CBC interpretation

CBC interpretation objectives

- Safe CBC interpretation
- Approach to Anemia
- Diagnosis and highlight about polycythemia
- Diagnosis and highlight about thrombocytopenia
- Diagnosis and highlight about Thrombocytosis
- Diagnosis and highlight about neutropenia and leukopenia.
- Diagnosis and highlight about Pancytopenia

- The major components of CBC are:

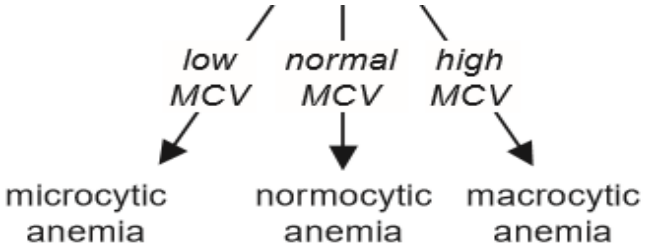
  1-Hb2-WBC3-plateltes

  If all major components are normal, then it is very less likely you miss a serious disease.

- Safe CBC interpretation:
  1- look at Hb>>if low >> look at other major components (WBCs and Platelets) to not miss a bone marrow disease.
  2- if there is no striking abnormality of WBC and platelet then check MCV to classify the anemia into microcytic, normocytic or macrocytic.
  3- some references recommend to check reticulocyte before MCV to not miss hemolytic anemia but not practical.

Anemia

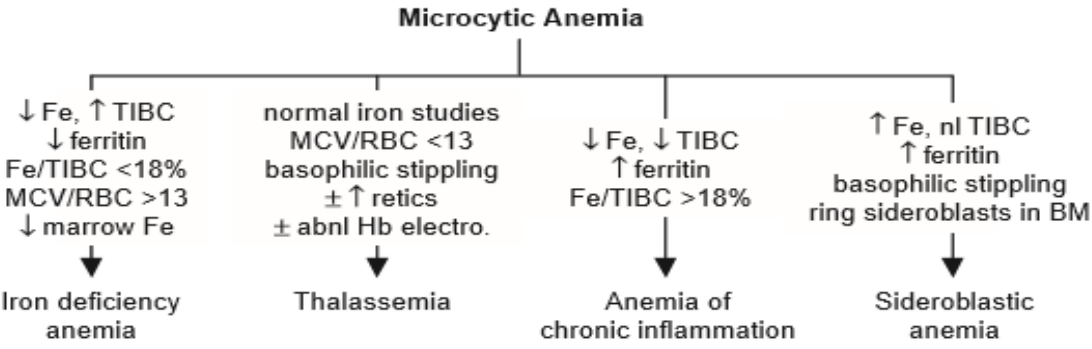
- Anemia Classification based on MCV:



- Helpful parameters to diagnose the underlying cause of anemia
  - Size of red blood cells (MCV): (small/ normal/ big)
  - Abnormal cells on microscopic examination (like blast cells in leukemia)
  - Status of leukocytes and platelets (bone marrow function)
  - Reticulocyte count (ability of marrow to respond to anemia)>> can help in hemolytic anemia (if high) and in marrow suppression (if low).
  - Evidence of destruction(hemolysis) >> (elevated LDH and indirect bilirubin)

Microcytic anemia

Figure 5-2 Approach to microcytic anemias



- **features might help in distinguishing between IDA and Thalassemia**

feature	IDA	Thalassemia
RBC	Low, Low normal	High, High normal
MCV	Mild to moderate low (most likely above 70)	Very low (< 70)
RDW	Mostly High	Mostly normal
Mentzer index: MCV/RBC	> 13	< 13

IDA treatment

NOTE: Consider upper and lower GI endoscopy for any males (esp. elderly) and postmenopausal women to R/O GI malignancy

- How much Hb increment is excepted with treatment?

  -Around **2** to **4 g/dL**every three weeks.

  (if Hb increased in slower rate >> check for ongoing bleeding??
- How long the treatment course is expected?

  -Oral Fe TID (or less if not tolerated)

  (around 6 weeks to correct anemia; and 6 months to replete Fe stores)

❖ Case: A 25 year- old lady, presented with 2 months H/O dizziness and fatigue

WBC	7. 0	4 – 11	x10.e9/L	
RBC	3.7	L	4.2 – 5.5	x10.e12/L
HGB	90	L	120 – 160	g/L
HCT	28	L	42 – 52	%
MCV	73	L	80 – 94	fl
MCH	23.6 L		27 – 32	pg
MCHC	320		320 – 360	g/L
RDW	15.8 H		11.5 – 14.5	%
PLT	330		140 – 450	x10.e9/L

Interpretation: Hypochromic microcytic anemia, Most likely: IDA

NOTE: Generally, The Hb threshold for blood transfusion for asymptomatic patient is <70 g/L

- -

❖ Case: A 29 years old female came for premarital checkup:

WBC	7. 0	4 – 11	x10.e9/L	
RBC	5.3	L	4.2 – 5.5	x10.e12/L
HGB	101	L	120 – 160	g/L
HCT	40	L	42 – 52	%
MCV	62 L		80 – 94	fl
MCH	25.3	L	27 – 32	pg
MCHC	320		320 – 360	g/L
RDW	14.1		11.5 – 14.5	%
PLT	339		140 – 450	x10.e9/L

interpretation: Hypochromic microcytic anemia, Most likely: Thalassemia

-What you will order to confirm Dx?
Hemoglobin electrophoresis (HE).

