Practical Endocrinology

Red Cell Indices

Zhikal O. Khudur
Gasheen Bakhtiyar

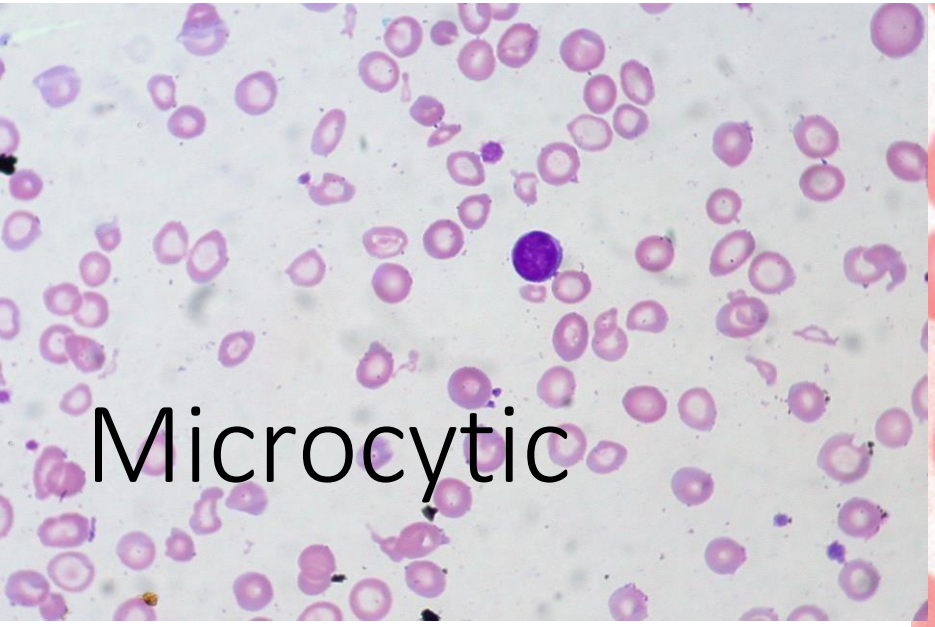
Endocrinology BIO
Spring semester
Week 7
0/ 0 /2024

Red Cell Indices

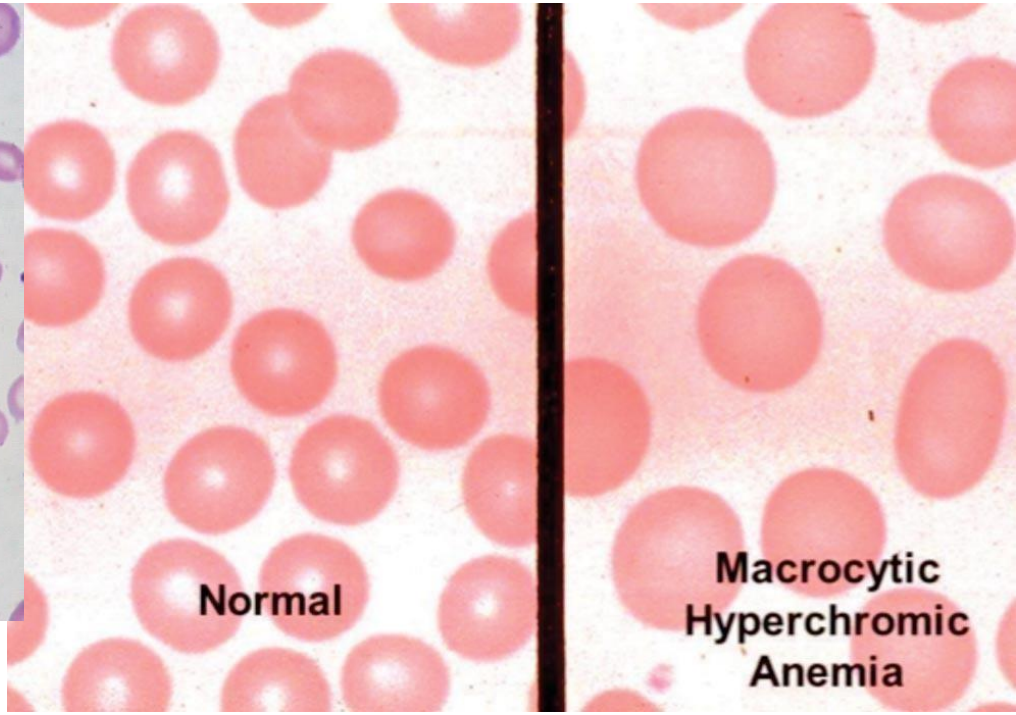
- The calculation of the **size** and **haemoglobin** content of the red cells from the **Hb**, **PCV** and **red cell count**, have been widely used in the classification of anemia. The three most common indices are the **MCV**, the **MCH, MCHC.**
- The **MCV** is the **average volume of a single red cell** expressed in femtoliters (fl) or 10^{-15} L. It helps in determining the size of the RBC. The PCV and red cell volume are used in its calculationHC and the MCHC

