The median (Me) and 25–75 percentiles were used to describe the data. The statistical significance of differences was determined using the nonparametric Wilcoxon T-test. The critical significance level (p) when testing statistical hypotheses was taken equal to 0.05. To assess the rate of change in indicator levels, growth and loss rates were calculated.

**Research results and discussion.** A comparative analysis of venous and capillary blood parameters before general cooling is presented in Table 1. No significant differences were established in the levels of erythrocytes, HGB, MCH, MCHC and lymphocytes. When studying the lymphocytogram, it was shown that in venous blood the content of large forms of lymphocytes is higher, the levels of small and medium lymphocytes do not differ significantly. In capillary blood, such indicators as HCT, MCV, RDW-SD, RDW-CV, PDW, MPV, P-LCR are higher. The average level of leukocytes, eosinophils, basophils, monocytes and neutrophils is also higher in capillary blood. A higher level of neutrophils in capillary blood is provided by mature segmented cells with two, three and four nuclear segments. The monocytogram of capillary blood is characterized by a higher content of mature monocytes and polymorphonuclear cells.

A comparative analysis of changes in venous and capillary blood parameters after general short-term cooling was carried out. It was found that the number of leukocytes in venous blood increases from 5.13 (4.13 – 6.14) to 5.46 (4.06 – 6.52) × $10^9$ cells/l (p = 0.006), in capillary blood – from 5 .55 (4.74 – 6.57) to 6.07 (5.00 – 7.36) ×$10^9$ cells/l (p=0.001). To assess the dynamics of changes in capillary and venous blood parameters, the rates of growth and loss of leukocytes were calculated. It was determined that the rate of increase in the number of leukocytes in capillary blood was actually 3 times higher and amounted to 9.4%, versus 3.61% in venous blood.

**Changes in neutrophil levels.** In capillary blood, the total number of neutrophils increases from 2.86 (2.15 – 3.59) to 3.15 (2.34 – 4.09) × $10^9$ cells/l (p = 0.001), without a significant change in the level of band cells concentration which before and after general cooling were 0.20 (0.09 – 0.28) and 0.18 (0.10 – 0.26) × $10^9$ cells/l, respectively. An increase in the content of segmented neutrophils was recorded from 2.82 (2.14 – 3.45) to 3.06 (2.31 – 3.38) × $10^9$ cells/l (p = 0.027). When studying the structure of the segmentogram, an increase in the number of cells with 2, 3 and 4 nuclear segments was established (Table 2). In venous blood, the level of neutrophils also significantly increases from 2.46 (2.00 – 3.19) to 2.89 (2.09 – 3.72) × $10^9$ cells/l (p = 0.001), without changing the level of band cells (0.18 (0.09 – 0.29) and 0.18 (0.10 – 0.32) ×$10^9$ cells/l) and with an increase in the number of segmented neutrophils from 2.27 (1.78 – 2.98) to 2.62 (1.90 – 3.44) ×$10^9$ cells/l (p=0.001). In the structure of the segmentogram, the number of cells with 2, 3 and 4 nuclear segments increases.

Despite the same dynamics of changes in the circulation of neutrophils, the growth rates vary significantly. In capillary blood, the growth rate of the total number of neutrophils was 10.1%, segmented cells – 9.65%; in venous blood, the growth rate for neutrophils was 17.8%, for segmented forms – 15.4%. A more active increase in the number of neutrophils and their segmented forms in the venous blood is a classic reaction to an irritating factor and may be associated with the release of cells from the depot in response to stress, because such a short period of influence of a negative factor eliminates the possibility of cell accumulation due to activation of proliferation. However, chronic exposure to a stress factor affects the functional activity of neutrophils, with the activation of their formation of neutrophil traps, which significantly changes the microenvironment and the likelihood of damage to surrounding tissues, which is more clearly manifested in pathological conditions [9, 20].

