

Red cell indices MCV, MCH, MCHC

Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were first introduced by Wintrobe in 1929 to define the size (MCV) and hemoglobin content (MCH, MCHC) of red blood cells. Termed *red cell indices*, these values are useful in elucidating the etiology of anemia's. Red cell indices can be calculated if the values of hemoglobin, hematocrit (packed cell volume), and red blood cell count are known. With the general availability of electronic cell counters, red cell indices are now automatically measured in all blood count determinations.

Normal value and Definition

MCV defines the size of the red blood cells and is expressed as femtoliters (10^{-15} ; fl) or as cubic microns (μm^3). The normal values for MCV are 80-100 fl

MCH quantifies the amount of hemoglobin per red blood cell. The normal values for MCH are 26-32 picograms (pg) per cell.

MCHC indicates the amount of hemoglobin per unit volume. In contrast to MCH, MCHC correlates the hemoglobin content with the volume of the cell. It is expressed as g/dl of red blood cells or as a percentage value. The normal values for MCHC are 32-36 g/dl.

Technique

Red cell indices MCV, MCH and MCHC are calculated from hemoglobin, hematocrit, and red blood cell count as follows:

$$\text{MCV (fl or } \mu\text{m}^3) = \frac{\text{PCV} \times 10}{\text{RBCs count}}$$

$$\text{MCH (pg/cell)} = \frac{\text{Hb} \times 10}{\text{RBCs count}}$$

$$\text{MCHC (g/dl or \%)} = \frac{\text{Hb} \times 100}{\text{Pcv}}$$

Most clinical laboratories now use automated machines to perform blood counts (commonly called CBC) that include red cell indices as part of the profile.

Although the automated cell counters are fast, convenient, and precise, certain conditions can interfere with machine calculations and result in spurious values. It is important that clinicians become familiar with the more common causes of spurious results with electronic counters

- In *red cell agglutination*, doublet erythrocytes are counted as one, and larger clumps are not counted as red blood cells at all. This leads to a "decrease" in red cell count and a falsely elevated MCV. Determination of the hemoglobin value is not affected. Rewarming the sample eliminates these spurious values.
- Hemoglobin is quantified based on its absorption characteristics. Conditions such as *hyperlipidemias*, hyperbilirubinemia, a very high white blood cell count, and high serum protein can interfere with this measurement and result in falsely elevated hemoglobin values.
- Presence of immunoglobulin or fibrinogen precipitated by low temperatures in the blood sample leads to interference with cell counts, resulting in spuriously increased white blood cell count and sometimes small elevations in hemoglobin, hematocrit, red blood cell count, and a slight decrease in MCV. rewarming the sample to 37°C will correct the artificial values.
- When the values of hemoglobin, red cell count, and MCV are affected, MCH and MCHC also become abnormal, since these indices are calculated and are not directly measured.

Interpretation the results

1-MCV results:

The MCV is higher than normal when red blood cells are larger than normal. This is called macrocytic anemia can be caused by:

- Vitamin B-12 deficiency
- folate deficiency
- chemotherapy
- preleukemias

The MCV will be lower than normal when red blood cells are too small. This condition is called microcytic anemia may be caused by:

- iron deficiency, which can be caused by poor dietary intake of iron, menstrual bleeding, or gastrointestinal bleeding
- thalassemia
- chronic diseases

2-MCHC results

If you have a high MCHC, this means that the relative hemoglobin concentration per red blood cell is high. MCHC can be elevated in diseases such as:

- hereditary spherocytosis
- sickle cell disease
- homozygous hemoglobin C disease

If you have a low MCHC, it means that the relative hemoglobin concentration per red blood cell is low.

- iron deficiency
- chronic diseases
- thalassemia

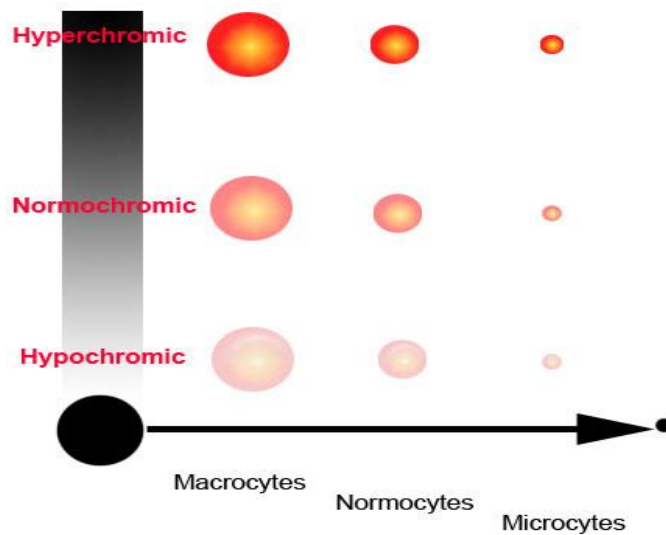
3-MCH results

The conditions that cause low level in MCH are:

- Different types of anemia
- Celiac disease
- lacking vitamins such as B12

The conditions that cause high level in MCH are:

- liver diseases
- an overactive thyroid gland
- complications from certain cancers
- taking too many medications containing estrogen



Erythrocytes that have a normal size or volume (normal MCV) are called **normocytic**,

When the MCV is high, they are called **macrocytic**.

When the MCV is low, they are termed **microcytic**

Erythrocytes containing the normal amount of hemoglobin (normal MCHC) are called **normochromic**.

When the MCHC is abnormally low they are called **hypochromic**, and when the MCHC is abnormally high, **hyper chromic**.