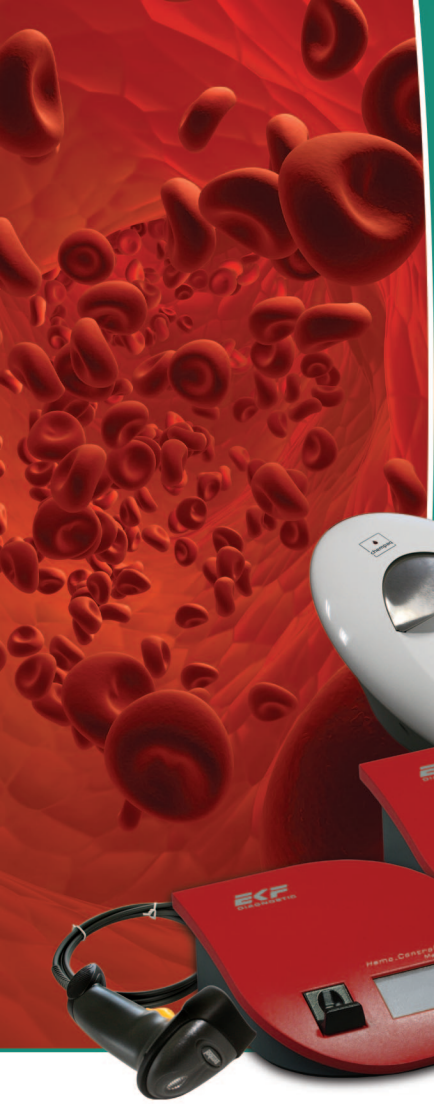
EKF DIAGNOSTIC



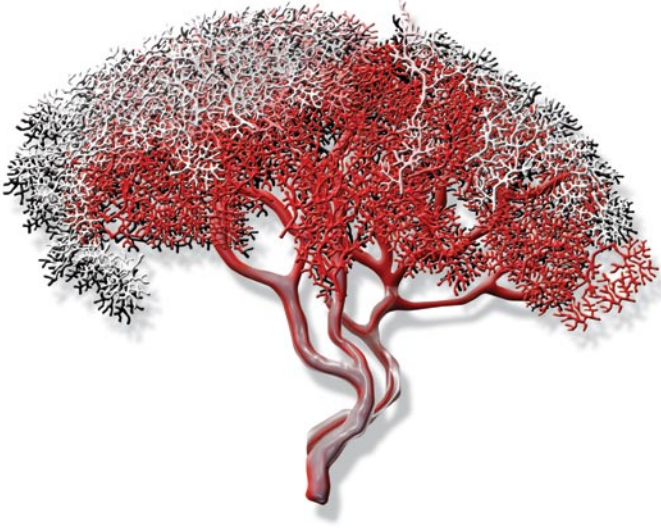
HEMATOLOGY

Meaning, Applications and Measurement

EKF DIAGNOSTIC

Hemoglobin

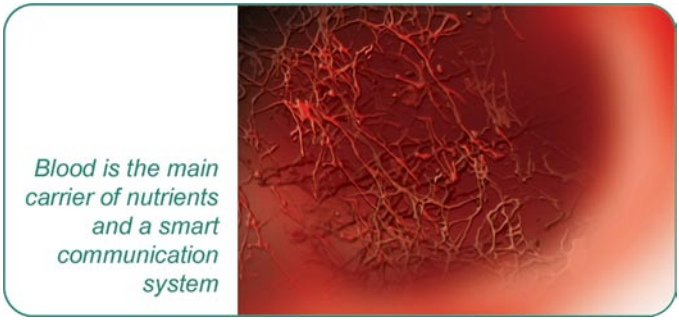
Meaning, applications and analysis



HEMOGLOBIN:
MEANING, APPLICATIONS AND ANALYSIS

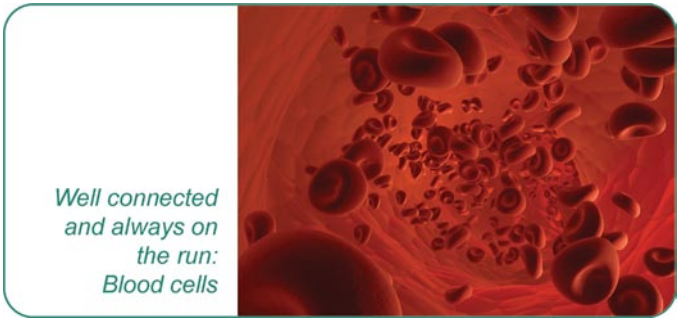
1. The red lifeblood

1.1. Our blood works like a “liquid organ”, with a lot of tasks of vital importance. Circulating through the vessels, it regulates our body’s temperature and ensures a balance of the water, electrolytes and pH-levels. All internal and external organs are well connected by thick veins and arteries, ramified to very thin capillaries to support smallest cell groups. As a main carrier of nutrients (like fats, glucose and oxygen), the blood also transports metabolic products to and from e.g. the heart, liver, lung and kidneys. By this way, it activates manifold processes by hormones, and the blood platelets and white blood cells (the leucocytes) protect us against little injuries, bacteria and viruses.



Blood is the main carrier of nutrients and a smart communication system

1.2. An impressing range of functions, and a very special “cocktail” at all. Checking the components of blood, 1% are nutrients as glucose, lactate, amino, uric and fatty acid, solved in the plasma, a bright yellow liquid with a quota of 50-60% of the approximately 5 liter total blood volume. Please note: Plasma is not to confuse with serum, what is separated from fibrinogen (a substance responsible for some coagulation processes, closing wounds).
The other 40-50% is represented by the red blood cells, the erythrocytes. The amount of red blood cells is also called hematocrit, and differs depending on sex, age, environment and health condition. Typically, women have a 10% lower hematocrit than men. New born babies show a very high hematocrit of 70%, lowered quickly to 30% in their first weeks and rising to normal levels within the years to the adolescence. Increased hematocrit values – or “thick blood” - may be caused by high altitude, compensating the lack of oxygen in the air.



Well connected and always on the run: Blood cells

Other typical reasons are heavy loads, related with a loss of water by sweating. Vice versa, lowered hematocrit values indicate very often an anemia – a typical, first sign of many diseases and the main topic of this brochure.