**Changes in monocyte levels. T**here was no change in the level of monocytes in venous blood (0.43 (0.30 – 0.56) ×$10^9$

Table 1

**Indicators of venous and capillary blood before general cooling, Me (25-75)**

| Indicator name | Capillary blood, n=212 | Venous blood, n=212 | The level of significance of the differences, p |
|---|---|---|---|
| WBC (leucocyte), $10^9$ cells/liter | 5.55 (4.74 – 6.57) | 5.13 (4.13 – 6.14) | 0.002 |
| RBC (erythrocyte), $10^{12}$ cells/liter | 4.61 (4.28 – 4.96) | 4.58 (4.22– 4.90) | - |
| HGB (hemoglobin), grams/liter | 137 (126 – 150) | 136 (124 – 143) | - |
| HCT (hematocrit), % | 40.3 (38.0 – 44.5) | 39.1 (36.8 – 42.3) | 0.029 |
| MCV (average volume erythrocyte), femtoliter | 88.1 (85.2 – 92.1) | 86.3 (82.6 – 90.0) | - |
| MCH (the average hemoglobin content in the erythrocyte), picograms | 29.8 (28.7– 31.2) | 29.3 (28.4 – 30.5) | - |
| MCHC (saturation of erythrocytes with hemoglobin) , grams/liter | 338 (329 – 344) | 340 (332 – 349) | - |
| RDW-SD (distribution index of erythrocytes), femtoliter | 41.8 (39.5 – 44.4) | 39.8 (37.5 – 42.3) | 0.018 |
| RDW-CV (the degree of deviation of the size of erythrocytes from the normal), % | 13.3 (12.6 – 14.1) | 12.9 (12.4 – 13.6) | 0.001 |
| PLT (thrombocyte ), $10^9$cells/liter | 192 (161 – 239) | 228 (181 – 266) | 0.001 |
| PDW (thrombocytes distribution width), % | 15.1 (13.5 – 16.6) | 13.9 (12.7 – 15.7) | 0.001 |
| MPV (average thrombocytes volume), femtoliter | 11.5 (10.7 – 12.2) | 10.9 (10.3 – 11.6) | 0.001 |
| P-LCR (percentage of the content of large thrombocytes), % | 37.5 (31.3 – 42.9) | 33.3 (29.0 – 39.0) | 0.001 |
| PCT (thrombocrit), % | 0.22 (0.18 – 0.27) | 0.25 (0.22 – 0.29) | 0.001 |
| Eosinophils $10^9$ cells/liter | 0.14 (0.09 –0.20) | 0.11 (0.06 – 0.17) | 0.001 |
| Basophils, $10^9$ cells/liter | 0.04 (0.02 – 0.11) | 0.02 (0.01 – 0.03) | 0.001 |
| Neutrophils and segmentogram | | | |
| Neutrophils, $10^9$ cells/liter | 2.86 (2.15 – 3.59) | 2.63 (2.04 – 3.34) | 0.013 |
| Rod-shaped neutrophils $10^9$ cells/liter | 0.20 (0.09 – 0.28) | 0.18 (0.09 – 0.29) | - |
| Segmented neutrophils, $10^9$ cells/liter | 2.82 (2.14 – 3.45) | 2.27 (1.78 – 2.98) | 0.005 |
| Neutrophils with 2 core segments, $10^9$ cells/liter | 0.94 (0.59 – 1.23) | 0.74 (0.55 – 1.03) | 0.001 |
| Neutrophils with 3 core segments, $10^9$ cells/liter | 1.27 (1.00 – 1.60) | 0.95 (0.73 – 1.31) | 0.031 |
| Neutrophils with 4 core segments, $10^9$ cells/liter | 0.57 (0.37 – 0.81) | 0.39 (0.25 – 0.56) | 0.001 |
| Neutrophils with 5 core segments, $10^9$ cells/liter | 0.07 (0.04 – 0.11) | 0.06 (0.03 – 0.11) | - |
| Lymphocytes and lymphocytogram | | | |
| Lymphocytes, $10^9$ cells/liter | 1.79 (1.21– 2.15) | 1.80 (1.36 – 2.26) | - |
| Small lymphocytes, $10^9$ cells/liter | 1.10 (0.79 – 1.43) | 1.10 (0.79 – 1.59) | - |
| Average lymphocytes, $10^9$ cells/liter | 0.54 (0.40 – 0.74) | 0.56 (0.39 – 0.73) | - |
| Large lymphocytes, $10^9$ cells/liter | 0.14 (0.11 – 0.20) | 0.18 (0.12 – 0.25) | 0.005 |
| Monocytes and monocytogram | | | |
| Monocytes, $10^9$ cells/liter | 0.53 (0.43 – 0.64) | 0.43 (0.30 – 0.56) | <0.001 |
| Promonocytes, $10^9$ cells/liter | 0.14 (0.01 – 0.24) | 00.14 (0.09 – 0.22) | - |
| Monocytes, $10^9$ cells/liter | 0.230 (0.162 – 0.337) | 0.135 (0.078 – 0.224) | <0.001 |
| Polymorphonuclear monocytes, $10^9$ cells/liter | 0.07 (0.05 – 0.10) | 0.04 (0.03 – 0.06) | <0.001 |