Mean Corpuscular Volume (MCV)

- MCV = $\frac{\text{Hct(L/L) x 1000}}{\text{RBC count (x } 10^{12}\text{/L)}}$
- Normocytic: 80-100 fL
- Microcytic: Red cells <(80 fL)
- Macrocytic: Red cells (>100 fL)
- The MCV is increased in macrocytic anemias (e.g. **megaloblastic anemia**) and decreased in microcytic anemias (e.g. **iron deficiency, thalassemia**)
- Example:
- **PCV** = 0.45 L/L (45%), **RBC** = 5 x 1012/L
- MCV = $\frac{\text{PCV X 10}}{\text{RBC}} = \frac{\text{45(\%) x 10}}{\text{5}} = 90$ fl



Microcytic



MEAN CELL HEMOGLOBIN CONCENTRATION

- The **MCHC** is the **concentration of haemoglobin per unit volume of red blood cells** expressed as a percentage, g/dl or g/l. Hemoglobin and PCV are required to calculate MCHC. It is the ratio of hemoglobin mass to volume in which it is contained
- $\text{MCHC} = \frac{\text{Hb(g/dl)}}{\text{PCV\%}} \times 100$
- Normochromic: 32-36g/dl
- Hypochromic: less than 32g/dl
- Hyperchromic: >36g/dl
- Example:
- If one liter of blood contains 0.45 liters of packed cells and 150g of Hb (150g Hb are contained in
- 0.45 liters of RBCs). What is the MCHC(Hb) concentration?
- **Hb** = 15 g/dl (150 g/l), **PCV** = 45% (0.45 l/l)
- $\text{MCHC} = \frac{\text{Hb (g/dl)}}{\text{PCV\%}} \times 100 = \frac{15}{45} \times 100 = 33.3\%$ or 33.3 g/dl = 333.3 g/l

MEAN CELL HEMOGLOBIN CONCENTRATION

- **Hypochromic**: If the area of central pallor is >1/3rd of the cell size
- **Hyperchromic**: The only erythrocyte that is hyperchromic with an MCHC of > 36g/dl is the spherocyte
- **Apparent hyperchromasia** (high MCHC) is usually due to an artifactual increase in the haemoglobin result, due to haemolysis, lipaemia, or large numbers of Heinz bodies

- **Low MCHC** values are found in **iron deficiency anemia** and other conditions in which the red cells are microcytic and hypochromic.
- An **increased MCHC** can occur in marked **spherocytosis**.

MEAN CELL HEMOGLOBIN

- **MCH** is the **average weight in picograns of Hb in one red cell**. The Hb level and the RBC count are used for calculation.
- MCH = $\frac{\text{Hb (g/dl) x 10}}{\text{RBC(x 10 12/L)}}$

MCH varies in **direct linear** relationship with the **MCV**.
Cells with less volume contain less Hb and vice versa