1.3. Related to the named meanings and relations of blood for our personal health, the consequences of any unexpected shifts in blood composition are easily to imagine. If there is something wrong, we have or we will get problems. Fortunately, blood diagnostics can be performed quickly and painless today.
With modern hemoglobin analyzers, a doctor needs a tiny droplet and a half minute only to check for hidden maladies or treatment requirements. In our responsibility as a market leader in hemoglobin diagnostics, we like to give some information herein about the medical backgrounds, specific kinds and symptoms of anemia.
In addition to the clear advantages of frequent blood tests for everybody's personal care, we hope to demonstrate the related importance for the public as well. Regardless the manifold progresses in modern medicine, blood donations stay an essential, life-saving need for many people. E.g., latest studies show a significant evidence of fresh blood support for a successful therapy and optimum cure in intensive care treatments – not only to provide surgeries and to help victims of road accidents, but mainly to fight against different kinds of cancer. You may not be concerned personally thereof – but as a voluntary blood donor, you can help to improve many patient's prospects. In fact, the secret of life may be found very easy. It flows through your veins, literally!

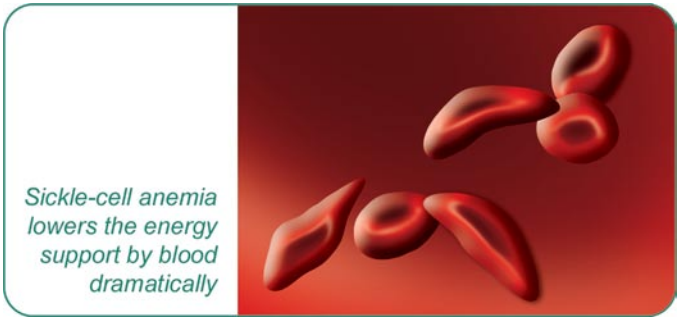
2. Hemoglobin and anemia

2.1. Normally, the amount of red blood cells (the hematocrit) correlates with the hemoglobin. This protein is originally responsible for the red color of blood and for the transport of oxygen by ferrous links in its molecule structure. Caused by an additional, very unfortunate affectation of these links for carbon monoxide and sulfate, such substances are favored by the hemoglobin as well and very dangerous, leading people to the death quickly and without any premonitions.
Also comparable to regular hematocrit levels, reference values of hemoglobin differ from 12 to 17 g/dl. As higher the hemoglobin value, as more oxygen will be carried, providing the body with more energy for higher performance – what is explaining the high interest in blood doping for professional athletes.
A hemoglobin concentration below the reference is called anemia, what means "poverty of blood". With values below 7 g/dl, physicians talk from a serious anemia, involving immediate health risks always related to the reduced blood transport of oxygen.