cells/l – before general cooling and 0.44 (0.28 – 0.58) ×$10^9$ cells/l – after). There were also no significant differences in the structure of the monocytogram. The number of promonocytes was 0.14 (0.09 – 0.22) and 0.14 (0.08 – 0.25) ×$10^9$ cells/l, respectively, before and after cold exposure; mature monocytes – 0.14 (0.08 – 0.22) and 0.12 (0.07 – 0.23) ×$10^9$ cells/l; polymorphonuclear – 0.05 (0.03 – 0.06) and 0.04 (0.02 – 0.06) ×$10^9$ cells/l. In capillary blood, the content of monocytes significantly increases from 0.57 (0.46 – 0.82) to 0.65 (0.49 – 0.88) × $10^9$ cells/l (p = 0.001). Assessing the structure of the monocytogram, we can say that the increase in the total level of monocytes occurs primarily due to promonocytes (0.14 (0.01 – 0.24) – before cooling and 0.16 (0.01 – 0.26) × $10^9$ cells/l – after cooling, p=0.021). The content of mature monocytes and polymorphonuclear forms does not actually change and amounts to 0.23 (0.16 – 0.34) and 0.25 (0.16 – 0.35) ×$10^9$

cells/l, respectively; 0.07 (0.05 – 0.10) and 0.07 (0.05 – 0.10) ×$10^9$ cells/l. An increase in the number of monocytes in capillary blood indicates the need for these cells to enter tissues to participate in adaptive processes. Considering the absence of venous blood monocyte levels in the dynamics, it can be assumed that the increase in the number of cells occurs due to the active migration of cells into smaller vessels from the parietal pool of larger vessels, and not due to the circulating part of the population. Prolonged and chronic exposure to a stress factor through increased levels of glucocorticoids activates the trafficking of monocytes from the spleen, and their level in the circulation exceeds the rate of release into the tissue [7].

**Changes in the level of lymphocytes.** In both capillary and venous blood, the absolute number of lymphocytes does not change significantly. In capillary blood, the content of lymphocytes was 1.80 (1.21 – 2.15) – before cooling and 1.74 (1.32 – 2.19) × $10^9$ cells/l – after; in the venous – 2.02 (1.42 – 2.58) and 1.90 (1.46 – 2.47) ×$10^9$ cells/l, respectively. A decrease in the relative levels of lymphocytes was established: in venous blood from 39 (32.5 – 46.0) to 36.0 (30.0 – 43.1) % (p = 0.001); in the capillary – 30.3 (24.2 – 35.3) to 28.2 (23.1 – 34.8) × $10^9$ cells/l (p = 0.001). Assessing the structure of the lymphocytogram, it was shown that in capillary blood the number of small forms of lymphocytes increases, with a decrease in medium and large forms (Table 3). The same trend is recorded in venous blood.

