Blood count

(Total) **blood count** (BC) is a routine screening test. It is performed at each admission to the hospital, as well as when a hematological or more serious infectious disease is suspected.

BC components:

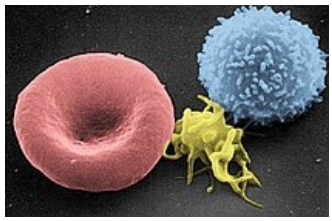
- Leukocytes (Leu, WBC) + so-called differential, i.e. percentage of lymphocyte, monocyte, neutrophils, basophils, and eosinophilic granulocytes.
- Erythrocytes (Ery, RBC).
- Erythrocyte parameters, i.e. their volume (MCV), hemoglobin content in the cell (MCH), its concentration in the cell (MCHC), erythrocyte volume distribution width (RDW).
- Content of hemoglobin u per blood volume (Hb) and hematocrit (Hct).
- Thrombocytes (Tr, PLT).

Procedure and methods used

Venous blood is collected in a tube with EDTA. The numbers and relative proportions of the individual cell lines are analyzed using flow cytometry. Flow cytometry determines not only the number of cells of each cell type per unit volume but also the volumes of a given type. Some abnormal cells may be inaccurately identified (schistocytes, immature and leukemic forms of leukocytes). In case of suspicion of the presence of abnormal cell types, evaluation under a microscope by an experienced laboratory worker (so-called "manual" differential) is necessary.

Hb concentration is determined using colorimetry (= absorption spectrometry). Hct is determined after centrifugation of the sample as the ratio (percentage) of the condensed ("crushed") volume of cell elements (Ery + Leu + Tr) to the total volume. Erythrocyte parameters (MCV, MCH, MCHC) are calculated using simple equations.

Physiological values

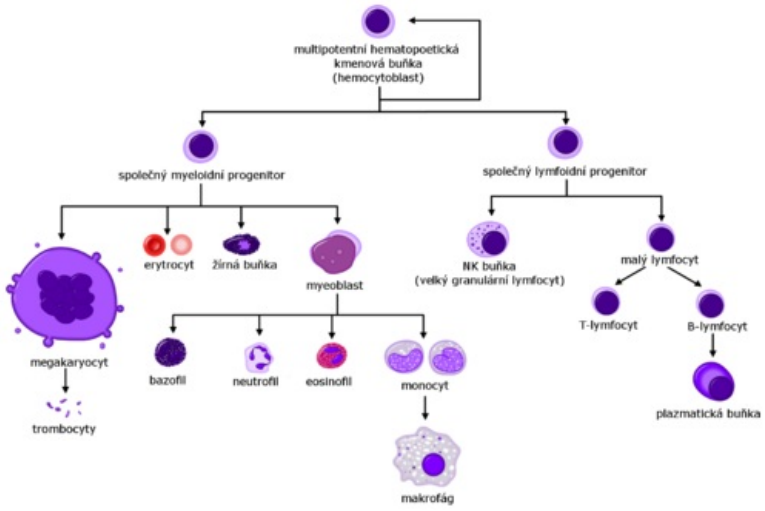


Erythrocytes (left), thrombocytes (middle) and leukocytes (right)

Parameter	Men	Women	Unit and commentary
Ery	5±0,7	4,6±0,7	× 10^6/µl (= 10^{12}/l)
Hb	150±20	140±20	× g/l (also expressed in g/dL)
Hct	0,46±0,06	0,43±0,06	(or ×100 in percent)

Reticulocytes: 0,5–1,5%

- *It reflects the dynamics of changes in the number of erythrocytes. Decreased values usually indicate anemia from underproduction, while increased values indicate anemia from increased losses.*



Hematopoesis

Parameter	Calculation	Value
MCV	Hct/Ery	90±5fL
MCH	Hb/Ery	31±3pg
MCHC	MCH/MCV = Hb/Hct	34±3g/dl

MCV (*mean corpuscular volume*, mean erythrocyte volume),

- *divides anemia into microcytic, normocytic, and macrocytic*.

MCH (*mean corpuscular hemoglobin*, the average amount of Hb in the cell),

- *divides anemia into hypochromic and normochromic*.

MCHC (*mean corpuscular hemoglobin concentration*, mean concentration of Hb in erythrocytes).

RDW (erythrocyte distribution width): **11,5–14,5%**,

- *provides an overview of variability in red blood cell size (anisocytosis)*.

Leu: 4000–10 000/µl (children about 25% more, toddlers – about 50% more)

Leukocyte differential count

- Neutrophils: 30-85% (children less);
- Lymphocyte: 15–50% In absolute number: 1500–40 00/µl (children more, up to 10,000);
- Monocyte: 1–12%;
- Eosinophils: 3 ± 3%;
- Basophils: 1 ± 1%.