2.2. Indeed, it is only a small step from the poverty of blood to the poverty of oxygen, or “hypoxia”. Probably we all have felt slight symptoms of a mild hypoxia already, when getting tired, pale or suffering from headache. Our respiration and pulse accelerate, trying to compensate the insufficient support by an increased “turnover”. Very often, this is a first sign for “inner fights” of the immune system of our blood, or from a beginning illness.

Beside such (mostly harmless) phenomena, an anemia may have deeper reasons. There are three general possibilities for low hemoglobin values and bad oxygen support. An increased loss of blood (e.g. after accidents or menstruation), a diminished production (typically caused by insufficient nutrition) or a destruction of blood cells (effect by special infections like jaundice and malaria, or as a result of cancer therapies).

2.3. To evaluate the different kinds of uncommon anemia, it is possible to use special blood cell counters in the lab. These very complex analyzers detect not only the amount, but also the size of red blood cells. Low amounts of normal sized cells may point out a low production, caused e.g. by kidney diseases, dysfunctions of the thyroid gland or protein deficiencies. Oversized red blood cells are a reaction to a lack of folic acid, too much alcohol or gastro-intestinal disorders. A well-known type of destructive or “hemolytic” anemia is the sickle cell anemia, where the red blood cells are deformed and unable to bind oxygen sufficiently. In addition, the immune system recognizes these strange cells as “alien invaders” and tries to eliminate them.



2.4. But at all, with 80% the most common type of anemia are narrowed red blood cells, mainly caused by an iron deficiency. How many serious consequences may result from ignored anemia can dramatically seen

in many developing countries. Every year, a million deaths are caused by iron deficiency, and three-quarters of these deaths occur in Africa and South-East Asia. Besides many other factors, the low awareness of anemia risks is one of the most critical aspects – and the continual hemoglobin monitoring one of the key factors for well manageable, successful health prevention also in industrial countries.
Instead bulky lab analyzers, compact sized hemoglobin photometers like the Hemo_Control and Hemo_Speed are very robust and flexible in use. These modern point-of-care devices are established in most modern doctor's surgeries and analyzing hemoglobin and hematocrit from a tiny blood sample within a few seconds. The following chapters may help to realize what can be detected with, and why we should ask for a hemoglobin test more frequently.

3. Applications for hemoglobin tests

3.1. **Pregnant women** have an increased need of iron and folic acid, not to cover by regular nutrition. In addition, the total blood volume grows 40-50% during the pregnancy, in difference to a 25% increase of red blood cells only. Mild anemia can be managed easily by adapted food provision, but a discounted long-term anemia may lead to premature births and low weight of the infant. In many countries, frequent hemoglobin tests are a strict obligation for pregnant women, to avoid such complications in advance.

Iron supplements may be prescribed to help immediately, but should only be taken in consultation with a doctor and in limited amounts. Too much iron can be toxic! A much better way is to supply the blood production by iron-rich meals with meat, poultry and fish. Beans and cereals are also useful against iron deficiency, and fruits (rich in vitamin C) help to improve the absorption of iron.

3.2. **Children and teens** are also affected by anemia very often, noticeable e.g. by extreme fatigue. After the first six months of infancy, the stored iron is mainly depleted and has to be compensated by iron-rich food.
Breast milk or cow milk cannot cover these needs sufficiently, so a good dietary supply of iron is strictly required in addition. At this early stage, negative impacts by anemia are not leading to temporary delays in children's development only. Sometimes, poorer cognitive or psychomotor capabilities may not be reversible! Children are also harmed by many infections in their first years, as long as the immune system is still "learning". Viruses or chronic inflammations slow the body's ability to produce hemoglobin herein. Undergoing a growth spurt in later years, the production of red blood cells is not going along with and depends on an increased support of iron by nutrients.

Youth people's affinity to fast food fulfils these needs rarely, but leads typically to a lack of vitamins. Regardless low fat diets mean an undue restriction for the blood production, an "overkill" of fats and glucose (especially when combined with low activities) is rather a risk for common "lifestyle" diseases like diabetes, worsening the health situation at all.