Normal value for the MCH : **28 to 34 pg**

MEAN CELL HEMOGLOBIN

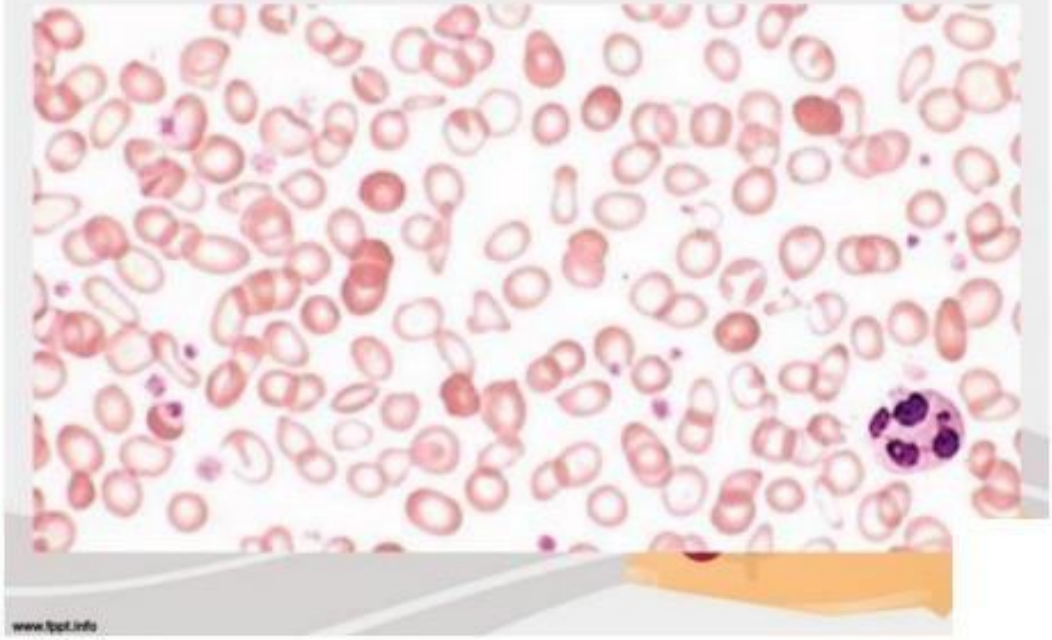
MCH Increase

- B12 deficiency
- Folic acid deficiency
- Reticulocyte
- Hemolytic anemia
- alcoholism

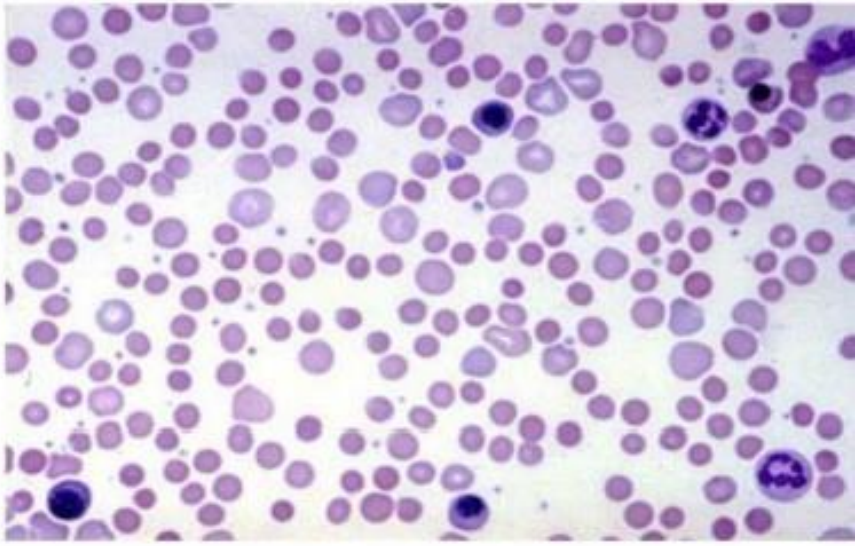
MCH Decrease

- Iron deficiency anemia
- Thalassemia
- Anemia of chronic disorder

Hypochromic microcytic anemia of iron deficiency (peripheral blood smear)