Thrombocytes: 150 000–350 (tel:150+000–350) 000/µl

Nomenclature of changes in the number of cells in BC

Cell type	Rise	Decline
Erythrocytes	polyglobulia/polycythemia	anemia
Leukocytes	leukocytosis	leukopenia
lymphocytes	lymphocytosis	lymphocytopenia
granulocytes	granulocytosis	granulocytopenia or even agranulocytosis
neutrophils	neutrophilia	neutropenia
eosinophils	eozinophilia	eozinopenia
Thrombocytes	thrombocytosis	thrombocytopenia
All blood lines		pancytopenia

Causes of changes in blood counts

Red blood cell line

Parameter	Increase	Decreased[1]
Hemoglobin	polycythemia, high altitude, hypoxia-related conditions, erythropoietin-producing tumors (e.g. renal cell carcinoma), stress states, smoking, dehydration	anemia, hemolysis, renal insufficiency, blood loss, marrow aplasia, medication (chloramphenicol, gold), pregnancy (hemodilution predominates over only a slight increase in erythromass)
Erythrocyte count	polycythemia, high altitude, heart disease, erythropoietin-producing tumors, stress, smoking, haemoconcentration	anemia, haemolytic conditions, renal insufficiency, blood loss, marrow aplasia, toxic substances (benzene), drugs (chloramphenicol)
MCV	B12 deficiency (pernicious anemia), folic acid deficiency, liver disease, alcohol abuse, myxedema, marrow aplasia, reticulocytosis (young forms of erythrocytes are larger), myelofibrosis (typical lacrimal erythrocytes – dacryocytes), drugs (anticonvulsants)	Fe withdrawal, hemoglobinopathy (thalassemia), anemia of chronic diseases, sideroblastic anemia, lead poisoning
Erythrocyte distribution width	**higher MCV**: deficiency of vitamin B12 or folic acid, liver disease, immunohemolytic anemia, cold agglutinin disease	
	lower MCV: sideropenia, DIC (disseminated intravascular coagulation), consumption coagulopathy and conditions associated with erythrocyte fragmentation (schistocytes), haemoglobinopathy	
Reticulocyte count	hemolytic anemia, acute blood loss, anemia during therapy	aplastic anemia, anemia with impaired red line maturation, liver disease, post-transfusion conditions, conditions after chemotherapy

White blood cell line

Parameter	Increased	Decreased
Neutrophil count	acute bacterial infections, acute and chronic myeloid leukemias, myeloproliferation, generalized malignancies, stress states – pain, cold, heat (so-called distributional leukocytosis with the transfer of leukocytes from the marginal pool to the circulating), tissue necrosis (myocardial infarction), vasculitis with acidosis, drugs (G-CSF and GM-CSF – granulocyte and granulocyte and macrophage colony-stimulating factors, lithium, corticoids, adrenaline), leukemoid reactions (over 30,000 segmented and younger granulocytes) in sepsis, endocarditis, miliary tuberculosis, and tumor metastasis	viral infections, aplastic anemias, X-rays, agranulocytosis, immunosuppression, drugs (antibiotics, chemotherapeutics, thyrostatics, analgesics, psychotropic drugs), lymphatic and monocyte leukemias **CAVE!** When evaluating neutropenias, the decrease in their absolute number is important.
Number of lymphocytes	chronic infections, tuberculosis, chronic lymphadenosis, infectious mononucleosis, other virosis, chronic lymphadenosis, Hodgkin's disease, hypocorticalism, idiopathic proctocolitis, idiopathic thrombocytopenic purpura	AIDS and related diseases, bone marrow damage after chemo- and radiotherapy, steroid treatment, hypercorticalism, aplastic anemia, neurological diseases (multiple sclerosis)
Monocyte count	viral, protozoal and parasitic infections, granulomatous diseases (sarcoidosis, Crohn's disease), tumors (malignant lymphomas, monocyte leukemia)	
Eosinophil count	allergic diseases, bronchial asthma, parasitic infections (most often toxocariasis, trichinosis, and intestinal helminthiasis), drug allergies, collagenosis, angioneurotic edema, Hodgkin's disease and other generalized malignancies, skin diseases (urticaria, pemphigus)	
Basophil count	chronic myeloid leukemia, hypothyroidism, mastocytoma, event. systemic mastocytosis	

Platelets

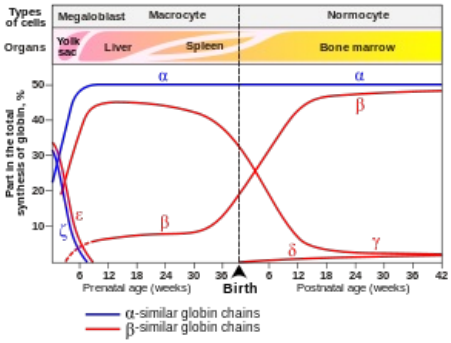
Parameter	Increase	Decreased[1]
Platelet count	malignant disease (especially GIT), inflammatory bowel disease, conditions after splenectomy, myeloproliferative disease (thrombocythaemia, polycythemia vera), infections, after blood loss, sideropenia, pancreatitis	hypersplenism (especially liver cirrhosis), marrow damage, alcohol, immune disorders (most commonly drug), infections (e.g. Helicobacter pylori), collagenosis, DIC and other consumptive coagulopathies, septic conditions

Physiological changes in blood count and in differential calculus in childhood

Normal levels of red and white blood cells in the peripheral blood in children vary with age.