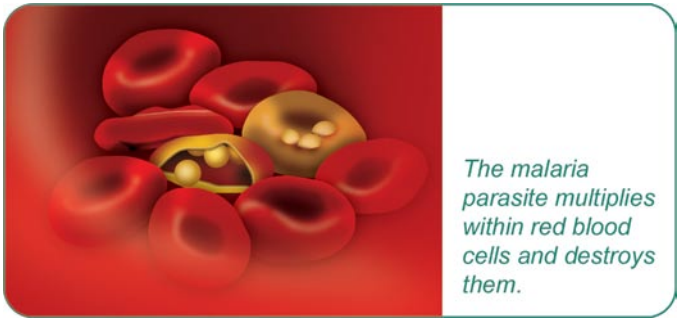
3.3. In total contrast to these phenomena in industrial nations, **malnutrition** is an especially serious danger for children in developing countries. The main problem is not the body weight, but the loss of muscle mass and the limitation of physical functions. Children are a specific risk group herein, because they have a comparatively higher requirement in nutrients, and cannot build a sufficient "deposit" yet. Weakened by malnutrition, the organism loses its ability to oppose against any kind of infectious diseases. Important elements of blood production like iron, folic acid and vitamins are reduced significantly, including a decrease of related kidney functions.
Anemia is caused typically by each of these disorders already, and their combination leads to the death very often. Accompanied by foodstuff supply, screening for anemia is an essential part of prevention herein, performed e.g. in schools or by health services. Cooperating closely with health ministries, the EKF-diagnostic GmbH also supports screening projects in many developing countries, e.g. supplying Hemo_Control hemoglobin meters (well suitable for such applications and easy to handle) as well as establishing "EKF schools" to educate and to assist medical staff locally.

3.4. **Hookworm infections** often occur at malnourished people in southern Europe, Africa and northern Asia – what is about 20% of the worldwide population. As a parasite, the hookworm is transmitted by

contaminated soils and settles down in the small intestine. Sucking blood, he causes diarrhea, cramps, weight loss and anemia, and may retard irreversibly the further development of harmed children. Hookworm infections also mean an increased risk of morbidity and mortality for pregnant women and newborns. To treat it properly and in-time, anemia screening by hemoglobin tests is the quickest, easiest and safest method, performed very successfully in many health projects.

3.5. **Malaria** is a widespread infection disease especially in tropical and subtropical regions, transmitted by mosquito bites and also harming travelers and tourists sometimes. There is no sufficient vaccine protection available yet, but the disease and its symptoms can be well managed by medicals – if supported and affordable: In industrial nations, 99% of malaria patients survive without serious complications. Vice versa and commonly associated with poverty, the majority of 2 million death cases per year are young children (under five years) in Africa.

The parasites multiply within the red blood cells, causing fever, chills, flu-like illness and anemia. As a so-called “hemolytic” anemia, the parasites destroy the red blood cells. This lowers the provision of oxygen and nutrients. Additionally, the increasing amount of unbound hemoglobin in the circulation harms the kidneys and the production of new blood cells in consequence. The only way to stop this severe proceed of infection (e.g. by foodstuff supply and other stimulations of blood production) is an early diagnosis, realized by hemoglobin tests when first symptoms of anemia are given.



3.6. **Hepatitis C** is a common virus infection, mostly showing its first symptoms after decades. Harming the liver (liver cirrhosis), old red blood cells cannot be removed properly. It seems to be in total contrast to an anemia, but leads often to gastrointestinal bleedings and a significant loss of blood finally. To avoid any progress herein and to achieve a

“sustained viral response”, Hepatitis C is typically treated by ribavirin or similar pharmaceuticals. Unfortunately, these kinds of drugs may also lead to a mild anemia and has to be supplied by iron-rich nutrients or medications for an improved hemoglobin production.

3.7. **HIV infections** suppress the production of red blood cells in manifold ways, especially at persons with a progressed infection and symptomatic AIDS. A general limitation is given by the weakened immune system and additionally upcoming bacterial and fungal infections, also affecting the bone marrow as the “starting point” of blood cells. Similar effects are shown at typical treatments with antiretroviral drugs, antibiotics and antifungal medications. In addition, the body’s absorption of urgently required nutrients like iron, folic acid and vitamins is also lowered significantly. Closely related with a high risk of lymphoma cancer, it is very hard to re-establish a sufficient production of red blood cells and hemoglobin again.