The rate of decrease in the level of lymphocytes in capillary blood was lower and amounted to -6.9%, in venous blood this figure was -7.7%. Despite the similar dynamics in the structure of lymphocytograms, the rates of increase and decrease indicate a more rapid increase in the number of small forms of lymphocytes in capillary blood (growth rate of 11.9% versus 5% in venous blood) and a slower decrease in medium and large forms of lymphocytes (rate of decrease -15.1% and -10.3% – in capillary blood; -24.9% and -28.0% – in venous blood). Small lymphocytes represent the main population of recirculating long-lived cells, i.e. an increase in their level in capillary blood indicates the participation of this part of lymphocytes in maintaining homeostasis when exposed to low temperatures with their subsequent migration to lymph nodes and organs for antigen-stimulated differentiation and proliferation [16]. A decrease in the number of large and medium-sized lymphocytes probably occurs due to an increase in their adhesion and transition to the parietal pool. It is known that large and medium-sized lymphocytes for the most part do not recirculate, but migrate to the lamina propria of the small intestine, where they are transformed into plasma cells.

**Table 2**

**Structure of the neutrogram before and immediately after short-term general cooling, Me(25-75)**

| Indicator of name | Before short-term general cooling | After short-term general cooling | The level of significance of the differences, p |
|---|---|---|---|
| Capillary blood | | | |
| Neutrophils with 2 core segments, $10^9$ cells/liter | 0.94 (0.59 – 1.23) | 1.03 (0.75 – 1.58) | 0.025 |
| Neutrophils with 3 core segments, $10^9$ cells/liter | 1.27 (0.99 – 1.61) | 1.50 (1.18 – 2.03) | 0.001 |
| Neutrophils with 4 core segments, $10^9$ cells/liter | 0.57 (0.37 – 0.81) | 0.65 (0.41 – 0.920) | 0.001 |
| Neutrophils with 5 core segments, $10^9$ cells/liter | 0.07 (0.04-0.11) | 0.09 (0.06-0.13) | 0.060 |
| Capillary blood | | | |
| Neutrophils with 2 core segments, 109 cells/liter | 0.74 (0.55 – 1.03) | 0.80 (0.54 – 1.18 | 0.046 |
| Neutrophils with 3 core segments, 109 cells/liter | 0.95 (0.73 – 1.32) | 1.06 (0.72 – 1.44) | 0.002 |
| Neutrophils with 4 core segments, 109 cells/liter | 0.39 (0.25 – 0.56) | 0.42 (0.27 – 0.67) | 0.001 |
| Neutrophils with 5 core segments, 109 cells/liter | 0.06 (0.03-0.11) | 0.06 (0.04-0.14) | 0.146 |

**Table 3**

**Structure of the lymphocytogram before and immediately after short-term general cooling, Me(25-75)**

| Indicator of name | Before short-term general cooling | After short-term general cooling | The level of significance of the differences, p |
|---|---|---|---|
| Capillary blood | | | |
| Small lymphocytes, $10^9$ cells/liter | 1.01 (0.79 – 1.43) | 1.23 (0.86 – 1.54) | 0.001 |
| Average lymphocytes, $10^9$ cells/liter | 0.54 (0.41 – 0.73) | 0.46 (0.34 – 0.64) | 0.006 |
| Large lymphocytes, $10^9$ cells/liter | 0.14 (0.11 – 0.20) | 0.12 (0.07 – 0.20) | 0.025 |
| Venous blood | | | |
| Small lymphocytes, $10^9$ cells/liter | 1.10 (0.79 – 1.60) | 1.15 (0.87 – 1.62) | 0.036 |
| Average lymphocytes, $10^9$ cells/liter | 0.56 (0.39 – 0.73) | 0.42 (0.28 – 0.64) | 0.001 |
| Large lymphocytes, $10^9$ cells/liter | 0.18 (0.12 – 0.25) | 0.13 (0.09 – 0.18) | 0.001 |

