COMPLETE BLOOD COUNT (CBC)

TERM DEFINITION

A test that measures blood cell counts and morphology using an automated cell counter.

NORMAL CBC

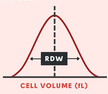
Example of a normal CBC:

WBC	RBC	Hgb	Hct	MCV	MCH	MCHC	RDW	RDWSD	Plt Ct
6.1	5.19	16.0	46.3	89	30.8	34.6	12.6	41.1	276

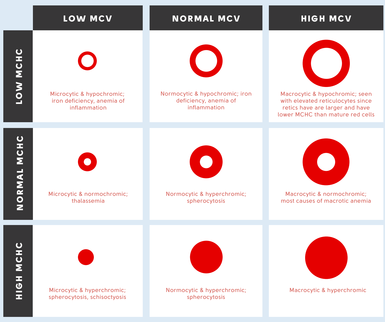
CELL COUNTS	COMMENTS
WHITE BLOOD CELL COUNT (WBC)	• Normal 4.5-11 x 10^3/L. • Includes total white cells. • Does not include differential.
RED BLOOD CELL COUNT (RBC)	• Normal 4.2-6.1 x 10^{12}/L. • Provides little useful information. • Higher in thalassemia than iron deficiency anemia.
PLATELET COUNT (Plt Ct)	• Normal 150-450 x 10^3 /L • Artificially low if platelet clumping

Hb & Hct	COMMENTS
HEMOGLOBIN (HB) Directly measured	• Normal 12-17.5 g/dL. • Carries oxygen.
HEMATOCRIT (Hct) Derived from: Hct = MVC x RBC count	• Normal 36-50%. • Typically calculated from MCV and RBC count. • Does not equate with oxygen carrying capacity.

RED CELL MORPHOLOGY / INDICES	COMMENTS
MEAN CORPUSCULAR VOLUME (MCV)	• Normal 80-100 fL. • Measures mean volume of red cells. • The most clinically helpful of the red cell indices.
MEAN CORPUSCULAR HB (MCH)	• Normal 28-32 pg. • Measures weight of cell in Hb. • Not clinically helpful since it tracks with MCV & MCHC.
MEAN CORPUSCULAR HB CONCENTRATION (MCHC)	• Normal 32-36 pg/dL. • Measures concentration of Hb inside red cell. • Especially helpful in differential diagnosis of microcytic anemia.

RED CELL WIDTH DISTRIBUTION (RDW)	COMMENTS
Histogram of red cell volumes from a single individual, based on analysis of millions of cells.  CELL VOLUME (fL)	Dotted vertical line corresponds to the MCV, the horizontal line with the degree of size variation (RDW). • Increased variation is called anisocytosis. • **2 TYPES OF RDW:** ◦ **RDW-CV:** expressed as a percentage of the MCV (normal < 15%). ◦ **RDW-SD:** expressed as an actual volume (width of the horizontal line; normal = < 45 fL).

SCHEMATICS



Note: *The MCH increases as one moves from left to right (increasing MCV) and from top to bottom (increasing MCHC).*

HEMOGLOBIN OR HEMATOCRIT?

When anemia is present, we should refer to the Hb since that is the rate limiting step in oxygen delivery. When the Hct/Hb are elevated, it is reasonable to speak of the Hct, since that is now rate limiting owing to its effect on blood viscosity.

CLINICAL PEARLS

Don't be intimidated by the CBC; with some practice you will feel like a true detective!

Compare the Hb & Hct; if the ratio is not 1:3, the patient has hypochromia (MCHC = Hb/Hct) and most likely iron deficiency.

Regardless of the white cell count, order a differential if there is any suspicion of an abnormality. Abnormalities in the differential can get buried under a normal WBC.

If the platelet count is low for the first time in a patient, obtain a peripheral smear to rule out platelet clumping and pseudothrombocytopenia.

If there are additional CBCs available for a patient, take a look at them. There is a lot of information to glean from a time series (for example, if a patient with microcytosis has always had a low MCV, thalassemia is high on the differential).

APPROACH TO INTERPRETING THE CBC

STEP 1

1. **Examine the WBC:** decreased (leukopenia), normal or increased (leukocytosis)
2. **Examine the Plt Ct:** decreased (thrombocytopenia), normal or increased (thrombocytosis)
3. **Examine the Hgb:** decreased (anemia), normal or increased (polycythemia)
4. **Check the MCV:** decreased (microcytosis), normal, or increased (macrocytosis)
5. **Check the RWD:** normal or increased (anisocytosis) [no such thing as abnormally low RDW]
6. **Check the MCHC:** decreased (hypochromia), normal or increased (hyperchromia)

STEP 2

Summarize the changes (succinctly)

STEP 3

Consider the differential diagnosis

EXAMPLE

STEP 1

1. **WBC:** normal
2. **Plt Ct:** increased
3. **Hb:** decreased
4. **MCV:** decreased
5. **RWD:** increased
6. **MCHC:** decreased

STEP 2

Microcytic, hypochromic anemia with anisocytosis and thrombocytosis

STEP 3

Almost certainly iron deficiency anemia

HISTORY OF MEDICINE

The complete blood count arose from the introduction of automated counters in the later 1950s. Before that time, clinicians had to count red cells by hand under the microscope, which was a laborious and error-prone exercise. They coupled hand counts with Hct measurements (the earlies centrifuges to determined Hct were manually operated!) to obtain the mean cell volume (MCV = Hct/RBC count). They also had methods to quantitate hemoglobin concentration. But it simply wasn't feasible to scale up these red cell assays, so very few patients were actually tested.

NOTES

ATTRIBUTIONS
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The Blood Project
ENCYCLOPEDIA OF BLOOD