3.8. **Cancer** has similar bad influences to the blood production. Patients are harmed as well by a poor absorption of nutrients and a bone marrow infiltration by tumors, or blood loss by colorectal cancer. Beside it, usual kinds of treatment like chemotherapy or radiation may prevent the body from producing enough blood, even killing many blood cells as a “collateral damage”. Vice versa and according latest studies, higher hemoglobin levels (what means a lower hypoxia, both realized by iron supplements or blood transfusions) are backing the success of radiation therapies. As more oxygen is in the blood, as easier the cancer infiltrated cells can be killed and as better is the outcome of the patient.

4. Blood donation

4.1. Even the best and newest pharmaceuticals cannot replace the manifold and complex functions of “real” blood, urgently required for surgeries, cancer therapies and research tasks. In consequence, the donation of own blood stays continually an indispensable need. A common method is the donation of whole blood. Therefore a half liter is taken from the basilic vein, to be separated in different “blood products” (erythrocyte concentrations, blood platelets and plasma) afterwards. This means the blood from a single donor can be used for different patients, providing different therapies.

4.2. Including the preparation and recreation phase of the donor, the whole procedure lasts less than one hour. The suitability of a donor is proven by a quick hemoglobin-test in the beginning, ensuring a health condition and avoiding donations with a Hemoglobin-level out of the regular range. As an additional advantage, the blood will be checked

after donation for potential HIV, Hepatitis or other diseases. Like the donation itself, all of these analyses, cross-checks of blood groups and subsequent preparations reduce the risk of any infections and make the transfusion of blood very safe also for the patient. The body compensates the blood donation within 2-3 months, allowing a frequent donation 4-5 times per year.

4.3. Donations of plasma and blood platelets can also be performed more frequently and lowering body's stress. Thereby the blood of the donor is set back to its blood circulation again, separated only from the required components. This method is much more economic than a typical whole blood donation, and helps significantly to cover the growing demand of hospitals. In addition, the compatibility of blood platelet donations is determined by some other particular features. Often, well-suitable donors will be individually listed for the long-term treatment e.g. of cancer patients, improving their state of health and the success of therapy.

5. Basic sampling notes

5.1. Correct sampling of blood is an essential supposition for proper analyses and meaningful readings. Whereas clinical analyzers require big sample volumes and an elaborate sample preparation (e.g. centrifuging the sample container), the handling of point-of-care analyzers like Hemo_Control and Hemo_Speed is much more convenient for doctor and patient both. The uptake of a pinhead-sized droplet of blood has to be performed by small microcuvettes from the earlobe or the fingertip directly.

5.2. Therefore the skin must be prick by a "lancet", available in different types and lancing depths for different sample sizes. Single-use metal lancets were used very often in past times, but patient's pain can be reduced by using modern safety-lancets. Protected in a plastic case, they release once only when pressed briefly and cannot be used by mistake again. As an alternate method were also offered lancing devices with replaceable lancets inside, more common for individual diabetics and not recommended for clinical use according to their strict hygienic directives.

5.3. To avoid resting risks of infections, disposable protection gloves are a "must have" for the medical staff, as well as a careful disinfection of patient's skin with alcohol pads or disinfection sprays. It is also helpful to wash the skin with warm water, to eliminate sweat rests and to stimulate the blood circulation, and to dry the skin afterwards.

5.4. Sampling from the earlobes is recommended because there are less nerves and sweat glands. Finger tips are much more sensible and have to be cleaned very carefully. In addition, hemoglobin readings from finger tip are slightly lower than readings from the earlobe! Wrong readings can also be caused by heavy pressing of the sampling area, contaminating the sample by interstitial fluid and sweat from the surrounding skin. If the blood drop should not be sufficient, a new “prick” may help as well as warm water or massaging the skin before disinfection and cleaning.

5.5. Regardless the many advantages of a direct sample uptake, the medical staff has to keep in mind the quick changes of a non-stabilized blood sample. Within a half minute the coagulation of blood already starts, and newly generated sweat contaminates the sample. Also the “wound” is closing quickly and the patient has to be lanced again. For that reason, lancing and sampling should be performed in an immediate sequel.