Hemoglobin

In the perinatal period, hemoglobin (Hb) is composed of 80% fetal hemoglobin (HbF – chains α2 γ2) and 20% adult hemoglobin (HbA1 – chains α2 β2). After birth, fetal hemoglobin is exchanged for adult hemoglobin within 6-12 months.



Hemoglobin gene expression before and after birth (data on Wood W.G., (1976). Br. Med. Bull. 32, 282.).

Erythrocytes

In the first days after birth, short-term polyglobulia (relative polycythemia) with a hemoglobin concentration of about 195 g/l due to a reduction in blood volume, an increased reticulocyte count to 3% and erythrocyte macrocytosis is present. After the neonatal period, there is a steady decrease in hemoglobin levels due to attenuated erythropoiesis. At the age of 10 weeks, the lowest hemoglobin level is reached (up to 95 g/l, on average 115 g/l) – a phenomenon sometimes called "three-month anemia". This is followed by a steady increase until the adult values reach puberty. The normal value of reticulocytes is around 1% and the lifespan of the erythrocyte in the blood is 120 days. In premature infants, the decrease in hemoglobin is more pronounced due to insufficient production of erythropoietin – "premature anemia". The decrease in Hb is compensated by shifting the oxygen dissociation curve to the right and easier delivery of oxygen to the tissues. The volume of erythrocytes also changes. After birth it is 119 fl (macrocytosis), then decreases to 70-77 fl at 6 months and gradually rises to 80-90 fl in adulthood.[2][3]

Normal values of red blood count[4]

Age	Hemoglobin (g/l)	Hematocrit (%)	Erythrocytes (10^{12}/l)	Reticulocytes (‰)	MCV (μm^3)	Note
1 day	140–240	58–62	4,5–6,5	15–65	106±7	polyglobulia
1 month	110–170	30–37	3,9–5,3	3–13	100±6	
3 months	100–130	30–37	3,2–4,3	10–35	88±6	"three-month anemia"
1 year	110–150	33–40	4,2–5,5	3–13	73±8	
13–17 year-old men	130–160	39–47	4,8–5,7	1–13	78±8	
13–17 year-old women	110–160	36–44	4,3–5,5	1–15	78±8	

Leukocytes

The number of leukocytes rises sharply during the first days of life to values around 20×10^9/l (leukocytosis formed by granulocytes – neutrophils, eosinophils, and basophils) – neutrophils with a shift to the left. After about one week, the number of leukocytes decreases again ("first crossing" on day 5)[3] and the predominance of lymphocytes (relative lymphocytosis) occurs by the age of 4, then the neutrophil/lymphocyte ratio equalizes and later granulocytes predominate until old age ("second crossing" in the 5th year). Monocytes make up 5-10% of the cells in the differential budget.[2][3]

Platelets

The normal number is 140-400 × 109/l regardless of age, volume 7-11 fl and their life in the circulation 7-10 days.[3]

🔎 *For more information see Physiological and pathophysiological notes on pediatric hematology (pediatrics).*

References

Related Articles

- Blood
- Blood plasma
- Blood samples for examination
- Hemocoagulation ■ Blood clotting test ■ Bleeding examination ■ Erythrocyte sedimentation
- Biochemical analysis of blood ■ Laboratory examination of acid-base balance
- Hemoculture ■ CRP ■ PCT
- Physiological values of blood elements

External links

- Krč, I.: Hematology – evaluation of blood count (http://www.solen.sk/index.php?page=pdf_view&pdf_id=2830)

References

1. KRČ, I. HEMATOLOGIE – HODNOCENÍ KREVNÍHO OBRAZU. *UROLÓGIA PRE PRAX* [online]. 2007, vol. -, no. 5-6, p. 231-232, Available from <http://www.solen.sk/index.php?page=pdf_view&pdf_id=2830>.
2. MUNTAU, Ania Carolina. *Pediatrie.* 4. edition. Grada, 2009. pp. 233. ISBN 978-80-247-2525-3.
3. LEBL, J – JANDA, J – POHUNEK, P. *Klinická pediatrie.* 1. edition. Galén, 2012. 698 pp. pp. 529-530. ISBN 978-80-7262-772-1.
4. MUNTAU, Ania Carolina. *Pediatrie.* 4. edition. Grada, 2009. pp. XX. ISBN 978-80-247-2525-3.

Sources

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