**Changes in the level of eosinophils and basophils.** In capillary blood, the content of eosinophils increases from 0.16 (0.10 – 0.25) to 0.32 (0.16 – 1.00) × $10^9$ cells/l (p = 0.019), without a significant change in the level of basophils (0. 04 (0.02 – 0.11) and 0.04 (0.02 – 0.09) ×$10^9$ cells/l). In venous blood, the content of eosinophils decreases from 0.11 (0.06 - 0.17) to 0.10 (0.06 - 0.17) × $10^9$ cells/l (p = 0.002) also without a change in the level of basophils (0. 02 (0.01 – 0.03) and 0.02 (0.01 – 0.04) ×$10^9$ cells/l). Thus, it has been shown that changes in the size of the basophil population are little susceptible to short-term cold influences. An increase in the level of eosinophils is associated with the need for the participation of these effector cells in the formation of innate immune responses in response to adrenergic stimuli [17, 19]. However, an excessive increase in eosinophils can lead to their aggregation, blockage of small vessels and tissue ischemia.

**Changes in platelet levels and platelet parameters.** After general short-term cooling, no significant changes in the

level of platelets and platelet parameters were found, either in venous or capillary blood (Table 4). Thus, it can be assumed that platelet parameters in practically healthy people are more stable and less susceptible to the influence of short-term exposure to low temperatures.

**Changes in the level of red blood cells and erythrocyte parameters.** In capillary and venous blood, similar reactions from erythrocytes and erythrocyte parameters are recorded (Table 5). Increased levels of red blood cells (RBC), hemoglobin (HGB) and hematocrit (HCT) were found. The rate of increase in indicators in capillary blood was higher than in venous blood and amounted to 2.80 and 1.74% for RBC, 2.20 and 1.41% for HGB, and 1.70 and 1.29% for NCT, respectively. Red blood cells are involved in the regulation of endothelial dysfunction by altering the balance between levels of nitric oxide (NO) and reactive oxygen species to prevent the induction of vascular oxidative stress [22]. Thus, an increase in the number of erythrocytes in practically healthy individuals during short-term general cooling can be considered as a positive adaptive reaction that ensures the maintenance of vascular homeostasis.

**Conclusion.** The background levels of venous and capillary blood parameters in practically healthy people living in the North differ somewhat, but are within the physiological norm. Red blood cells of capillary blood have a large degree of variation in size and the degree of deviation of their sizes from normal. After general cooling, erythrocyte indicators such as RBC, HGB and HCT have the same tendency to increase, but in capillary blood a higher rate of increase is recorded, which may indicate their importance in regulating the maintenance of homeostasis of small vessels during cooling. The total number of platelets is higher in venous blood, while in capillary blood the platelet population is more heterogeneous and the content of large cells is higher. During cooling, the levels of platelets and platelet parameters are more stable and do not change significantly in both capillary and venous blood. It has been shown that in capillary blood there is a higher level of leukocytes mainly due to mature forms of monocytes, neutrophils, eosinophils and basophils. This distribution is probably due to the fact that these cells exhibit the main functional activity in tissues and it is in the capillary pool that there are cells ready to respond to antigens. In response to general short-term cooling, regardless of the hematological test, adaptive reactions are recorded with an increase in the total level of leukocytes. At the same time, in capillary blood a more rapid replenishment of this pool occurs mainly due to small forms of lymphocytes, promonocytes and eosinophils, while in venous blood the increase in the number of leukocytes is supported by an increase in the content of segmented neutrophils. Thus, it has been shown that even short-term stress leads to changes in the cellular composition of capillary and venous blood, reflecting increased reactions of cell release from the depot, maintenance of vascular homeostasis, migration of leukocytes from larger vessels to small ones and activation of lymphocyte recycling.