-What do you expect in HE?
If HB A2 is > 3.5 >>> B-Thalassaemia Minor
If HB A2 is normal >>> alpha Thalassaemia Minor

○ Normocytic anemia

DDxof normocytic anemia:

- ❖ Anemia of chronic inflammation or disease like:

1. Chronic kidney disease
2. autoimmune disorders
3. chronic infection
4. malignancy.
5. Combined Macrocytic and microcytic anemia in the same time.

Case : A 44 years old gentleman k\c of CKD , c.o generalized weakness:

WBC	8.5	4 – 11		x10.e9/L
RBC	5.1	L	4.2 – 5.5	x10.e12/L
HGB	107	L	120 – 160	g/L
HCT	41	L	42 – 52	%
MCV	88		80 – 94	fl
MCH	29		27 – 32	pg
MCHC	340		320 – 360	g/L
RDW	14.1		11.5 – 14.5	%
PLT	339		140 – 450	x10.e9/L

Creatinine :.....	188	H	53-106 µmol/L
Urea :.....	7		2.5 to 7.1 mmol/L
eGFR:	34	mL/min/1.73 m^2	

interpretation: normocytic normochromic anemia, Most likely: secondary to chronic kidney disease

---

MACROCYTIC ANEMIAS

- **Megaloblastic :**
  - Vitamin B12 deficiency
  - Folate deficiency
- **Non-megaloblastic**:
  - Liver disease, Myelodysplastic syndrome, Increased reticulocyte count , Alcoholism >>> :BM suppression &macrocytosis independent of folate/B12 deficiency.or liver cirrhosis

Case: 38 years old gentleman post gastric bypass, c.o fatigue

WBC	6.5		4 – 11	x10.e9/L
RBC	5.3		4.2 – 5.5	x10.e12/L
HGB	109	L	120 – 160	g/L
HCT	41	L	42 – 52	%
MCV	99	H	80 – 94	fl
MCH	42	H	27 – 32	pg
MCHC	340		320 – 360	g/L
RDW	14.1		11.5 – 14.5	%
PLT	339		140 – 450	x10.e9/L

Interpretation: Macrocytic hyperchromic anemia, could be secondary to Vit b12 deficiency

- What you will order for this patient?

Vit b12 and folate level.

Hemolytic anemia:

hemolytic anemia is suspected in a patient with chronic or new onset anemia with reticulocytosis and not due to another obvious cause.

Case: 17 years old girl, c.o yellowish discoloration of skin and dark urine.

CBC

WBC 10.5		4 – 11		x10.e9/L
RBC 4.9		4.2 – 5.5		x10.e12/L
HGB	92	L 120 – 160		g/L
HCT 36		L 42 – 52		%
MCV 86		80 – 94		fl
MCH 29		27 – 32		pg
MCHC 352		320 – 360		g/L
RDW 14.3		11.5 – 14.5		%
PLT 223		140 – 450		x10.e9/L

LFT:

Total bilirubin	48	H	(3- 17 umol/L)
Direct bilirubin 4			(0 – 5 umol/L)
Total protein	73		(60-80 g/L)
Albumin 38			(35-50 g/L)
Alkaline phosphatase 55			(50-136u/L)
Alanine aminotransferase ……40			(20-65 u/L)
Aspartate aminotransferase ...22			(10-31 u/L)
G.G. Transferase 40			(5-55 u/L)

Interpretation: anemia (normocytic) associated with high indirect bilirubin.

What you will order?

Reticulocyte>> excepted to be high > 4%, LDH expected to be high and Haptoglobin expected to be low.

Main DDx of high indirect bilirubin:

Blood Hemolysis,Gilbert's syndrome and Crigler–Najjarsyndrome(mainly in neonate).

Some Causes of hemolytic anemia :

Sickle cell anemia
G6PD
Thalassemia
Drugs
Autoimmune diseases

Polycythemia:

Polycythemia is a laboratory finding in which there is an increased number of red blood cells (RBC), along with an accompanying increase in the concentration of hemoglobin in the peripheral blood.

- It could be primary (polycythemia vera) or secondary (in response to hypoxia)

Case: 37 years old lady c.o headache and plethora of face.