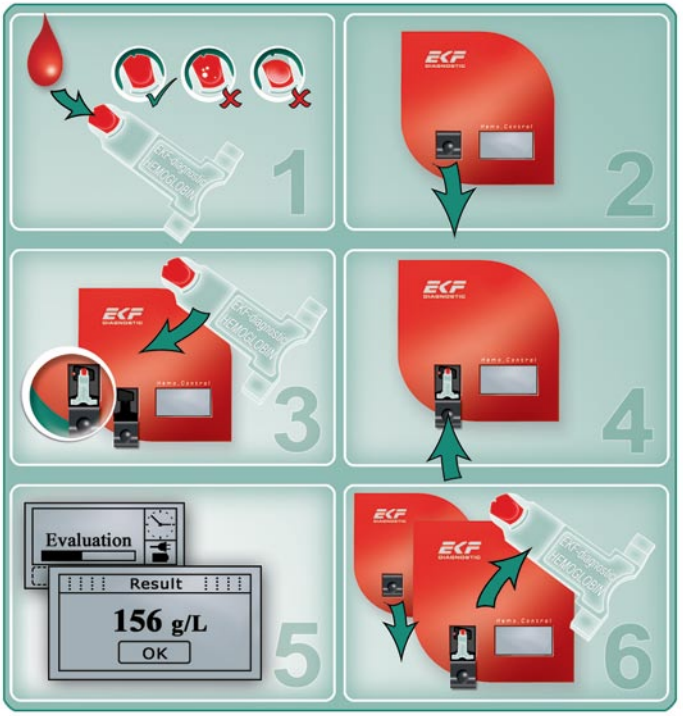
5.6. Additionally, the first droplet has to be wiped away, to get a 100% clean, sufficiently sized blood drop for the following sample uptake in one step. A repeated uptake of too small blood amounts by the same microcuvette may lead to enclosed air bubbles, an uneven mixture with the chemistry reagent inside and potential misreadings at the end.

5.7. The sample uptake itself takes less than a second, with automatic dosage of the required blood volume of 8 µl (remaining blood rests outside of the microcuvette can be wiped away with a tissue).
With the new microcuvettes for Hemo_Control and Hemo_Speed and their improved sampling tip, the uptake is very easy now. Other systems require a special position and angle of the cuvette therefore, what was hardly to manage for less experienced users.

6. Hematology analyzer

To get familiar with the comfort use of Hemo_Control, please visit our homepage and try the “VisiGuide” for a demonstration of general operation and menu functions. There will also be found additional information to hematology analyzers, added by our latest product catalogue with all EKF devices, supplies and consumables.

Quick guide to hemoglobin analysis with Hemo_Control:



Hemo_Control
Quick reading of hemoglobin and hematocrit from one sample for safe and easy handling with the new EKF micro cuvettes. Measurement time approx. 25 sec., low sample volume of 8 µL for painless sampling, wide measurement range, no maintenance required, graphical touchscreen with multilingual menu, cost-effective consumables, worldwide proven photometer for mobile and stationary use.

Hemo_Speed
Specially developed photometer for blood donor services, offers very quick readings in standard range including automatic calculation of hematocrit. Measurement results approx. 10 sec. with 8 µL sample volume only, graphical touchscreen with multilingual menu, cost-effective consumables, no maintenance required, for mobile and stationary use.

Chempaq XBC
Comfort hematology analyzer for quick detection of leucocytes (WBC, LYM, MON, GRN and HGB) or erythrocytes (RBC, HCT, HGB, MCV, MCH and MCHC) within three minutes, using pre-filled PAQ cartridges for simple use. Blood cell counter without additional reagents, pre-calibrated for simple use. A time-saving, budget and demand-oriented solution for GPs and small labs. Compact sized and easy to operate with WBC-cartridge, RBC-cartridge or cost-effective micro cuvettes for simple haemoglobin measurements. No maintenance required thanks automatically performed electronic quality control. Available in selected countries.

Appendix:

Common abbreviations of hematology terms

WBC	White blood cells
RBC	Red blood cells
HGB	Hemoglobin
HCT	Hematocrit
MCV	Mean corpuscular/cellular volume
MCH	Mean corpuscular/cellular hemoglobin
MCHC	Mean corpuscular/cellular hemoglobin concentration
RDW	EVB
PLT	Platelets
MPV	Mean platelet volume
PCT	Thrombocrit
PDW	Platelet distribution width

8. Literature (selection):

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Please ask for further information, available as download or printed brochures for free:

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Additional diagnostic tools can be found in our latest product catalogue and in the Internet:
www.EKF-diagnostic.com, sales@EKF-diagnostic.com
Select a device and click to the “VisiGuide” button!

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Visiguide Lactate SCOUT

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