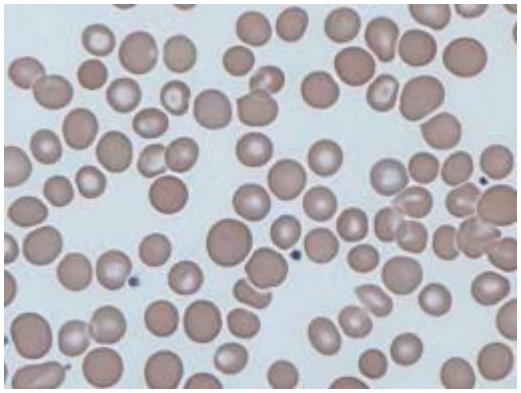
Hyperchromic RBCs



Value	Formula	Normal Range
MCV (fl)	$\frac{\text{PCV (\%) x 10}}{\text{RBC (millions / mm}^3\text{)}}$	**(80-100)76 – 96 fl**
MCH (pg)	$\frac{\text{Hb (g/100ml) x 10}}{\text{RBC (millions / mm}^3\text{)}}$	**28 – 34 pg**
MCHC (x 100%w/v)	$\frac{\text{Hb (g/100ml) x 100}}{\text{PCV (\%)}}$	**32 – 36%**

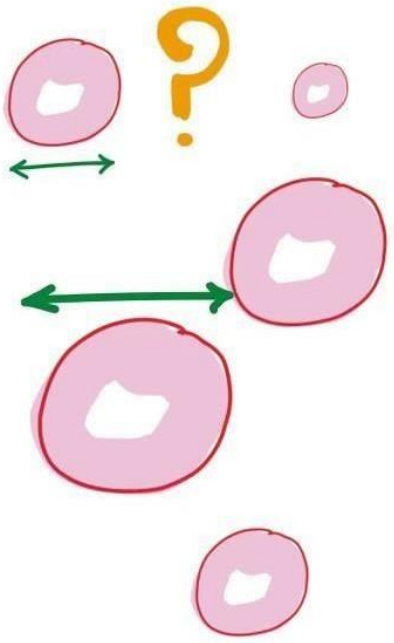
RED CELL DISTRIBUTION WIDTH

- **RDW** is **used because MCV is less reliable in describing the erythrocyte population when considerable variation in erythrocyte size occurs**.
- RDW is **a coefficient of variation in size distribution of RBCs**
- Measured as : RDW = $\frac{\text{Standard deviation of MCV} \times 100}{\text{MCV}}$
- Normal value:11.5-14.5%
- Increased value indicates **ANISOCYTOSIS**



- RDW is **increased** in **Iron deficiency anemia**.
- While RDW is **normal** in **Thalassaemia minor**.
- **Combination of low MCV and high RDW** is one of the best screening test for the **Iron deficiency anemia.**

Red Cell Distribution Width (RDW)



differential diagnosis anaemia depend on MCV RDW

Condition	RDW	MCV
Nutritional deficiencies		
Iron deficiency	↑	↓
Folic acid deficiency	↑	↑
Vitamin B deficiency	↑	↑
β-thalassemia	↑	↓
Hemolytic anemias		
Immune hemolytic anemia	↑	↑
Hereditary spherocytosis	N/↑	N/↓
Anemic hemoglobinopathies (i.e., SS, SC)	↑	N
Sickle cell trait	N	↓
Chronic disorders		
Chronic diseases anemia	N	↓
Chronic liver disease	↑	N/↑
Hematologic disorders		
Aplastic anemia	N	↑
Chronic leukemias	N	N
Myelodysplastic syndrome	↑	↑
Other thalassemias	N	↓
Acute hemorrhages	N	N

↑, increased; N, normal; ↓, decreased. RDW, red blood cell distribution width; MCV, mean corpuscular volume.

- 25 yr old Patient with history of fatigue
- RBC: 3.0 x 106 /µl
- Hb: 8.0 g/dl
- MCV: 62 fl
- MCH: 19.0 pg
- MCHC: 30 g/dl
- WBC: 5.3 x 10^9/l
- Platelets: 400 x 10^9/l
- Impression:
- MICROCYTIC HYPOCHOMIC ANEMIA
- Differential diagnosis?

26 yr, Patient of low socio economic status comes with history of weakness since 6 months, history of chronic abuse of PPI.

- RBC: 3.0 x 106 /µl
- Hb: 11.0 g/dl
- MCV: 75 fl
- MCH: 24.0 pg
- MCHC: 29 g/dl
- WBC: 5.3 x 109/l
- Platelets: 400 x 109/l
- RDW: 17%
- Interpretation?
- Microcytic hypochromic anemia
- Is Vit B12 def possible in this patient?
- A case of dimorphic anemia or combine anemia.

If yes - explain MCV?