WBC	17.6	H4 – 11	x10.e9/L
RBC	7.2	H 4.2 – 5.5	x10.e12/L
HGB	19.3	H120 – 160	g/L
HCT	59	L 42 – 52	%
MCV	91	80 – 94	fl
MCH	30	27 – 32	pg
MCHC	340	320 – 360	g/L
RDW	14.1	11.5 – 14.5	%
PLT	339	140 – 450	x10.e9/L

- What is the most important test to approach polycythemia?

-erythropoietin

- Low erythropoietin >> most likely primary polycythemia (polycythemia Vera)
- High erythropoietin >> most likely secondary polycythemia (smoking, COPD, high altitude congestive heart failure ..)

Polycythemia Vera sometimes combined with high WBC and/or platelet.

Thrombocytosis:

Case: A 48 years old lady c.o leg redness and hotness (cellulitis)

WBC	6.5	4 – 11	x10.e9/L
RBC	5.3	4.2 – 5.5	x10.e12/L
HGB	132	120 – 160	g/L
HCT	45	42 – 52	%
MCV	88	80 – 94	fl
MCH	31	27 – 32	pg
MCHC	340	320 – 360	g/L
RDW	14.1	11.5 – 14.5	%
PLT	521	H140 – 450	x10.e9/L

Interpretation: Thrombocytosis, Most likely reactive based on Hx

- **patients with elevated platelet counts, the initial diagnostic question is whether their thrombocytosis is**
  1. reactive phenomenon (infection, post-surgery or Trauma..)

  or

  2. a marker for the presence of a hematologic disorder (chronic myeloproliferative neoplasms...).

Thrombocytopenia

WBC	9.2	4 – 11	x10.e9/L
RBC	5.1	4.2 – 5.5	x10.e12/L
HGB	14.2	120 – 160	g/L
HCT	46	42 – 52	%
MCV	91	80 – 94	fl
MCH	30	27 – 32	pg
MCHC	340	320 – 360	g/L
RDW	14.1	11.5 – 14.5	%
PLT	92	L140 – 450	x10.e9/L

- Thrombocytopenia (ie, platelet count <150,000/microL [150 x 10^9/L])
- Severe spontaneous bleeding is most likely with platelet counts <20,000 to 30,000/microL, especially below 10,000/microL.
- Surgical bleeding generally may be a concern with platelet counts <50,000/microL
- DDx is wide and including bone marrow malignancy.

Leukopenia and neutropenia:

Case: A 17 y old gentleman k/c of AML on chemotherapy c.o Fever

Test Name	Result	Units	Flag	Reference Range
CBC W/ 5 PART DIFF. (X6)				*Run by:*
WBC	2.2	K/uL		4.0 - 11.2
RBC	4.35	M/uL		4.00 - 5.60
HGB	14.5	gm/dL		12.0 - 16.0
HCT	41.7	%VOL		35.0 - 50.0
MCV	96	fl		82 - 98
PLATELETS	210	K/uL		140 - 440
MCH	33.3	pg		26.0 - 36.0
MCHC	34.7	g/dL		27.0 - 36.0
RDW	12.0	%		9.0 - 18.0
MPV	7.4	fl		6.0 - 12.0
NEU%	42.3	%		45.0 - 65.0
LYMPH%	38.6	%		20.0 - 50.0
MONO%	14.3	%		0.0 - 11.0
EOS%	3.9	%		0.0 - 7.0
BASO%	0.9	%		0.0 - 3.0
NEUT#	0.91	K/uL		2.00 - 8.00
LYMPH#	0.83	K/uL		1.80 - 4.80
MONO#	0.31	K/uL		0.10 - 1.10
EOS#	0.08	K/dl		0.00 - 0.80
BASO#	0.02	K/dl		0.00 - 0.30

- **We classify neutropenia based on NEU# (Absolute NeutrophilCount) not NEU% (Neutrophil percentage)**
- **Leukopenia = low WBCs**
- **Neutropenia = low absolute neutrophils count (ANC)**
- **Leukopenia ≠ neutropenia**
- **Febrile Neutropenia is a medical emergency**
- **Neutropenia classification is based on Absolute Neutrophil count (ANC)**

- **Mild < 1.5 K/uL (1500 cells / MicroL)**
- **Moderate <1.0 K/uL (1000 cells / MicroL)**
- **Sever < 0.5 K/uL (500 cells / MicroL)**

Pancytopenia:

Case: 19 years old lady c.o weakness

WBC	2.8	L	4 – 11	x10.e9/L
RBC	3.2		4.2 – 5.5	x10.e12/L
HGB	92	L	120 – 160	g/L
HCT	36	L	42 – 52	%
MCV	86		80 – 94	fl
MCH	29		27 – 32	pg
MCHC	352		320 – 360	g/L
RDW	14.3		11.5 – 14.5	%
PLT	76	L	140 – 450	x10.e9/L

❖ **What are the common causes pancytopenia?**

- ✓ Bone marrow malignancy
- ✓ Viral infection
- ✓ Drug induced
- ✓ Autoimmune disease

Usually a careful management is warranted in such case.

Good luck