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**Table 4**

**Changes in platelet levels and platelet parameters before and immediately after short-term general cooling, Me (25-75)**

| Name of indicator | Before general cooling | After general cooling | Level of significance of differences, p |
|---|---|---|---|
| Capillary blood | | | |
| PLT, $10^9$ cells/liter | 192 (161.0 - 239.0) | 208.5 (162.0 - 247.0) | 0.133 |
| PDW, % | 15.10 (13.50 - 16.60) | 15.3 (13.2 - 16.8) | 0.340 |
| PCT, % | 0.22 (0.18 - 0.27) | 0.230 (0.200 - 0.280) | 0.368 |
| MPV, femtoliter | 11.5 (10.7 – 12.2) | 11.4 (10.7 – 12.1) | 0.239 |
| P-LCR, % | 37.5 (31.3 – 42.9) | 37.1 (30.8 – 42.5) | 0.081 |
| Venous blood | | | |
| PLT, $10^9$ cells/liter | 228 (181 – 266) | 230 (181 – 275) | 0.488 |
| PDW, % | 13.9 (12.7 – 15.7) | 14.1 (12.6 – 15.4) | 0.324 |
| PCT, % | 0.25 (0.22 - 0.29) | 0.260 (0.210 - 0.290) | 0.132 |
| MPV, femtoliter | 10.9 (10.3 – 11.6) | 10.9 (10.3 – 11.5) | 0.114 |
| P-LCR, % | 33.3 (29.0 – 39.0) | 33.6 (28.7 –38.5) | 0.115 |

**Table 5**

**Changes in the level of erythrocytes and erythrocyte parameters before and immediately after short-term general cooling, Me(25-75)**

| Name of indicator | Before general cooling | After general cooling | Level of significance of differences, p |
|---|---|---|---|
| Capillary blood | | | |
| RBC, $10^{12}$ cells/liter | 4.61(4.28-4.96) | 4.74(4.28-5.10) | 0.022 |
| HGB, grams/liter | 137(126-150) | 140(126-153) | 0.020 |
| HCT, % | 40.3(38-44.5) | 41(38.6-45.4) | 0.022 |
| MCV, femtoliter | 88.1(85.2-92.1) | 88.3(85.8-92.2) | 0.042 |
| MCH, picograms | 29.8(28.7-31.2) | 29.7(28.7-31.1) | 0.450 |
| MCHC, grams/liter | 338(329-344) | 325(335-344) | 0.065 |
| RDW-SD, femtoliter | 41.8(39.5-44.4) | 41.7(39.6-44.5) | 0.937 |
| RDV-CV, % | 13.3(12.6-14.1) | 13.2(12.6-14.1) | 0.775 |
| Venous blood | | | |
| RBC, $10^{12}$ cells/liter | 4.58 (4.22 – 4.90) | 4.64 (4.35 – 5.02) | 0.001 |
| HGB, grams/liter | 136 (124 – 143) | 138 (127 – 146) | 0.005 |
| HCT, % | 39.1 (36.8 – 42.3) | 39.7 (37.6 – 42.2) | 0.014 |
| MCV, femtoliter | 86.3(82.6-90.0) | 86.1(82.4-89.9) | 0.007 |
| MCH, picograms | 29.3(28.4-30.5) | 29.3(28.3-30.5) | 0.828 |
| MCHC, grams/liter | 340 (332 – 349) | 341 (335 – 349) | 0.153 |
| RDW-SD, femtoliter | 39.8(37.5-42.3) | 39.8(37.7-42.2) | 0.367 |
| RDV-CV, % | 12.9(12.4-13.6) | 12.9(12.4-13.7) | 0.075 |

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